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BACKGROUND DOCUMENT FOR THE:

IN-DEPTH REVIEW OF THE PROGRAMME OF WORK ON THE BIOLOGICAL DIVERSITY OF INLAND WATER ECOSYSTEMS

INTRODUCTION

1. In annex II of Decision VIII/10, the Conference of the Parties decided to undertake an in-depth review of ongoing work under the programme of work on the biological diversity of inland water ecosystems at its tenth meeting. Consequently, this document has been prepared as a basis for relevant consideration by the fourteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA). This document provides, *inter alia*, the background information for document UNEP/CBD/SBSTTA/14/3 and a summary of the information contained here is provided in document UNEP/CBD/SBSTTA/14/INF/3.

2. This document represents a snapshot of relevant information and considerations on this subject. An extended summary is provided for ease of reference, as well as a detailed table of contents. In view of the length of this document it has not been edited nor is it published formally. It serves to provide background information and in particular the sources of information for documents UNEP/CBD/SBSTTA/14/3 and INF/3.

Structure of this document

3. This review is organised into the following sections:

- **Section 1 - Extended Summary:** providing a shorter overview of all of the other sections (listed below). Conclusions drawn are based on documented and referenced sources in the latter sections (unless otherwise stated). The summary is not drafted in the sequence of subsequent sections but attempts to organise the information structured more around Drivers→State→Responses.

- **Section 2:** reviews **The Status and Trends of Inland Waters Biodiversity**. This section is based largely on a collaborative analysis undertaken by the Secretariat and the Secretariat and Scientific and Technical Advisory Panel of the Ramsar Convention. Other sources of information are referenced.

* UNEP/CBD/SBSTTA/14/1.

- **Section 3:** considers **Drivers of Change – Water Resources Use**. This is a detailed section because of the importance of water. Information contained in this section is derived largely from the Third World Water Development Report (WWDR3) (UNESCO 2009) – which is a collaborative effort of all 26 U.N. agencies and programmes dealing with water (UN-Water). The Secretariat was a contributing partner in the preparation of WWDR3. Unless otherwise stated, the conclusions contained in this section are those drawn by WWDR3. Information in WWDR3 is derived largely through analysis of data/experience provided by national governments and draws upon relevant and credible assessments (such as the IPCC, The Comprehensive Assessment of Water Management in Agriculture, World Bank, The FAO etc.) and peer reviewed scientific literature (reference sources are provided).

- **Section 4:** provides a **Synthesis of information contained in CBD National Reports.** Additional information specifically on climate change in relation to the programme of work available from CBD National Reports and Reports of Parties to the UNFCCC is also included in section 6. Information from Ramsar National Reports is included in particular in section 2.

- **Section 5:** provides a brief overview of some activities being undertaken by five large NGOs dealing with inland waters biodiversity related subjects. This includes 50 case studies.

- **Section 6:** deals with **Climate Change**, although it is noted that climate change is a cross-cutting issue and is also discussed in most other sections (particularly section 3).

- **Section 7:** looks at **Responses and Challenges**, although these subjects are also considered throughout other sections.

- **Section 8:** provides references.

4. The review contains < 100 case studies illustrating the points made.

Additional dimensions of this in-depth review

5. Two dimensions of this review are important to mention to enhance understanding of this document. These relate to (i) the need to consider indirect drivers of change, and (ii) in particular, the need to frame water[1] and its role, not only in this programme of work, but across the entire convention.

(i) Indirect Drivers of Change

6. Thorough assessments largely undertaken by other processes, for example the Millennium Ecosystem Assessment and WWDR3, support the conclusion of this review that the conservation and sustainable use of inland waters biodiversity cannot be achieved by managing direct drivers of change (threats) alone. The indirect drivers of change must be factored in, and are arguably more important. A major driver of change is water use and water use is intimately related to sustainable development across all sectors. This makes the consideration of both indirect and direct drivers of change complex. Therefore, significant attention to this aspect is included, in particular in Section 2.

[1] Consistent with UN and worldwide common terminology, "water" in this review essentially means freshwater. It is acknowledged that water participates in the earth's water cycle and therefore at times trascends brackishwater and marine phases, and the ecological nature of freshwater itself can (technically) change through human impacts (e.g., salinsation). But we are dealing here with water in the context of how it drives terrestrial and inland water ecosystem ecology, and in particular, water in the context of human development.

(ii) Water

7. Water is a central dimension of this review. It is obvious that changing water availability and condition is a major driver of changes in inland water ecosystems. But the relationship is a recriprocal and complex one because:

(a) Water participates in the water cycle – a dynamic process which involves water flows and recycling through the atmosphere, ground and surface waters and ice.

(b) The availability of water, and its condition, is a service provided by ecosystems, underpinned by biodiversity. For example, a key wetland function (service) is in supporting the water cycle. But the inter-relationships go well beyond wetlands. For example, a global average of 60% of preciptation (rainfall) on land arises through evapo-transpiration (that is – largely through terrestrial plants, particularly forests).

(c) Water is central to ecosystem functioning. Obviously, inland waters biodiversity depends upon it – but so too do *all* terrestrial lifeforms (and quite a few marine ones). For example, deteriorating functions of inland water ecosystems have serious consequences for terrestrial ecosystems.

8. Whilst this review focuses as far as possible on "inland waters biodiversity", because of the above relationships, the topic transcends many other areas of the convention. This is not so much "unavoidable"- but rather essential. This is the major finding of this review and ways and means to address this the major consideration regarding recommendations.

9. The relevance of the water cycle is explained further in the introduction of the extended summary (Section 1).

Acknowledgements

David Pritchard and Nick Davidson (Ramsar STRP) for contributions in particular to Section 2.

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I. EXTENDED SUMMARY

A. Introduction

1. ***Water is central to biodiversity and vice-versa.*** Recognising the role of water in ecosystems, and the role of inland water ecosystems in this context, is a fundamental aspect of this review. The earth's water cycle connects ecosystems, and those ecosystems drive the water cycle (Figure 1).

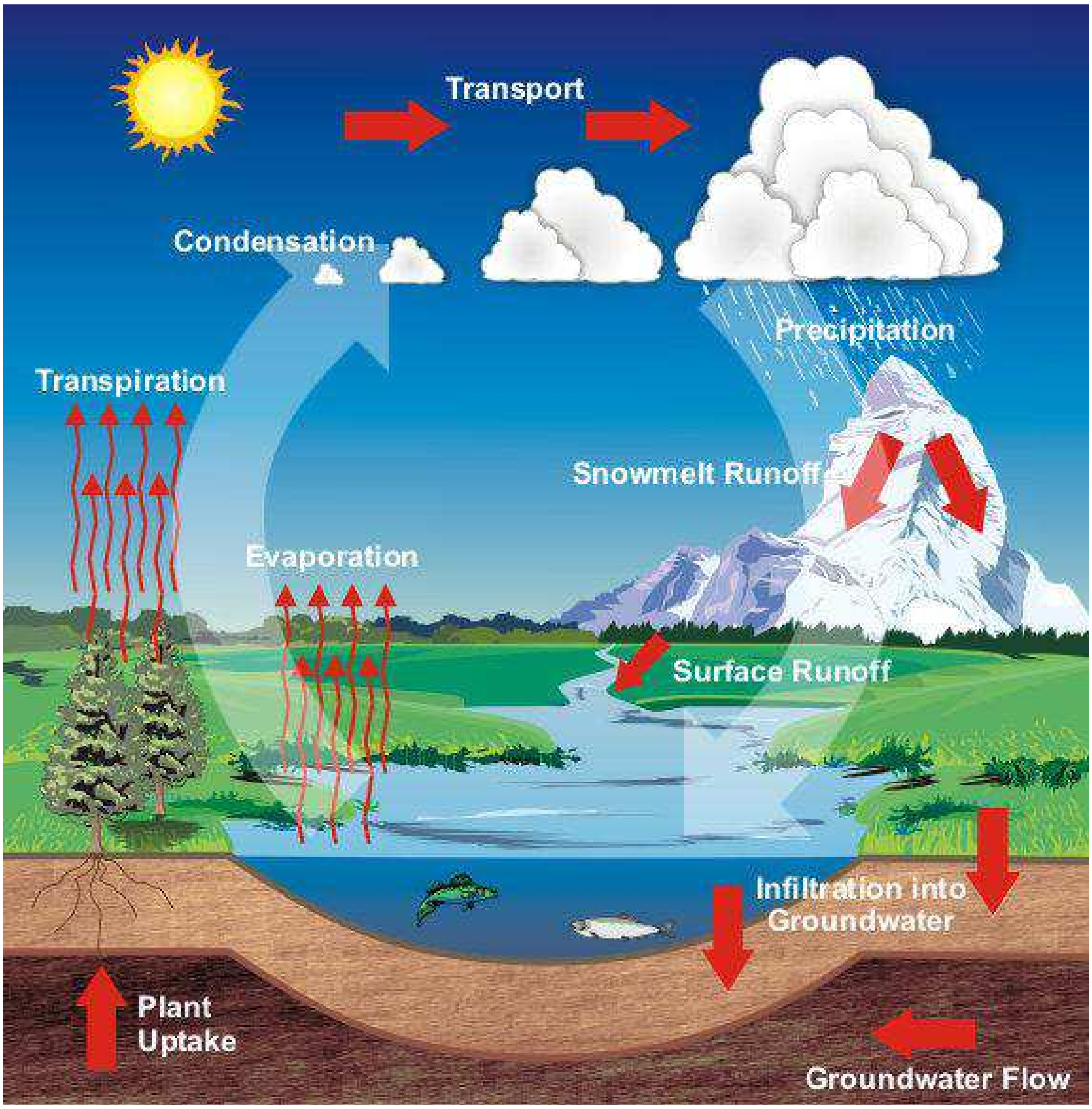


Figure 1: The (simplified) water cycle on earth. A more complex graphic would include additional inter-relationships with estuaries and coastal zones and include human dependency on water.

2. Figure 1 represents the context in which "the biological diversity of inland water ecosystems" must be viewed – including the way in which the water cycle creates inter-dependency between all terrestrial and

freshwater ecosystems, and many aspects of coastal ecosystems, and the role of water in sustainable development.

3. Water availability, and the condition of it, is a service provided by ecosystems and ecosystems depend upon it. This applies to the quantity, timing and distribution of the availability of water, and its quality for both ecosystem and human purposes. Wetlands are critical in this context. But terrestrial ecosystems are also part or this cycle – they influence it and depend upon it. For example, whilst water regulation is a critical service provided by wetlands, an average of 60% or precipitation on land, hence recharging wetlands, arises from evapo-transpiration through terrestrial vegetation, particularly forests. Land-based human activities influence all these factors and largely determine the quality of water (e.g., pollution, eutrophication, siltation).

4. The contemporary water cycle, and hence freshwater resources, are defined by the interaction of natural and humans factors. It is insufficient to view water from purely a biogeophysical perspective, as humans are deeply embedded into contemporary water systems on Earth. Water is an essential component of the Earth system, unifying the climate, biosphere and hemolithosphere of the planet. The importance of freshwater, which strongly limits productivity and supports critical habitat and biodiversity, is evident throughout the biosphere. These phenomena collectively define the contemporary water resource challenge, as they have for millennia, with humans struggling to stabilize and make available adequate water in light of an unforgiving climate, as well as failed governance and mismanagement, leading to depletion and pollution.

5. ***Water is central to development.*** There are already major global problems regarding the use and availability of water. Ongoing changes in the global hydrological cycle through direct human interventions are causing major disturbances to biodiversity. Potential implications for sustainable development are astonishingly clear, and are already being seen.

6. ***Water is our most valuable natural resource.*** Water is recyclable but not replaceable. Useable water is extremely finite; its distribution very uneven (including nationally). ***Sustaining water (water security) is widely agreed to be the primary natural resource challenge;*** exceeding the challenge of energy supply, indeed also the challenge of climate change.

7. ***Climate change impacts ecosystems and people primarily through changing the water cycle[2]. Adapting to climate change is primarily about water security.*** Climate change is an additional driver of ongoing hydrological changes. It draws additional attention to challenges already patently clear.

8. . These and other factors make the subject of this in-depth review cut across most other programmes of work. Changes in the extent and functions of inland water ecosystems are driven primarily by activities on land, including water used for land based purposes. There is a feedback mechanism whereby the loss of functions of these ecosystems eventually impacts the activities which drive those changes. ***The limits of sustainable use are already being exceeded, by a considerable margin, at regional scales***.

9. ***The changes occurring threaten biodiversity at regional and global scales.*** For example, groundwater depletion and contamination (through direct use, without considering climate change impacts) threatens terrestrial vegetation (forest included), and the terrestrial fauna which depends upon it, sometimes at continental scales. Excess use of groundwater in many large-scale coastal cities (Lima, Jakarta, Chennai, Tel Aviv, etc.) has depleted local aquifers and allowed seawater to intrude and salinize

[2] The only major global impact of climate change identified in this review which is not due to hydrological change is ocean acidification and coral bleaching (although exceptions occur at the local scale).

these aquifers. The implications of these considerations extend to the undermining of sustainable development. They question the sustainability of climate change mitigation efforts through REDD. In short, this subject touches on the issue of sustainability of the entire planet.

10. Addressing the issue of sustainability of inland water ecosystems cannot be achieved by managing the direct drivers of change alone. Major indirect forces are at play in economic, social and political contexts. ***The indirect drivers of change must be addressed*** and factored into assessments and solutions derived from these. Competition for water exists at all levels, and is forecast to increase with demand in almost all countries; in 2030, 47% of the world population will be living in areas of high water stress. Water management around the world presents major shortcomings in terms of performance, efficiency and equity. Water-use efficiency, pollution mitigation, and implementation of environmental measures are low in most sectors. Access to basic water services – for drinking, sanitation and food production – remains insufficient in a large part of the developing world, and more than 5 billion people, 67% of the world population, may still be without improved access to sanitation in 2030 (meaning that inland water ecosystems will have to continue to deal with this pollution).The conflict between agriculture and cities (urban and domestic sectors) is paramount. This reflects the fact that half the world lives in cities, a percentage due to increase in the future, while agriculture is generally the largest user of water.

11. ***A "water perspective" enters this review not because it is "unavoidable"- but because it is essential.*** Certainly, it adds complexity; water is a complex subject and therefore challenges to, and solutions for, "the conservation and sustainable use of inland waters biodiversity" no less complex. But there are challenges that fundamentally astonishingly clear, and simple intelligent solutions for them. An overarching message is that science and technology helps, but it is in the fields of awareness, institutional reform and change, capacity, policies, and financing where the greatest progress towards sustainability is on offer.

12. Some of the issues and solutions are beyond the immediate remit of the CBD. The review process must therefore consider where and how the CBD can contribute to addressing the broader challenges. Strengthening "conservation" efforts to stem the tide of loss of biodiversity is an obvious and necessary response. But water is so important that few doubt the winner in a race between "conservation" and "development". This is already self evident. The opportunities lie in shifting to an "ecosystems" based dialogue in the context of sustainable development. In practical terms, and to influence financing policies, that means going to the development table with better, cheaper and more sustainable solutions to water problems.

13. It is easy to be pessimistic. Inland water ecosystems lay claim to ***the fastest rate of loss of biodiversity*** compared to both terrestrial and marine biomes and probably ***the most rapid acceleration away from the 2010 target***. There are dire prospects for inland waters biodiversity, if not entire ecosystems. There are considerable doubts whether existing conservation efforts in inland waters are sustainable, overall, let alone when factoring in trends in drivers of change. For example, there is strong evidence that even many of the world's premier wetland protected sites are under escalating threat. The situation in many non-protected areas is much more unequivocal – there is increasingly little left to protect. Neither is it particularly clear whether global sustainability is actually achievable, given the near impossibility of reducing global impacts on water. Sustainable development must sustain water and the ecosystems which supply it and depend upon it – or water will level sustainable development by imposing its own limits.

14. But there reasons for hope. One is, perversely, that the history of water shows that better management arises from crisis, and the obviously increasing crises suggest that better management is inevitable (but at

what cost?). It is clear that the functions and services provided by inland water ecosystems in many cases can be restored, and relatively quickly since they tend to be adapted to natural change and hazards (particularly so for rivers); but disturbingly this is not the case with groundwater quality. We have many tools and approaches that work and many signs of better policies emerging. The issue is clearly not what will happen but what do we want to happen – and how serious are we about ensuring it.

15. ***This review presents the convention with considerable opportunities.*** The approaches to major resource issues identifiable in this review, backed up by a solid case study evidence base, demonstrate solutions at the forefront of the convention's interests. These include, as examples: how to use biodiversity to save a lot of money (on the scale of billions of dollars, even in a small watersheds); one of the best arguments, and most easily understood if well articulated, to influence economic policy, including in major fora such as the G8; examples of small village communities responding to increasing local disasters, exacerbated through climate change, by using their own initiative and resources to restore local river functions; potential low cost solutions to address vulnerability of countries to disaster risk, the continued existence of which sustains a 14% reduction in GDP in the least developed amongst them; post conflict social and cultural reconstruction (including in Iraq); enhanced international cooperation in conflict zones (including between North and South Korea); water supply as a primary motivation for the protection and management of forests, globally; effective institutional reform; enhanced international cooperation amongst riparian river States leading to sustained conflict reduction and increased stability and prosperity; the clearest links between cities and their dependence upon ecosystem functioning beyond their boundaries; the driving force behind policy shifts in major countries towards ecosystem rehabilitation and the wiser use of natural infrastructure; some of the best examples of payments for ecosystem services schemes, and well advanced incorporation of PES approaches into regional water conventions compared to the progress in the CBD; clear south-south cooperation opportunities; strikingly obvious links between biodiversity, poverty reduction and sustainable development; increasing public awareness and concern over natural resources (three times as many Americans worry about water compared to climate change); probably the highest natural resource issue on the world business agenda and some of the finest examples of the business sector developing its own, often voluntary, solutions to contribute to sustainability; by far the clearest platform linking the objectives of the MEAs, in particular the UNCCCD, UNFCCC, CBD and Ramsar Convention; driving universal consensus amongst the U.N. agencies about what the priorities regarding climate adaptation are; and, last but not least, consistently generating the highest values in comparative assessments of ecosystem services across all biomes.

16. These claims are not all exclusive to this programme of work. Wider influences are often in play. But they are claimed universally by ***water.***

17. ***These, and other, findings are unequivocal***. There is also clear evidence of lack of appropriate attention to them in major forums, including very clearly the CBD, international and regional processes and at national level. But not always. Many of these processes have got it right. Examples of good practice abound. Achievable solutions are identifiable. But the current status and trends of resources and drivers, not to mention the likely, if not certain, scenarios for these, is a wake up call that now ***everybody needs to get it right***.

18. ***Major changes in policies, approaches and priorities are required to achieve this.*** The task before SBSTTA is to reflect on how this can best be done.

B. Indirect drivers

1. Population and macro- economic trends

19. There is general agreement that population growth, economic growth, urbanization, technology and changes in consumption patterns are the main factors influencing water use, and therefore the biodiversity associated with it.

20. Population dynamics (growth, gender and age distribution, migration) create pressures on freshwater resources through increased water demands and pollution. Changes in the natural landscape associated with population dynamics (e.g., migration, urbanization) also can create additional pressures on local freshwater resources and the need for increased water-related services. The world's population, currently estimated at 6.6 billion, is growing by about 80 million people each year. This number implies an increased demand for freshwater of about 64 billion cubic meters a year. The distribution of age and gender also can have considerable implications for consumption and production patterns.

21. The year 2008 marked the transition from a rural dominated world to an urban dominated world, as the world population was estimated to be equally split between urban and rural. By 2030, the towns and cities of the developing world will make up 81% of urban humanity. But in spite of the great deal of attention that is given to megacities, most of the world’s urban populations actually live in cities with less than 500,000 inhabitants. The growth of small and mid-size cities will have significant impacts on water resources. Sustainable water supplies for these urban populations, and reducing their water footprints, is already a major global challenge.

22. An increasing standard of living has major implications for water resources. The consumption of consumer goods, energy and food are major indirect drivers of water use and consequently impacts upon inland waters biological diversity. The trend of increasing consumerism around the world is evidenced with the 25 members of the Organization for Economic Cooperation and Development (OECD), which collectively consume about half of the world’s energy (which is related to water use). Changing consumer preferences for food is possibly a more worrying water-related driver than simply increasing demand for basic staples. Foods preferred by more affluent societies (such as meat) – are generally very water demanding. The result is a continuously increasing demand for finite water. The outcome is already evident and escalating - overexploitation of aquatic ecosystems, as each sector or user group tries to satisfy its own water needs at the expense of others.

23. Expansion in the global economy has a major impact on water – through the growth in the number of consumers, changes in their consumption habits, changes in the way goods and services are produced, and shifts in the location of activity, which affects international trade. What transforms water into a global issue is the trade in goods and services that have a water content (often referred to as “virtual water”). Global water saving as a result of international trade of agricultural products has been estimated at 6% of the global volume of water used for agricultural production. An estimated 16% of the existing problems of water depletion and pollution in the world relate to production for export. The prices of the traded commodities seldom reflect the costs of water use.

24. Water in all its aspects is being increasingly viewed as a potential threat and constraint to economic growth. As an example, China’s remarkable economic growth has translated into serious environmental problems, notably rapid wetland degradation and loss, serious water shortages in the North, and pollution from wastewater effluent across the country (and as noted positively elsewhere in this review China is already making major policy shifts to respond to these trends).

25. Few sectors or economic activities, if any, do not rely on water nor have an impact upon it. The tourism sector is a case in point. It is a significant factor of growth of domestic water demand and can lead (on coastlines, islands or mountain areas) to supply difficulties in peak seasons. Around the Mediterranean Sea, for example, it is estimated that seasonal water demands from the tourism industry increase annual water demands by 5 to 20 fold.

26. Water footprints are estimated by multiplying the volumes of goods consumed (whether produced or manufactured) by their respective water requirement. The United States appears to have an average water footprint of 2480 m^3/cap/yr, while China has an average footprint of 700 m^3/cap/yr. The global average water footprint is 1240 m^3/cap/yr. But footprints can be externalised. For example, that of European and North American citizens has been significantly externalised to other parts of the world. Europe is a large importer of cotton – one of the thirstiest crops produced in many water scarce areas. European consumption strongly relies on the water resources available outside its boundaries and thereby influences agricultural and industrial strategies elsewhere. About 80% of the virtual water flows (water imported embedded in the crops transported) relate to the trade in agricultural products. An estimated 16% of the existing problems of water depletion and pollution in the world relate to production for export. The prices of the traded commodities seldom reflect the costs of water use in the producing countries.

2. Domestic water supply and sanitation

27. Globally, neither sanitation nor domestic water, in particular for drinking, are major consumers of water per capita (compared to other sectors); although they can be big users locally, particularly in cities. And both are obviously priorities in relation to human development targets. Relationships between drinking water and biodiversity tend to be reinforcing, in that drinking water supply depends on a clean environment. Lack of sanitation remains a major source of water contamination globally and an improvement in sanitation is effectively a reduction in this direct driver of biodiversity loss. The bulk of human excreta is still basically released directly into the environment, and recycled there (although often beyond the capacity of ecosystems to cope). Both topics are discussed further below in relation to water quality.

28. While rapid progress has recently been made in drinking water supply in all regions, except sub-Saharan Africa, sanitation is still lagging behind. Except for sub-Saharan Africa and Oceania, all regions of the world are on track to meet the MDG drinking water target. However, if current trends continue, 2.4 billion people will still be without access to basic sanitation by 2015.

3. Agriculture and food consumption patterns

29. Water is essential for the production of food and agriculture is by far the greatest consumer of water, estimated at about 70% of all water consumption. The importance of agriculture to an economy and the extent of irrigation clearly create a divide between countries in terms of water use. In the first group of countries (comprising Africa, most of Asia, Oceania, Latin America and the Caribbean), agriculture is by far the main water-use sector, while in the other group (Europe and North America) withdrawals are mostly related to industry and energy – up to 59%. The demand for domestic supply is essential to life (drinking, hygiene and bathing) but remains the smallest for both groups.

30. The environmental limits of hydraulic systems are being reached in an increasing number of places. Increasing water scarcity and concern for environmental sustainability now constrain further development of water for agriculture, and in places, competition from other sectors leads to a reduction of volumes allocated to agriculture. Without further improvements in agricultural water productivity or major shifts in agricultural production patterns, the global amount of agricultural water demand in agriculture would increase by 70%–90% by 2050, an unsustainable situation.

31. In the Near-East irrigation water requirements are expected to grow from 64% to 83% of renewable water resources – all very high values compared to global averages. Taking into account the expected impacts of climate change by 2050, the situation may become significantly worse. This combined effect would result in an expected additional stress on the scarce water resources of 9%, with total water withdrawals representing the equivalent of 92% of the region's renewable water resources. It may even be higher if we consider also the leaching requirements in agricultural areas affected by salt/sea water intrusion and upwards leakages from brackish aquifers.

32. In large irrigation systems relying for their water on high mountain glaciers, climate changes may influence decisions concerning the construction of new water-control infrastructure to compensate for changes in river runoff.

33. While on average it is estimated that only 37% of all the water withdrawn for agriculture is effectively consumed by crops, a substantial share of the unused water returns back into rivers and aquifers and is available for downstream uses (although often of poor quality). The net loss of freshwater due to irrigation is therefore substantially less than expected and potential gains through programmes aimed at increasing water-use efficiency are often over-estimated. In the current context, it is unlikely that programmes aimed only at reducing losses in irrigation will have a substantial impact on freshwater usage. Reducing pollution from agriculture and thereby sustaining downstream uses is however a more promising approach. The majority of large irrigation schemes also serve other functions, such as providing water for drinking, bathing, swimming, fishing and livestock drinking; savings may take water away from these and therefore ' multiple use' strategies seem to be favoured.

34. Shifting consumer food preferences is a paramount consideration. It is estimated that the production of a kilogram of wheat takes 800-4,000 litres of water, a kilo of beef 2000-16000 litres, and a kilo of cotton 2000-8700 litres and one cup of coffee requires 140 litres of water. The question "how much water do people drink?" (on average, between two and five litres per day each in developed countries) is much less relevant than the question "how much water do people eat?" (according to one estimate, 3,000 litres per day in rich countries). It is estimated, for example, that the Chinese consumer that ate 20 kg of meat in 1985 will eat over 50 kg of meat in 2030. The annual "water footprint" of this change in the diet of the estimated 1.3 billion Chinese people will translate into the need for an additional 390 km^3 of water for its production. This is a formidable additional quantity of required water for a country already experiencing serious water shortages in different regions. It should be noted, however, that these levels of beef consumption in China remain well below those of several other countries. For example, in 2002, Sweden consumed 76 kg of meat per capita and the USA consumed 125 kg.

35. To meet the future food needs and rural socio-economic aspirations of the world, pressure to develop new supply sources or increase water allocation to agriculture will continue. The recent acceleration in the production of biofuels and the prospect of climate change bring new challenges to agriculture and further pressure on land and water resources. Biofuels represent a graphic illustration of the interrelationship between food, energy supply, global warming and water through the impact on water supplies. The production of biofuel requires considerable amounts of water though this depends heavily on the type of crop and the conditions under which it is produced. It takes between 1,000 and 4,000 litres of water to produce a litre of biofuel. Thus, measures taken to tackle energy self sufficiency and climate change can inadvertently add to the gravity of a country's water problem. Despite this, the water dimension of the biofuel, and broader energy, debate continues to receive limited attention.

36. The emergence of an increasing number of areas where water has become a limiting factor for irrigated agriculture, associated with increasing claims for releasing water to guarantee or restore environmental services, has made the food production situation tighter in an increasing number of regions. The Middle East, for example, can no longer satisfy its food requirements and needs to rely increasingly on food imports.

37. If a drive toward food self-sufficiency were to materialize, it would have considerable implications for national water security, and consequently biodiversity, especially in the case of countries located in arid regions. Although they can be highly beneficial for rural development as a whole, by adopting policies for food self-sufficiency, countries also increase their national water footprints as well as forfeit growth in higher income, less water-intensive sectors. There are already examples of countries abandoning food security policies because of these water related considerations.

38. Today's food production and environmental trends, if continued, will lead to crises in many parts of the world. Only through a combination of supply and demand-side measures will it be possible to address the acute freshwater challenges facing humankind over the coming 50 years. The challenge is to manage the additional water needs in a way that minimizes the adverse impacts on, and where possible enhances, other ecosystem services while providing the necessary gains in food provisioning and poverty alleviation.

4. Industry and energy

39. After agriculture, the two major sectors in terms of consumptive use for development are industry and energy, which together represent 20% of total water demands. Water for industry and energy are growing in line with rapid development, and in so doing are transforming the patterns of water use in emerging economies.

40. The power-water nexus is complex. Energy and water are inextricably linked. Water is an integral part of energy resource development and utilization. For example, the total evaporation from reservoirs in the 22 countries of the Mediterranean Action Plan comes to around 24 km^3 per year, nearly the water use of Argentina, of which nearly half evaporates in Egypt. The demand for energy is therefore a major driver of water development, creating pressures which have significant impacts on the quantity and quality of freshwater resources.

41. Cooling in the energy sector is one of the main industrial water users, with a final consumption (evaporation) estimated at around 5%. The cooling of nuclear plants also means that outflows have a much higher temperature, while ecological constraints state that sufficient river flow must be ensured in order to mitigate this impact. As is the case for pollution dilution, this entails the availability of non-directly productive but substantial river flows.

42. The link between energy and water is further strengthened by the fact that the water sector itself is an important user of energy. Energy can represent 60 to 80% of water management costs and 14% of water utility costs. Energy efficiency and conservation are, therefore, not only good for energy resources but they are also a means to conserve water.

43. Electricity generation from hydroelectric and other renewable energy resources is projected to increase at an average annual rate of 1.7% from 2004 to 2030, representing an overall increase of 60% through 2030. This increase is highly significant with respect to its potential impact on water resources.

44. There are a number of complex, and partly competing, challenges associated with energy production, environmental issues and water resources management. The IEA in its 2007 World Energy Outlook

forecasts that fossil fuels represent the brunt of the demand for increased energy resources. However, the pressure for further hydropower development may also increase due to climate change

45. Around 10% of the total energy supply comes from biomass, out of which some 80% comes from ‘traditional’ biomass, in other words, wood, dung and crop residues. These represent a significant part of the energy used in many developing countries. Commercial or ‘modern liquid biofuel’ represents the remaining 20% of total biomass used for energy. Two-thirds of it is made of fresh vegetable material and organic residues used to produce electricity and heat. The remaining part of biomass, amounting to about 5%, is actually used to produce liquid biofuel for transport, and currently accounts for less than 2% of the total needs of transport energy worldwide.

46. The quest for greater energy autonomy amid concerns over the impacts of greenhouse gas emissions in OECD countries has pushed the significant and recent surge in transport biofuel. This new situation has led to increased inter-linkages between food and energy production and possible impacts on natural resources, including land and water. The potential impact of biofuel production on freshwater resources is most severe in places where agricultural production cannot take place without irrigation, while it is practically negligible in places where rainfed production is practiced. In such places it could result in reduced allocation to other crop commodities. This situation has been cited as explaining the current hostility of some of the most arid countries to the global trends towards increased reliance on bio-energy.

47. Like food security, energy security represents a necessary pathway towards GDP growth. The world will need almost 60% more energy in 2030 than in 2002.

48. The degree of water consumption for most industrial uses – apart from what is incorporated in the products – is low relative to agriculture and energy (less than 10% of withdrawals). But use for specific activities can be high. For example, it takes 230,000 litres to produce one ton of steel in the US. High technology industries, increasingly important for many economies, are highly consumptive. Producing one 300 mm silicon wafer consumes 8,600 litres. But industrial uses put significant additional pressure on water resources through the impacts of the wastewater discharged and their pollution potential.

C. Direct drivers (threats)

49. Analyses of common characteristics of populations in decline can help to point towards likely sources of the problem, and hence to shape priorities for responses. Declines have been linked to agricultural intensification, wetland drainage and water abstraction, coupled with increasingly severe and prolonged droughts.

50. Conversion (clearing or transformation) or drainage for agricultural development has been the biggest single cause of inland wetland loss worldwide. It is estimated that by 1985, 56-65% of suitable inland water systems had been drained for intensive agriculture in Europe and North America, 27% in Asia, and 6% in South America. In New Zealand recent estimates are that 90% of wetland area has been lost since historical times[4]. Canada's fourth national report to the CBD provides some estimates of wetland loss. For example, for 6 out of 9 categories and regions assessed, historical loss (up to the middle of the 20th Century or thereabouts) exceeds 60%, and 80% for three regions; and 96% of wetlands near major prairie urban centres. Since the 1970s wetlands loss has continued in five selected areas, and in one has been a

[4] Ausseil, A. et al. 2008. Wetland ecosystems of national importance for biodiversity: Criteria, methods and candidate list of nationally important inland wetlands. Landcare Research New Zealand Limited and Department of Conservation, New Zealand.

further 20% loss in ten years (1989-1999). The construction of dams and other structures along rivers has resulted in fragmentation and flow regulation of almost 60% of the large river systems in the world.

51. There is evidence that the changes being made, and growing pressures from multiple direct drivers, are increasing the likelihood of nonlinear and potentially abrupt changes in ecosystems, which can be large in magnitude, difficult, expensive, or impossible to reverse, and likely to have important consequences for human well-being.

52. The frequency of different types of threat recorded across the global network of over 1,800 Ramsar Sites is reported through Ramsar National Reports. Although there are regional differences, pressures associated with water resources management, land use change (land claim and habitat loss) and agricultural activities are by far the most dominant issues recorded. In Africa in 2007-08, among the "challenges to sites" rated highest by respondents were: effects of land-use practices and activities (on- and off-site), development pressures, changes to the water regime, overexploitation (both legal and illegal), trespassing and poaching. The MedWet (Mediterranean Wetland) Initiative, for wetlands in general not just Ramsar Sites, reports the most frequent negative drivers as urban development/infrastructure (featuring in 57% of responses), urban/industrial pollution (50%), tourism (45%), water abstraction (43%), agricultural intensification (43%), agricultural run-off (40%) and hunting (42%). Concerning trends, negative impacts of infrastructure developments, tourism, pollution and agriculture were reported the most frequently as intensifying overall; although nearly all drivers were reported as intensifying in at least some parts of the area. None was found to be diminishing overall. BirdLife International's Important Bird Area (IBA) programme shows, somewhat disturbingly, that every one of the IBAs/Ramsar Sites in the sample was recorded as subject to some level of threat. 59% were recorded as subject to "high" threat levels, 18% to "very high" levels, and just 6% to "low" levels.

53. Information at national levels supports the observation on trends and drivers. For example, managers of 15 (54%) of Canada's Ramsar Sites reported that there had been a change in the ecological character of their wetland since its designation as a Ramsar Site, and identified "effects of land uses, activities or practices (on-site or surrounding)" as the top management challenge.

54. The story these data tell is that even the world's most prominently protected wetlands are seemingly all still subject to some kind of threat, with over three-quarters of the sample tested being subject to "high" or "very high" threat levels. The markedly high frequency of agriculture-related threats is common to both the Ramsar National Reports and the IBA assessments. No regions, and probably few if any individual countries, appear to be exempt from this.

55. Various changes related to reservoirs have occurred, such as dam removals in the U.S., conflicts on reservoir water use between upstream and downstream countries and reservoir sedimentation. Over 25% of about 20 x 109 t y^{-1} of global suspended sediment discharge is thought to be trapped by reservoirs. Although the construction of dams, mostly during the 20th Century, is known to have resulted in a large increase in storage of impounded water over that period, recent trends in global reservoir storage, during a period of reduced dam construction over the last 20 years, is less clear. The change in reservoir storage has been modest over the last decade, and there have been suggestions that a prevalence of drought in key areas of the world may have actually reduced global reservoir storage over the last decade (although not in proportion to the total water available).

1. Water quality

56. The water quality characteristics and the ecological functioning of many of the world's rivers, lakes and other wetlands are now very different to their past, partly caused by changes in flow and partly by inputs of chemical and biological waste from man's activities. Over the past four decades, excessive

nutrient loading has also emerged as one of the most important direct drivers of ecosystem change in inland (and coastal) wetlands.

57. Water quality indicates both major direct threats to the sustainability of inland waters and the effects of unsustainable activities from beyond these ecosystems. For certain contaminants, in particular nitrogen, phosphorous and sediments, water quality trends indicate trends in the water purification related services provided by wetlands. Within limits, aquatic systems are able to manage pollution and hence the water quality of freshwater resources. In some cases, aquatic systems also permanently remove pollutants to the atmosphere, as for example denitrification of excess nitrates. These are important ecosystem services that rely heavily on the characteristics of the water cycle. Changes in the water cycle will inevitably lead to changes in the capacity of natural systems to provide these services.

58. The functioning and integrity of inland waters is an excellent indicator of the status of terrestrial ecosystems more broadly. Water quality in general is directly correlated to the status of inland waters biological diversity. It is a direct driver of biodiversity loss. Greater declines in water quality over time imply movement away from the 2010 target of reducing rates of biodiversity loss.

59. Trends in water quality are however difficult to interpret. Different assessments often produce contradictory results. Much depends on the water quality criteria chosen and method of analysis. Data availability is also skewed regionally and overall continues to be less than ideal. Water quality monitoring is one of the most serious monitoring challenges that the water community needs to address. The increasing pollution threat is evident but hard to quantify globally.

60. The WWDR3 concludes that, in spite of improvements in some regions, water pollution in general is on the rise globally. All economic sectors contribute directly or indirectly to point or non-point sources, and global trade continues to create more pollution and transfer its local impacts. A related trend is the shifting of many industries – some of which are known to be very polluting in nature (e.g. leather and chemical industries) – from high income to emerging countries. The often-serious impacts of polluting activities on human and ecosystem health remain largely unreported or under-reported.

61. The level of pollution is a function of the structure of a country's economy and its institutional and legal capacity to address it. Groundwater systems are the most vulnerable freshwater resource as contamination, once present, is difficult and costly to reduce – if technically feasible at all.

62. The most important water-quality contaminants created by human activities remain unchanged and include microbial pathogens, oxygen-consuming materials, heavy metals and persistent organic pollutants (POPs), as well as suspended sediments, nutrients, pesticides and oxygen-consuming substances, mainly from non-point sources in more affluent counties (particularly from agriculture) but point source contamination continues to be a major problem selsewhere. The most important water quality issue affecting human health is microbial contamination. Inadequate sanitation facilities, improper wastewater disposal, and animal wastes are the major sources of microbial pollution. More than 80% of the wastewater discharged into freshwater and coastal areas in five of UNEP's Regional Seas Programme regions, for example, is untreated, with the figure being no better than 50% in at least eight of the regions.

63. Water quality is not mainly a developing country issue. A recent study on drinking water in a country in Western Europe considered that more than 3 million people (5.8% of the national population) were exposed to drinking-water quality that does not conform to WHO standards (for nitrates, non-conformity above 50 ml/g were found for 97% in groundwater samples).

64. The most prevalent surface freshwater quality problem on a global scale is eutrophication, due to excessive nutrient inputs (particularly nitrogen, but also phosphorous). It is estimated, for example, that the nitrate load in the 80 main rivers flowing into the Mediterranean Sea doubled between 1975 and 1995.

65. Eutrophication is evidenced by increasing harmful algal blooms. Cyanobacteria, the main culprit, have increased in freshwater and coastal systems over the past two decades. There are global warming implications associated with this phenomenon, as cyanobacteria have a competitive advantage over other types of algae at higher temperatures. Regional trends have not been assessed but individual countries report rapidly increasing problems.

66. Storm-generated runoff from agricultural and urban areas is the most important non-point pollutant source (e.g. leaching of nitrates with runoff accumulated in rivers) in both developed and developing countries. The US Environmental Protection Agency, for example, indicated that agricultural activities contribute the largest quantity of pollutants to receiving water bodies in the United States, and the situation is probably similar in many other countries.

67. The level of treatment of urban wastewater is far from satisfactory in the world – even in developed countries – but for most countries sufficient data is lacking to adequately report on it. The range of tertiary treatment in Europe, for example, ranges from 3.6% to 90%.

68. Non-point pollution from agricultural land-use practices and urban areas often presents a greater problem in terms of total pollutant loads than industrial point-source pollution – and is certainly more difficult to control when leached into aquifers. Pesticide contamination has increased rapidly, particularly in freshwaters of developing countries since the 1970s, despite increased regulation of the use of these bio-accumulating and highly persistent substances, with the result being adverse effects on the environment and human beings.

69. Total commercial fertilizer consumption in the agricultural sector in some high-income countries has stabilized, or even decreased, since the 1990s, after a period of high growth between 1960–1990. Other countries still exhibit escalating fertilizer use; use could be increased by 50 to 70% by 2025. Information on pesticide consumption is less available, although pesticide consumption has stabilised in France (the world's second biggest user).

70. Mercury and lead from industrial activities, commercial and artisanal mining, and landfill leachates are also major human and ecosystem health concerns in some locations. The UNECE considers that mining activities have severe impacts on water and the environment in Eastern Europe, Southeast Europe, the Caucasus and Central Asia. Emissions from coal-fired power plants are a major source of mercury accumulating in the tissues of fish that reside at the top of fish trophic levels. Today, up to 70 million people in Bangladesh are exposed to water that contains more than the threshold value of arsenic (although in this case the source is "natural" but the problem is driven by lack of alternative water supplies). An additional reason for concern is the large amount of arsenic-contaminated groundwater used for irrigation with the resulting appearance of arsenic in the food chain. Natural arsenic pollution of drinking water is now considered a global threat with as many as 140 million people affected in 70 countries on all continents.

71. A further problem with monitoring water quality and assessing its impacts is the changing and evolving nature of the pollutants involved. An emerging water-quality concern revolves around the potential impacts of personal-care products and pharmaceuticals (e.g. birth-control residues, painkillers and antibiotics) on aquatic ecosystems. Little is known about their long-term human or ecosystem impacts, although some are believed to be endocrine disruptors. Only time and further study will provide

the necessary data and information to further analyse this potential environmental and human health threat.

72. Changing pollution interests, which vary considerably regionally, also result in changing data availability and hinder long-term assessments. For example, many countries no longer report on BOD, making assessments of progress since 2000 more difficult.

73. Polluted water has a high human health cost. One-tenth of the global burden of disease can be attributed to water, sanitation and hygiene, and water/environmental factors. Over 80% of sewage in developing countries remains discharged untreated, thereby polluting rivers, lakes and coastal areas. Almost 80% of diseases in developing countries are associated with water, causing about 1.7 million deaths every year.

74. A growing body of evidence indicates that land-based human activities impart a biogeophysical signal onto river chemistry at the global scale. It has been estimated that only a minority of the world's drainage basins (~20%) have nearly pristine water quality and that the riverine transport of inorganic nitrogen and phosphorous has increased several-fold over the last 150 to 200 years. Multiple human activities lead to additional sources of naturally occurring elements, as well as material not present in nature such as pesticides, endocrine disruptors, and metals. River systems have traditionally been considered as simple transporters of materials, but it is increasingly acknowledged that transformations occurring during water transit through basins have important influences on material fluxes and hence pollutant loads. The quantity and timing of water flows play a central role in determining the mobility of potential pollutant sources and their dilution potential. Where flows decrease they will in turn exacerbate water supply beyond the simple volumes involved.

75. The Biodiversity Indicators Partnership has developed the “Water Quality Index for Biodiversity” (WQIB), which incorporates additional parameters that have relevance for the status of biodiversity. The index includes dissolved oxygen, conductivity, pH, temperature, nitrogen and phosphorus as parameters. Greater declines in water quality over time imply movement away from the 2010 target. The WQIB yields different results according to the analytical approach. Average scores have generally improved in Asia and Oceania and deteriorated in the Americas and Europe, although the rate of decline is slowing there. The WQIB in Africa has been more variable over time, although tending to score generally towards the poor end of the scale. However examining station-by-station trends in WQIB scores over time yields a different picture (a result influenced greatly by Europe where there are a larger proportion of stations with long-term data). In Europe this analysis suggest continuing improvement. In Oceania the number of stations with increasing and decreasing scores is approximately the same, which again contrasts with the results above. Findings for Africa and the Americas (majority of stations declining) and Asia (small majority improving) are more consistent with those based on average scores. These discrepancies are believed to be due to the wide variability that can occur in the number of stations reporting in a given period in each region. Scores are significantly affected by the number of stations involved.

76. Average nitrate concentration in European rivers has decreased by approximately 10% since 1998. The overall trend reflects the effect of measures to reduce agricultural inputs of nitrate. Nitrate levels in lakes are in general much lower than in rivers, but here too there has been a 15% reduction in the average concentration, and a statistically significant decrease at 38% of lake monitoring stations (4% showed an increase). The overall trend is thought to be partly due to lower nitrogen oxides emissions to air. Nitrate concentrations in inland surface waters vary between sub-regional groupings of countries, particularly in the case of rivers. Countries with the greatest agricultural land use and highest population densities (such as Belgium, Denmark and the United Kingdom) generally had higher nitrate concentrations in rivers and

lakes than those with the lowest proportion of agricultural area and population density (such as Estonia, Norway, Finland, and Sweden). The average concentrations in western European rivers as a whole were double those in Eastern Europe, with rivers in the north of the region having the lowest levels. Since the mid-1990s, river nitrate concentrations have reduced by 11 %, 8 % and 6 % in the western, northern and eastern countries respectively.

77. Pollution of groundwater remains an area of significant concern because of significant groundwater dependency and the difficulty of restoration. Nitrate concentrations in Europe's groundwaters increased in the first half of 1990s but appear to have then remained relatively constant. But trends vary considerably by region - 11% of sites where data are available still show increasing nitrate levels. Concentrations of nitrate in groundwater in the different European countries generally reflect the relative importance and intensity of agricultural activities above the groundwater stores. Western and Eastern European countries have relatively high nitrate concentration in groundwater compared to northern countries. Over 60% of countries with available information for 2005 had groundwater sites exceeding the parametric value (EU Drinking Water Directive 98/83/EC) of 50 mg/l NO_3.

78. Phosphorus concentrations in European rivers and lakes have generally decreased during the last 14 years, reflecting the general improvement in wastewater treatment and reduced phosphate content of detergents over this period. During the past few decades there has also been a gradual reduction in phosphorus concentrations in many European lakes. The improvements in some lakes have generally been relatively slow despite the pollution abatement measures taken. As treatment of urban wastewater has improved and many waste water outlets have been diverted away from lakes, phosphorus pollution from point sources is gradually becoming less important. Agricultural sources of phosphorus are still important and need increased attention.

79. Industrial wastewater, expressed in terms of the volume of Biological Oxygen Demand (BOD) per year, has reportedly stabilized over the past 20 years in industrialized countries, or even decreased slightly, as seen in Eastern Europe. But such reports mask increasing localised problems and expanding impacts of river water quality on lakes and coastal zones. Lake Erie’s oxygen-depleted bottom zone, for example, has expanded since 1998, with negative environmental impacts on the lake’s fisheries. The eastern and southern coasts of North America, the southern coasts of China and Japan, and large areas around Europe have also undergone oxygen depletion. In addition, the world’s second largest ‘dead zone’ has appeared off the mouth of the Mississippi River in the Gulf of Mexico, attributed to excessive nitrogen loads from the river, and with negative impacts on biodiversity and fisheries. The projected need for increased food production, as well as increasing wastewater effluents, associated with increasing population over the next three decades, suggests an increase in the river input of nitrogen loads into coastal ecosystems of 10–20%, continuing a trend observed between 1970 and 1995.

2. Sediment

80. From a global perspective recent increases in soil loss are likely to have been at least partially offset by reduced erosion in other regions, as a result of the implementation of soil conservation programmes and improved land management during the 20th century. The sediment load of a river is sensitive to a range of environmental controls, related to both supply of sediment to the river and its ability to transport that sediment. Available data emphasize that important changes are occurring. Many rivers around the world provide evidence of reduced sediment loads in recent years, primarily as a response to the construction of dams along their courses, which trap a large proportion of the sediment load previously transported by the river. More than 40% of the global river discharge is currently intercepted by large dams. The Nile and the Colorado Rivers provide examples of where sediment trapping by dams has reduced the sediment load to near zero. Globally, fully one-third of sediment destined for the coastal zones no longer arrives there due to sediment trapping and water diversion, with concomitant increases in

the net erosion of sensitive coastal settings like deltas that require a steady supply of land-derived sediments.

3. Trends in water use

81. At present, around 3 billion people are suffering from chronic blue water shortage; however, if green water is accounted for, this figure drops to about 300 million, thus arguing for the consideration of green water as part of the water resource planning process.

82. In 2030, 47% of the world population will be living in areas of high water stress.

83. The ratio of water withdrawal to water availability on an annual basis is used as an indicator for both the Millenium Development Goals and Commission on Sustainable Development processes to monitor human pressure on water resources. An increasing number of river basins do not contain sufficient water to meet all the demands placed upon them, and competition among users can be intense. But available information fails to reveal the realities of scarcity occurring at local or basin levels. This is particularly true in large countries such as the United States, where water use accounts for only 25% of the available resources. But a very different reality inside the country's boundaries and indicates that water stress and shortages exist on large regional scales.

84. Losses have adverse effects on livelihoods and economic production and in some cases, ecosystems have passed thresholds through regime shifts, leading to a collapse in ecosystem services, making the cost of restoration (if possible) very high.

85. There are increasingly frequent instances where consumptive use and water diversion have contributed to severe degradation of downstream wetlands or closed seas. Emblematic examples include the shrinking Aral Sea in Central Asia and Lake Chapala, the world's largest shallow lake in Mexico. Some of the largest rivers have become small streams close to their mouth (e.g. the Nile River, Colorado River, Yellow River, Murray-Darling River, etc.), and flows are no longer sufficient to maintain aquatic ecosystem health. Water regulation and drainage for agricultural development are the main causes of wetland habitat loss and degradation.

86. Groundwater has major implications for biodiversity related considerations across many fronts. Ground and surface waters interact. They are both part of the same hydrological cycle. Wetlands recharge groundwater and *vice versa*. In addition, most (if not all) terrestrial vegetation is dependent on groundwater – even in water abundant areas (for example during seasonal periods of rainfall shortage, even if brief). There is growing evidence that groundwater depletion is already having major impacts on terrestrial ecosystems. And, *vice versa*, that restoring groundwater restores terrestrial vegetation. In Azraq, Jordan, for example, groundwater use for cities and agriculture has resulted in the desiccation of a Ramsar wetland associated with a high biodiversity and migratory birds.

87. The development of the energised pump in the mid-20th century led to the emergence of many groundwater-dependent economies. A sobering conclusion drawn from detailed local aquifer studies is that where groundwater services are in heavy demand, much of the good quality groundwater has already been used. Contemporary recharge to shallow aquifers has become seriously (perhaps irrevocably) polluted, and relaxing abstraction and pollution pressure on aquifers will take considerable time. Irrigated agriculture is the principal user of the major sedimentary aquifers of North America, North Africa, the Middle East and the Asian alluvial plains of the Punjab and Terai. But less evident is the conjunctive use associated with the concentration of irrigated agriculture and urban development in many alluvial

fan/delta environments (such as those of the Mekong, Yangtze, Yellow River, Chao Praya, Godavari, Krishna, Indus, Narmada, Ganges/Brahmaputra, Nile, Mississippi, Po, etc). Reducing stress on these groundwater systems involves more than just 'groundwater resource management', and will also entail reducing land-based pollution, rehabilitating degraded habitats, and conservation of freshwater resources. The agricultural demand for groundwater has often been spurred by both explicit and hidden subsidies for rural electrification, irrigation equipment and occasionally water well construction. Subsidised rural electrification in South Asia has been a key driver of groundwater use within existing irrigation demands and especially in 'dryland areas' with no surface water services.

88. Groundwater is a major source of urban water supply around the world (not just in mega-cities but also in thousands of medium-sized towns). An intimate but often little recognised interrelation between groundwater and urbanisation exists through the cycle of urban development. Some cities (e.g. Mexico DF, Lima, Dhaka, Beijing and Lusaka) are located on or near major aquifers and the corresponding urban water utilities have drawn heavily on groundwater for their supply. In others (e.g. Buenos Aires, Bangkok and Jakarta), the proportion of overall water supply derived from groundwater has reduced greatly as a result of aquifer depletion, saline intrusion and/or groundwater pollution).

89. Groundwater flow processes are usually much slower than atmospheric or surface water processes, often by 2 or 3 orders of magnitude. The groundwater portion of the water cycle has been subjected to massive changes, particularly during the past hundred years since humans have learned to dig or drill wells and abstract groundwater by pumps. In the past fifty years it has become very popular to pump groundwater for irrigated agricultural production. Some 70 percent of the global groundwater abstraction is thought to be used for irrigation, where enormous amounts of water are lost by evaporation and plant growth. Particularly in areas associated with the so-called green revolution, the consequences of heavy groundwater pumping are disastrous: falling water levels, degradation of groundwater bodies and increased salinisation.

90. Sharp points of competition over groundwater resources between urban and rural users are also now becoming more apparent. Expanding municipalities and light industrial/commercial expansion in peri-urban and linked rural areas are competing with agriculture over groundwater quantity and quality. All evidence points to an enormous disconnect between water and land-use regulations, which needs to be resolved in order to implement groundwater quality protection measures. The highest management priority, though, will always be protection of the main recharge zones.

91. Water use is uneven across sectors. Irrigated agriculture is by far the main user of water. It represents 70% of water withdrawals (mainly irrigated agriculture), which can rise to more than 90% in some countries. Although increasing in urbanised economies, industrial (including energy) and domestic usage represents respectively only 20 and 10% of total water use. Groundwater represents already 20% of total use and is increasing fast, particularly in dry areas (CA, 2007).

92. With rapid population growth, freshwater withdrawals have tripled over the last 50 years. This trend is explained largely by the rapid increase in irrigation development stimulated by food demand in the 1970s, and the continued growth of agricultural-based economies.

93. Total global freshwater use by all sectors is estimated at about 4000 km^3 per year and another 6400 km^3 of rainwater is also used 'directly' in agriculture, often called 'green water'. However, it important to reflect that "nature" is still the most important user of water and evapo-transpirates an estimated 70,000 km^3/year from forest, natural vegetation – not cultivated – and wetlands. It is inevitable that as water for humans becomes more scarce human activities will take an increasing share of this, having implications for all biomes. In particular, a worrying potential trend will be to divert green water to blue water flows (for direct human use) by removing vegetation. It is therefore becoming increasingly more critical that

policies and management are better informed about how the hydrological cycle functions and the role of ecosystems and biodiversity (wetlands) in sustaining it.

D. Status and trends of inland waters biodiversity:

1. species

94. While terrestrial and marine ecosystems support a larger percentage of the known species of the world, inland water ecosystems, relative to their area, have on average a higher species richness. Levels of endemism are particularly high in inland wetlands too. About 25-30% of all vertebrate species diversity is concentrated close to or in inland waters. Some 40% of known species of fish inhabit inland waters (more than 10,000 species out of 25,000 species globally). It is anticipated that the number of aquatic animals is in truth far higher than current estimates, given a lack of information about some taxa - for example, about 200 new species of freshwater fish are described every year.

95. There is increasing evidence of a rapid and continuing widespread decline in many populations of wetland-dependent species. Based on most indicators and comparisons, as with the wetland ecosystems themselves, the rates of decline in status of wetland-dependent species (inland waters species in particular, and coastal waterbirds too) continue to be worse than those dependent on other ecosystems.

96. The results in the 2008 Living planet index show an average decrease in the populations of the inland waters/freshwater species studied of 35% over the years 1970-2005 (with 95% confidence limits ranging from 10% to 52%). According to these results, inland water species have an overall worse status than the terrestrial and marine species studied (for which the index figures show average declines of 33% and 14% respectively over the same assessment period). It is clear that some of the most serious conservation problems depicted by the LPI relate to species inhabiting inland water systems. This observation is generally confirmed by a number of rigorous regional or national assessments.

97. Waterbirds are widely regarded as useful indicators of wetland ecological status. Throughout the world, considerably more waterbird populations are decreasing than increasing. This pattern holds for several different groups of waterbirds. Regional ratios vary according to the assessment. For one: in Oceania 3.8 times as many populations decreasing as increasing; in Asia, 3.7 times as many; in Africa, 2.8 times; in the Neotropics, 2.2 times; and in North America, 1.1 times as many. Another assessment of waterbirds showed for the 1,200 (52%) of the world's waterbird populations for which reliable trend data are available, overall 40% of these are in decline, with 17% increasing and 43% stable (the picture varies regionally and is worst in Asia, where the proportion of all waterbird populations in decline is 59%). Some long-term country-level studies paint an even more dramatic picture, for example a recent review of long-term trends of shorebird populations in eastern Australia reports that migratory populations have dropped by 79% over a 24-year period. The true global situation may be still worse than that portrayed.

98. The 2010 biodiversity target refers to a change in the rate of change. For water bird populations where robust data exist, and recent assessments made, the observed decline is over 2.5 times greater in recent years than before. In respect of the 2010 target, this indicates that not only is the rate of loss of biodiversity in the case of shorebirds not reducing, but on the contrary it has more than doubled over the last 10 years. Nearly all of the calculation methods used show worse rates of trend status deterioration in more recent times compared to earlier times.

2. Ecosystems

99. During the last century river modifications have massively increased in number. As of 2000, there were more than 50,000 large dams in operation and it is expected that demand for reservoirs – of all sizes – will continue to grow, particularly in regions with high water demands and where there is a need to cope with increased variability due to climate change. At present, more than 270 dams of 60 m or over are planned or under construction.

100. The river fragmentation index is an indicator of the importance of the anthropogenic modifications of river regimes. A study in 2005, covering 292 large river systems (representing 60% of the world's river runoff) recorded that over 50% of the systems assessed were affected by dams, and more than one-third, representing over half of the river basin area, were strongly affected by river fragmentation/flow regulation, with only 12% by area being unaffected. This is a likely increase in fragmentation in recent years (although differences in assessments limit direct comparisons). Current estimates are that there are more than 50 000 large dams (>15m height and 3 million m^3 storage capacity), 100 000 smaller dams (> 0.1 million m^3 reservoir storage) and one million small dams (<0.1 million m^3 reservoir storage) worldwide. About 350 large reservoirs are currently under construction in China, India, Southeast Asian countries, Iran, Turkey and in the Middle East. The ecosystems upon which impacts are strongest are wetlands, but terrestrial ecosystems such as forests and grasslands are also affected.

101. The speed of change in many ecosystems has increased rapidly, and there is now concern that large-scale changes will increase the vulnerability of some ecosystems to water-related agricultural activities. The non-linear dynamics of ecosystems may lead to abrupt changes that can affect their resilience and their capacity to absorb disturbances.

102. If the rate of input through irrigation exceeds the rate of crop consumption, this can lead to water-logging (when the pores are filled with water and oxygen is lacking) and salinization (when the rising water in the soil profile is bringing diluted salts to the surface). Worldwide, about 10% of all irrigated land suffers from water-logging. As a result, productivity has fallen by about 20% in water-logged areas.

103. Salinization is a worldwide problem, which is particularly acute in semi-arid areas that use lots of irrigation water, are poorly drained, and where the salt is never completely flushed from the land. These conditions are found, for example, in parts of the Middle East, in China's North Plain, in Central Asia, and in the Colorado River Basin in the United States.

104. Data on wetland extent remain poor and this is a critical information gap. Where data do exist, it is apparent that more than 50% of specific types of wetlands in parts of North America, Europe, Australia, and New Zealand have been destroyed during the twentieth century, and many others in many parts of the world have been degraded. There is also ample evidence of the dramatic loss and degradation of many individual significant wetlands and wetland types, such as tropical and sub-tropical swamp forests. On a global scale however there is insufficient information on the extent of specific inland water habitats, especially those of a seasonal or intermittent nature, to quantify the full extent of habitat losses.

105. The nonetheless the review confirms that rates of degradation and loss of wetlands are worse than for other ecosystems; and, where data exist, by a considerable margin.

106. An example of the impacts of development on wetlands is provided by China where one study shows that over 30% of natural wetland area has been lost in the past 10 years alone. It is unlikely that the situation is, or indeed has been, much different in other countries undergoing similar economic development. It is however noted that wetland policies have changed dramatically in China over the same

period, including shifts towards major rehabilitation efforts. The primary motivation for this has been economics/development based – with "biodiversity conservation" as a spin-off benefit.

107. While changes in lake extent over the past few decades have been observed in many parts of the world but the primary factors driving these changes are specific to each region. For example, the surface area of Lake Chad shrank from 23 000 km2 in 1963 to less than 2 000 km2 by the mid -1980s, largely due to drought. The Aral Sea also dramatically declined primarily due to diversions of inflows for irrigation. The Caspian Sea level, which fell 3m between 1929 and 1977, rose again by 3 m by 1995. Changes in total lake area over the last 3 decades of the 20th century have been correlated with the state of the underlying permafrost. In the continuous permafrost zone, total lake area has increased. Meanwhile, in the discontinuous, sporadic, and isolated permafrost of western Siberia, total lake area declined.

108. The European Commission has published figures for the conservation status of habitats which show that around 70% of remaining bogs and freshwater habitats are classed as being in “unfavourable” conservation status (meaning that their range and quality are in decline or do not meet specified quality criteria).

109. Ramsar National Reports tell the story that the overall need to address adverse change in the ecological character of wetlands was in 2005-2008 nearly everywhere at least the same, and in a majority of responding countries greater, than in the 2002-2005 triennium - in other words a net deterioration in wetland conservation status. In three out of six Ramsar regions in 2005-2008 (Africa, Neotropics, North America) a majority of Parties perceived that the need to address adverse change in the ecological character of wetlands in general had increased compared with the previous triennium. In Europe a majority of countries perceived the need as unchanged, and in Asia and Oceania the picture was more equivocal. In Europe the need to address problems remained on average at the same level over this period. However, since these problems include biodiversity declines, this implies that declines continued to the same degree; so even in this “best” region the result amounts to a failure to record achievements in the direction required for meeting the 2010 target.

110. The European Environment Agency core indicator 009 on “species diversity” shows that the 37% decline in wetland dependent species is worse than that for all the other groups. This decline is associated with direct habitat loss as well as habitat degradation through fragmentation and isolation.

111. Habitat loss, and deterioration, remains the primary cause of extinction of freshwater species, the introduction of non-native invasive species is the second most important cause of decline.

E. Progress towards Integrated Water Resources Management (IWRM)

112. IWRM is an approach that assists such decisions by drawing attention to efficient, equitable and environmentally-sound water management. It is a cornerstone of the CBD programme of work on inland waters. And most of the future needs relate to improve and more systematic implementation of IWRM.

113. Examples of the impacts of not having effective IWRM continue to abound. But there is rapidly growing experience with it and after a slow start substantial progress is now being made – even if there is much further to go.

114. The utility of IWRM as a framework and essential tool for effectively managing water resources and water resource issues was endorsed at the 16th Session of the Commission on Sustainable

Development, noting also that the Commission's review on progress in the water and sanitation sector should go beyond mere stocktaking of IWRM efforts.

115. A global target was agreed at the World Summit on Sustainable Development (WSSD) in 2002 to "Develop integrated water resources management and water efficiency plans by 2005, with support to developing countries through actions at all levels."

116. The second edition of the United Nations World Water Development Report (2006) concluded that, while some countries had IWRM plans and policies in place, their effective implementation remained disappointing. A recent United Nations water report made a similar conclusion, noting that, although many countries have progressed in formulating plans and policies, their actual implementation often was lacking, especially in regard to water use efficiency.

117. A survey, prepared and implemented by UN-Water in 2007/08 concluded that for the developed countries, it was found that, out of 27 questionnaires, only 6 (22%) have fully implemented national IWRM plans. A further 10 countries have plans in place and partially implemented. The results for developing countries indicated the proportion of completed plans was significantly higher at 38 per cent, with the Americas at 43 per cent, Africa at 38 per cent, and Asia at 33 per cent. Africa lags behind Asia and the Americas on most issues, although it is more advanced in stakeholder participation, subsidies and micro-credit programs. Asia appears to be leading in institutional reform. Another additional survey finding was that indicators and monitoring could provide countries with a better assessment of their needs to advance in IWRM implementation.

118. A report by the UNU in 2007 points to even slower uptake of the Johannesburg Summit objective stating "Possibly not a single country on earth produced their national plan by the end of 2005".

119. In the third national reports to the CBD, nearly 80% of Parties reported that they had "partially or fully integrated [the programme of work] into IWRM plans". This is inconsistent with the aforementioned more detailed sources of information (which conclude that at that time, mainly up to 2003, most Parties did not actually have such plans in place). Amongst other options for explaining this, it is possible that Parties refer to ongoing planning processes or individual IWRM projects. It is clear that at this stage systematic IWRM plans were generally not in place.

120. But it is emerging that progress in IWRM is now accelerating.

121. Reforms in water resource planning, policy and institutions are ongoing in developed and developing countries. European Union members, for example, are currently implementing the Water Framework Directive. Water reforms also are ongoing in many middle-income and least-developed countries in Africa, Asia and Latin America, many focusing on principles of Integrated Water Resources Management (IWRM).

122. An important rationale behind river basin management units is to improve coordination in water decision-making, having been done in many countries. The European Union Water Framework Directive is a stringent program for establishing sustainable water resources management, with a major impact in countries newly joining the EU, since it mobilizes funding for improved water resources management. The Government of Quebec has deposited a draft water law that identifies river basins as the fundamental water management unit. Utilization of organisations and catchment bodies smaller than the river basin scale may be ineffective. Evidence from countries such as South Africa suggest that some may simply be too complex to implement, with it being difficult to clearly determine what benefits may be obtained. Several river basin organisations have concluded that implementation of river basin organisations is challenging, with considerably uncertainty about their roles and functions when it comes to implementing

integrated approaches to water resources management. The quality of stakeholder participation also can vary considerably.

123. Activities in the São Francisco Basin in Brazil developed a watershed management programme for the Rio São Francisco Basin. The basin traverses 5 states in north-eastern Brazil before discharging into the Atlantic Ocean. A subsequent comprehensive Diagnostic Analysis and Strategic Action Program for the Integrated Management of the San Francisco Basin was completed in 2003, and is currently ongoing.

124. The participation requirements of Article 14 of the EU Water Framework Directive (WFD) are an example of launching a broader discussion about participatory approaches. The RhineNet Project highlights the value of public participation. Experiences show that the amount of time needed for such efforts should not be underestimated. Likewise, experience is showing that communication is a critical instrument in building the knowledge base and institutional and human capacities; in acquiring and disseminating knowledge from across the water sector; and in forging political consensus.

125. The Netherlands is preparing its fifth integrated water management plan, with the potential consequences of climate change high on its management agenda. Its first plan, made in 1968 was essentially supply-driven, addressing only water quantity issues. Subsequent water management plans continued the development of IWRM. The third plan (1989) added in-depth analyses of the role of ecology in water management, while the fourth plan (1998) focused on specific water systems and themes facilitating implementation of needed actions, and clarified institutional roles in the process. With its origins in a technical, supply-oriented, model-based decision process, the planning process is now multi-faceted, with a main pillar being stakeholder involvementand a focus on sustainability and climate proofing related to anticipated future developments. It also has demonstrated that IWRM takes time to develop and implement (more than 30 years in the Netherlands), and that consideration of external expertise and inputs can facilitate the implementation of new concepts in some cases. Many developing countries and economies in transition are working to transform their water management systems into IWRM approaches, incorporating a number of relevant elements, including (i) decentralization (subsidiarity); (ii) stakeholder participation and transparency; (iii) increased commercialization/privatization; (iv) partnerships (public-private, public-public, public-civil society); (v) integration/coordination; and (vi) developing new administrative systems based on river basins/catchments.

126. Analyses of 67 EU projects related to IWRM, spanning the period 1994-2006 suggest that, although it has not yet provided unequivocal guidance regarding the application and implementation of national water planning and reforms, IWRM can provide a useful reform and planning framework. The analyses also indicate that, in order to be most effective, IWRM must consider policy formulation and implementation as a primarily political process involving government officials, the private sector and civil society.

127. Tunisia developed a national water-savings strategy for both urban and agricultural needs at an early stage of water planning, confirming a cultural ‘oasis’ tradition of frugal and patrimonial management of water resources, being a rare commodity in Tunisia. Because of this tradition, irrigation water demands have been stable for the past 6 years, despite increasing agricultural development, seasonal peaks in water demands, and unfavourable climatic conditions (including droughts). Underlying principles of the Tunisian water strategy include: (1) shifting from isolated technical measures to a more integrated water management approach, an example being a participatory approach giving more responsibility to water users (2) gradual introduction of water reforms and adaptation to local situations;

(3) financial incentives to promote water-efficient equipment and technologies (4) supporting farmer incomes to allow them to plan for, and secure, agricultural investment and labour; and (5) A transparent and flexible water pricing system, aligned with national goals of food security, thereby leading to gradual recovery of costs. Wastewaters from urban centres are treated and made available for agricultural use. Further, using a targeted pricing policy, the costs of operating water services are completely recovered, with tourists paying the highest water prices and household users the lowest. Water system monitoring also is extensive, including real time information on all irrigation flows. One result is improved groundwater storage, and vegetation recovery in sensitive natural areas. Tunisia's water resources are still under considerable stress. A combination of increasing population growth and water use in all sectors signals major future threats, being an impetus for considering scenarios to address fundamental future water allocation choices.

128. Although development and application of IWRM is proving more difficult than originally envisioned, the approach was meant to facilitate the mainstreaming of water priorities and related environmental issues within the context of national economic development activities, a goal often considered only after considerable development activities have already been undertaken. However it still is largely an approach managed within the water sector, where it is well understood that water is essential to all life on the planet (human and the other species) and to human livelihoods. IWRM is still seen by many as a technocratic process. There is a beginning of recognition within the sector that it is the decisions by others outside the water sector that determine how water will be used.

129. Coordination with related sectors (i.e., land, agriculture, energy, etc.) is a fundamental requirement for improved water resources use and allocation. Sectoral approaches to water resources management inevitably lead to fragmented, uncoordinated development and management. Fragmentation of the institutional framework and overly complex coordination mechanisms continue to be common characteristics of the water sector in many countries. Weak water governance systems exacerbate competition for this finite resource.

130. Although they can be difficult to establish, effectively managing competing water uses requires clear, widely-accepted rules to allocate water resources, especially under water scarcity conditions. There are ongoing tendencies to ignore environmental concerns. In Chile, for example, the environment is not granted any water licenses. In contrast, decisions-makers in South Africa are determining how to operationalise water law on environmental protection.

131. One means of avoiding conflicts of interests in water legislature is separation of policy, regulation and implementation functions. The Mexican Congress passed the Law on National Waters in November 1992. This new regulatory structure began in 1993 under a programme of survey and registration of ongoing abstractions and disposals, requiring ten years, and a series of intermediate regulatory adjustments and massive information campaigns, to complete the process.

The history of IWRM, in many but not all areas, arises from an initial focus largely on integrating water storage and release, largely from reservoirs.

132. Experience with IWRM is growing, implementation expanding and its scope broadening. In relation to this in-depth review, three major areas of improvement are required. First, to incorporate environmental considerations more fully (in much IWRM they are still almost absent). Secondly, to refocus IWRM on the objective of sustaining the full suite of services that inland water ecosystems provide. The two needs are related in that the "environment" is what drives the shifts in ecosystem services. Using "ecosystem services" as the framework for IWRM requires the process to move away from managing water as a physical commodity to looking at the problem in terms of how we want water to benefit humans, encompassing all relevant benefits that humans derive from it (including biodiversity conservation values). Put another way, it needs to re-orient towards much more socio-economic

outcomes, the platform on which such are based being environmental change and its impact on the ecosystems delivery of services. Finally, the technological aspects of IWRM need to be linked with the societal and political questions that determine the real allocation and management of water resources. This must recognise that many of the drivers of water resource use and impacts arise from beyond water itself. As concluded earlier, the direct drivers (and their impacts, cannot be managed in the absence of consideration of the indirect drivers which are the real key to outcomes for water and the biodiversity associated with it.

F. Economics and financing

133. There are very significant linkages between biodiversity, ecosystems, water and economic development, although "water" continues, too often, to be considered as a physical resource unrelated to the ecosystem which provides it. the Third World Water Development Report makes a convincing case that the availability of water resources and their management is one of the key characteristics that determine the growth strategy of a country.

134. Awareness of the evidence of macro-economic returns of investments in water is growing, and likewise the impacts of not investing. Projections of average annual GDP growth rates across Africa drop by as much as 38% as a consequence of drought variability and even a single drought event within a 12-year period will diminish growth rates across this whole period by 10%. During the decade from 1992-2001, floods comprised 43% of all recorded disasters and affected more than 1.2 billion people. A recent study of the costs of disasters shows that they account for an average continuing annual loss of approaching 14% of GDP amongst the poorest of nations. Actual monetary value of losses is higher amongst richest nations (over US$ 500 billion per annum) because they have more assets, but still accounts for over 5% of their GDP. Most of these disasters are water related (droughts, floods) but there is often little awareness that they are often caused by, or their impact seriously escalates because of, ecosystem degradation (loss of the ability of ecosystems to provide related services – such as flood mitigation). For example, most of the major catastrophic floods of recent years, in developed as well as developing countries, are due in some part (often mainly) to inappropriate wetland management. A significant opportunity is to expand responses to planning for disasters by rehabilitating natural infrastructure.

135. Examples of the economic cost of lack of investment in water provide clear indications of the magnitude of the problem. In Kenya, the combined impact of the winter floods of 1997/98 and drought between 1998 and 2008 has been estimated at US$4.8 billion – effectively a 16% reduction in GDP. The Mozambique floods of 2000 caused a 23% reduction in GDP and a 44% rise in inflation. Inability to tackle hydrological variability in Ethiopia has been estimated to cause a 38% decline in GDP and a projected 25% increase in poverty for the period 2003–2015. More than 7,000 major disasters have been recorded since 1970, causing at least $2 trillion damage and killing at least 2.5 million people.

136. The cost of a series of major typhoons and resulting flood damage in post-war Japan has been estimated at between 5% and 10% of GDP. Rising investment in soil conservation and flood control in response to legislation in the early 1960s saw the impact of flood damage reduced to significantly below 1%. Much, but not all, of the response was through investment in physical infrastructure (dams, river embankments etc.) and the economic feasibility of the balance between the two (natural *versus* physical) has not been made. It is noteworthy, however, that "soil conservation" itself refers to rehabilitating natural infrastructure since the functions of soil include water cycling and other aspects of maintaining the health and functions of inland water ecosystems (in fact soil is part of this ecosystem). In common with the trend

in other richer nations, there is also a shift in the recent decade towards addressing the advantages of managing natural infrastructure more explicitly.

137. The stresses that environmental degradation, including increased vulnerability to disaster, in relation to water entail go far beyond immediate direct or indirect economic costs. To quote the U.N. Secretary General - "Our experiences tell us that environmental stress due to lack of water may lead to conflict and would be greater in poor nations". Water management crises exist locally or are developing throughout most of the world. In just one week in mid-November 2006, national media sources reported local but high-profile shortages in parts of Australia, Botswana, Canada, China, Fiji, Kuwait, Liberia, Malawi, Pakistan, Philippines, South Africa, Uganda, the United Arab Emirates and the United States of America. In accumulation, these crises risk threatening the lives and livelihoods of billions of people and irrevocably change ecosystems. And it is not inconceivable, indeed quite likely without improved approaches, that these tensions will promote armed conflict.

138. Similarly, excessive environmental degradation caused by water pollution and withdrawals also is a source of significant negative economic impacts. For example, the damage cost of this environmental degradation in Middle East and North Africa (MENA) was estimated in 2008 to be of the order of US$9 billion per year, or 2.1 - 7.4% of GDP, with a mean estimate of 5.7%. Meanwhile, industrialized countries are learning the enormous costs associated with some degree of restoration of essential ecosystems. In the USA alone such costs have been currently estimated at $60 billion and will continue to rise as more is known.

139. Expert opinion indicates that poor water, sanitation, and hygiene and inadequate water resources management contributed to 50% of the consequences of childhood and maternal underweight. Estimates of potential environmentally-displaced people range from 24 million to almost 700 million people that could be displaced by water-related factors, including physical infrastructure development projects designed to relieve some water availability stresses in the future. Climate change is likely to result in an overall increase in the displacement of people.

140. Detailed studies point to the dangers of ignoring groundwater issues. A recent study of the water economics of the MENA region noted that groundwater resource depletion appears to have reduced significantly the GDPs of certain nations – Jordan by 2.1%, Yemen 1.5%, Egypt 1.3% and Tunisia 1.2%.

141. History suggests some initial level of economic development may be necessary before attention is given to environmental sustainability. But history may not be the best mentor. The problems are, firstly, that some processes are irreversible (aquifer depletion, contamination, etc.) and secondly, that the state of water resources – and the environment in general – affects the poor disproportionately. Investment in environmental protection, water management, and water supply and sanitation services, among others, can have a high payoff in economic benefits.

142. It is not the case that restoring ecosystem functions (wetland functions) would necessarily have avoided all these kinds of impacts. Neither is it necessarily a universal remedy for all current or future problems and certainly not always a substitute for traditional hard engineered infrastructure solutions. But the magnitude of the issues, and the root causes, warrant that globally a much more holistic and intelligent approach to water and natural infrastructure be taken. It is very clear from case studies that in very many circumstances using (or restoring) natural infrastructure not only works, but can be very cost-effective. And there are many case studies showing that physical infrastructure approaches, on a case by case basis, often do not only fail to deliver development objectives but run counter to them, and can be both expensive and unsustainable.

143. Not always should it be assumed that investment approaches to physical infrastructure are driven by solid economic reasoning. For example, a global report on corruption in 2008 states that corruption in the water sector can raise the investment costs of achieving the MDGs on water and sanitation by almost US$50 billion (over $ 5 billion a year to 2015). One of the major constraints to re-focussing investments on natural infrastructure is the limited corruption opportunities in doing so.

144. Large amounts of investments are required and already being made in water. For example, in the United States one estimate is that bringing water supply and sewerage infrastructure up to current standards will cost more than $1 trillion over the next 20 years, with hundreds of billions more required for dams, dikes and waterway maintenance. The World Business Council for Sustainable Development estimates that the total costs of replacing ageing water supply and sanitation infrastructure in industrial countries alone may be as high as $200 billion a year. Even if 1% of these sums are spent restoring inland water ecosystem functions this represents $2 billion per year (in industrial countries alone) – and, indeed, there is not necessarily evidence that such sums, maybe even more, are not already being spent on this. Meanwhile global estimates of investment requirements in water by 2030, not including for agriculture, in the region of $ 22 trillion have been put forward (in the same range as that required for energy) – a trillion dollars a year (1% of which spent on ecosystems is $10 billion per annum).

145. Such figures are incomprehensible to most of us, vary widely and are controversial (as to precision, but not scale). They serve to illustrate that the primary need related to investment in "inland waters biodiversity" is to make ongoing, planned and future water related investments more intelligent. Achieving this at a success of influencing 1% of investment dwarfs traditional investments made directly in "biodiversity".

146. Valuation of the services provided by ecosystems remains an emerging discipline and the figures generated through such approaches remain subject to much debate. The approach however continues to be useful in providing comparative values between different ecosystem types and their services. Where relevant comparison is made, wetlands continue to generate values higher than other ecosystem types. Broad figures in use by the Ramsar Convention (arising largely from the Millennium Ecosystem Assessment) put the value of wetland services as accounting for 45% of the total global value of US$ 33 trillion annually. These are gross comparisons and do not take into account the fact that inland wetlands comprise less than 6% of the earth's terrestrial area (about 2% of the marine area); on a per unit area basis making them approaching an order of magnitude more valuable than terrestrial or marine systems.

147. The importance of paying attention to valuations was, for example, highlighted in the CBD third national report of Canada where valuations, although problematic, were a key to galvanising increased attention to investment in their management.

Virtually all water-related activities or projects, whether structural or non-structural (e.g., planning, data collection, regulation, public education, etc.) cost money to develop, implement and carry out. Generating the necessary financial flows for investments remains a considerable challenge – even for investments in more traditional ("water sector" related) approaches. An ongoing problem is how to reflect the full suite of ecosystem services provided by freshwater ecosystems in more effective financing frameworks. Even when such is done, financing appropriate responses is by no means easy. The primary need is for relevant financial mechanisms to consider how to incorporate relevant approaches which are sensitive to ecosystem considerations. One increasingly promising approach is to demonstrate how considering natural ecosystem infrastructure can actually lead to financial savings. There is a growing body of case-study based evidence that this often can be the case.

G. Awareness of the issues and their importance

148. The magnitude of the issues at hand, and their importance, prompts the question as to the extent to which they are recognised in relevant agendas at the global, regional and national levels. A brief, and by no means comprehensive, assessment of this issue reveals that in many important circles the required awareness is there but in too many others attention is seriously lacking. The following provides only a snapshot of examples.

149. The gravity of the issues is prominent in many fora. One leading businessman recently referred to water as "...the oil of the 21st century", echoing similar remarks of a former UN Secretary-General that "Water will be more important than oil this century". The heads of African States recently recognized that water is and must remain a key to sustainable development in Africa and states must put in place adaptation measures to improve the resilience of countries to the increasing threat of climate change and variability to our water resources. The Asian Water Development Outlook (2007) emphasises a "multi-disciplinary and multi-sector perspective [on water] around the Asia and Pacific region" and recognizes "the urgent need to address the inherent interrelationships between water and other important development-related sectors, like energy, food, and the environment". The Asia-Pacific region has 500m people still without access to safe drinking water, 1.8 bn without access to basic sanitation, is home to 90% of people affected by water related disasters and two-thirds of the world's hungry and the regions freshwater resources are imperilled by pollution, inadequate management, and climate change. The outcomes of the first Asia-Pacific Water Summit (December 2007) reveals an advanced level of awareness of both the issues and potential solutions, including, importantly, as reflected through its Ministerial Statement. This includes: regarding the environment as part of necessary infrastructure (not as a green "add-on"); recognition of the importance of IWRM as the key to water security (although acknowledging continued difficulties with implementation) and the utility of considering "environmental flows" as one necessary management step (and, importantly, in both, recognising the need to view the problem from the objective of balancing ecosystem services); and the need to develop water catchments whilst "keeping them green".

150. Water has been prominent in the discussions of the Commission for Sustainable Development since its early deliberations and is now largely considered as a cross-cutting issue. The Human Development Report devoted its 2006 edition to water ("Beyond scarcity: Power, poverty and the global water crisis"). It investigates the underlying causes and consequences of a crisis that leaves 1.2 billion people without access to safe water and 2.6 billion without access to sanitation; argues for a concerted drive to achieve water and sanitation for all through national strategies and a global plan of action; examines the social and economic forces that are driving water shortages and marginalizing the poor in agriculture; looks at the scope for international cooperation to resolve cross-border tensions in water management; and includes special contributions from, *inter alia*, four heads of state and the former Secretary General of the United Nations.

151. Resolution X.3 of the tenth meeting of the Contracting Parties to the Ramsar Convention, in adopting the "Changwon Declaration", presented a powerful message in these regards including, *inter alia*, that: there is an urgent need to improve water governance, instead of being demand-driven, which promotes over-allocation of water, water governance should treat wetlands as our "*natural water infrastructure*", integral to water resource management at the scale of river basins, and continuing with "business as usual" is not an option; action is needed to maintain the benefits provided by wetlands for economic development and the livelihoods of people, especially the poor; interrelationships between wetland ecosystems and human health should be a key component of national and international policies, plans and strategies; decision-making should, wherever possible, give priority to safeguarding naturally functioning wetlands; and adequate and sustainable financing for wetland conservation and wise use is essential.

152. The economy-water nexus has permeated thinking at the highest policy-making levels. Delegates at the 2008 meeting of the World Economic Forum in Davos (Switzerland) voiced their anxieties over the impacts of global economic processes on the worldwide availability of food, energy and water. These sentiments were echoed by the 2009 World Economic Forum which noted that "We are living in a water “bubble” as unsustainable and fragile as that which precipitated the collapse in global financial markets", concluding that "We are now on the verge of water bankruptcy" .

153. A recent Gallup survey revealed that pollution of drinking water is Americans’ No.1 environmental concern, with 59% saying they worry “a great deal” about the issue, *versus* just 34% worried about “global warming”. A survey of Fortune 1000 companies revealed that 40% said the impact of a water shortage on their business would be “severe” or “catastrophic,” although only 17% said they have prepared for such a crisis.

154. The fifth World Water Forum (Istanbul, 16-22 March 2009), according to its web-site, was attended by 33,058 participants from 192 countries, including nine Heads of State, 85 Ministers and 14 high level representatives of international organisations (and reported on-site by 1027 accredited journalists). The Ministerial Statement highlights water as a cross-cutting issue and stresses, *inter alia*, the need to intensify efforts to reach internationally agreed upon goals such as the MDGs and to improve access to safe and clean water, sanitation, hygiene and healthy ecosystems, and to further support the implementation of integrated water resources management (IWRM) at the level of river basin, watershed and groundwater systems. The declaration by the Heads of State recognises that: water sustains human life and the environment; it connects people, cultures and economies; water is indispensable for all economic and social development, food security, and ending poverty and hunger. The generalised summary of the meeting ("Water at a crossroads") notes that “Water security is the gossamer that links the web of energy, food, environmental sustainability and human security” and that “We need to build bridges between the water sector and the economic, social and environment sectors.”

155. The level of awareness of, and attention to, the role of ecosystems (and hence biodiversity) in water-related considerations is another matter. Again, this is probably variable. Regardless, these examples show that water is very clearly getting very high on the world political agenda and this in itself presents significant opportunity to seek openings leading to better outcomes for both biodiversity and human development.

156. That there is still much awareness raising to do is illustrated by several relevant arenas appearing to miss relevant points. The Commission on Growth and Development, for example, in its report of 2008, says that we may be entering a period in which natural resources, broadly defined, impose new limits on growth. Interestingly the report makes no major reference to the essential role of water resources. There is still a lack of water as an explicit agenda item in many major summits even though it has strong links with all human development and many more related issues.

157. At a U.N. Summit on June 3-5, 2008 in Rome, Italy, the participants of the High-Level Conference on "World Food Security: the Challenges of Climate Change and Bioenergy" stated their concern. The summit showed how various processes involving food security, climate change, markets, development assistance and energy were interlinked and could aggravate the situation in one sector while contributing to the solution in another. The Third World Water Development Report observed, however, the **lack of water as an explicit agenda item** even though agriculture is the major water user, water is considered by some the biggest constraint to expanding agricultural production, and water also has strong links with both climate change and energy.

158. According to the Third World Water Development Report, few current Poverty Reduction Strategies pay action on water anything other than scant recognition. Unless the growth and poverty reducing contributions of water resources are made more explicit and specific at country-levels, and the role of ecosystems and biodiversity within this better understood, the required development-oriented finances are unlikely to follow. Economic growth has yet to receive much prominence in Poverty Reduction Strategies so there is currently little in the way of a detailed roadmap for water resources development. Only national and local level action plans can secure the necessary alignments between water resources, economic growth and poverty reduction. Forging those alignments within proper frameworks such as a subsequent round of Poverty Reduction Strategies and National Development Plans that are more sustainable growth-orientated will help make essential connections.

159. Very few countries, if any, have a good knowledge of how much water is used and for which purposes, of the quantity and quality of water that is available and can be withdrawn without serious environmental consequences and the loss of essential services that this brings, nor indeed of how much is invested in water management and infrastructure.

H. Climate change

1. Overview

160. Climate change is a cross-cutting subject and most sections of this review make reference to it. Very clear headline messages are derived:

- The impacts of climate change are expressed on ecosystems (and biodiversity) largely through changes in the hydrological cycle (including most changes observed or predicted for terrestrial ecosystems, and many in coastal areas);
- The impacts of climate change on humans are due to ecosystem changes – these are largely driven by water-related changes;
- Water is central to human development;
- Adaptation to climate change, therefore, requires mainly water-related responses;
- The water cycle determines how all terrestrial (and most coastal) ecosystems function. Everything is inter-connected through water (and therefore wetlands);
- *Unsustainable water use and degradation* driven by increasing human demand is *the main driver of adverse water-related ecosystem changes* and subsequent impacts on both humans and biodiversity (including in many cases associated changes to terrestrial areas). Climate change is an additional driver which, by and large, simply exacerbates problems which are patently obvious already; and
- The solutions begin by recognising these realities.

161. What advocacy on climate change has done is to bring to the fore a dire projection of a worsening water situation – a different cause, but the same end result. It is an unfathomable paradox that the world is motivated to respond to the impacts of climate change of the future, yet has remained disinterested in taking the actions needed to meet the rising water crisis that is upon us today.

162. The fundamentals about water and climate change are such that they have even managed to promote consensus in the U.N. system. UN-Water, representing all 26 U.N. agencies and programmes

dealing with water, presented a message to the fifteenth Conference of the Parties to the UNFCCC, basically reiterating the above points, stating under the headline "Climate change adaptation is mainly about water" that "The sense of urgency for climate change adaptation and the recognition of the centrality of water therein have not yet permeated the political world and are not systematically reflected in national plans or international investment portfolios for adaptation".

163. The role of water (and the hydrological cycle) in how freshwater, terrestrial and to a large extent coastal, ecosystems function, the intimate relationships between water and most aspects of human development (including food, drinking water, sanitation, tourism, trade, energy and poverty reduction/livelihoods), and the central role of inland water ecosystems (wetlands) in these, lead to complex inter-connectivity between all these subjects. It is futile, counterproductive and out of context to consider one aspect in isolation from the others. The problem revolves around ecosystems – and the role of water is paramount in this.

164. All terrestrial and inland water (and much coastal) life depends on water. Water is central to sustainable development. These changes in the global water cycle will be far-reaching. They will have significant impacts across most, if not all, programmes of work. Projections from climate scientists and modellers warn that changes in water availability and quality may have disastrous consequences.

165. Wetlands provide a disproportionate amount of production of the ecological goods and services upon which humans depend. Because wetlands are dependent on a single major driver, hydrology, they may experience greater rates of change than terrestrial systems under climate change scenarios.

166. Countries that share water resources may face additional challenges under conditions of changing hazards. There will be great variations in how nations mitigate the hazards that affect international waters. Developing nations that have limited resources and hazard mitigating experience would be the most exposed.

2. Changes to ecosystems and species

167. The findings of the IPCC confirm that water (the changing hydrological cycle) is central to most of the climate change related shifts in ecosystems and human well-being. This reality is evidenced through projected impacts, although this is rarely articulated as such. The IPCC fourth assessment lists 32 examples of major projected impacts of climate change amongst 8 regions (covering the whole earth). Of these: 25 include primary links to hydrological changes; of the other seven, water is implicated in four and two are general; only one refers to main impacts not obviously linked to the hydrological cycle - coral bleaching. Notably, most of the impacts on terrestrial vegetation (and therefore also fauna) are also driven largely by hydrological shifts (changes in humidity, permafrost/snow/ice cover, rainfall patterns and groundwater). The 15th Session of the Commission on Sustainable Development considered climate change based on the findings of an expert scientific group and came to similar conclusions.

168. Significant uncertainties exist with water cycle projections. Many hydrologic processes are highly non-linear. Rapid changes can be anticipated – and possibly worse than projected. Current models are of limited use for local application. But it is clear that all regions need to plan for increasing uncertainty and risk with water.

169. There is a consensus among climate scientists that climate warming will result in an intensification, acceleration, or enhancement of the hydrologic cycle at the global level. The evidence base for this complicated by the fact that direct human interventions have already changed the water cycle

in most regions. The intensification could be, indeed probably already is, evidenced and/or caused by changing rates of evaporation, evapo-transpiration (ET), precipitation, and changes in stream-flow (in some areas). Associated changes in atmospheric water content, soil moisture and groundwater, ocean salinity, and in seasonal changes in glacier mass balance are also implicated. The strength of the intensification response to future warming, indeed any delayed responses to current warming, is unresolved and remains a critical question in assessing the hydrologic response to climate warming. (which are interconnected) through, for example, loss of soil functions (including water retention), decreased water quality and sedimentation in wetlands.

170. Climate change is likely to cause further changes in soil erosion rates, with the increased variability of rainfall and an increase in the frequency of high magnitude storm events resulting in increased erosion rates in many areas of the world. This is of significant relevance to the functioning of terrestrial, inland water and coastal ecosystems. Impacts will vary locally because soil transport by rivers has already been interrupted globally by water management interventions.

171. Water temperature change, globally, is less of a concern than water cycle changes (but not necessarily locally). It will exacerbate many forms of water pollution, promote algal blooms and increase bacterial and fungal content. The concentration of chlorophyll (an indicator of overall ecosystem production) has already increased at an alarming rate in Arctic lakes. Even in temperate regions, blooms of harmful cynaobacteria are already on the rise globally and climate change is implicated. Increased water temperatures are also affecting the growth rates and reproduction of organisms and species.

172. Wetland habitat is increasing in some regions but declining in others in response to glacier and permafrost melt. Most of these changes are likely to be transitional. Many Arctic lakes are expected to dry out completely.

173. There is now solid evidence that glaciers have retreated globally since the middle of the 19th century. This has very serious implications for those ecosystems, and more so people, dependent on seasonal glacial meltwater for sustainable water supplies. Over one sixth of the world’s population lives in areas where surface water is dominantly derived from snowmelt, either seasonally ephemeral snowpacks, or perennial glaciers. This area also accounts for over one-quarter of the global gross domestic product. Therefore, changes in the seasonal patterns of runoff, and/or permanent changes in runoff volume that result from changes in snow cover are of great concern.

174. Permafrost is also expected to degrade rapidly in the 21st century with very significant potential implications depending on how the resulting water participates in the water cycle. This will also expose enormous amounts of carbon to the carbon cycle – particularly in peatlands. Permafrost in North America and Eurasia occurs over the entire Arctic and boreal forest areas and includes the mountainous regions of central Asia, the Tibetan Plateau and high elevated areas of the Himalayas. Estimates include that the volume of excess water as ground ice (not including pore, interstitial, ice) in the Northern Hemisphere range up to 35 460 km^3 or an equivalent of 8.8 m sea-level rise. Seasonal and inter-annual variations of soil water storage within the active layer and seasonally frozen layer in non-permafrost regions can be substantial and have a significant impact on the hydrological cycle in cold regions.

175. Different regions of the world are experiencing different degrees of change related to both climate variations and population and development pressures. In a related way, different regions also respond differently to changes in hydrological extremes:

(a) Deserts face conflicting influences under climate change: potentially seeing more vegetation with higher CO_2 levels, but overall facing increases in drought and warmer temperatures. As ecosystems in deserts are already fragile, impacts could be severe;

(b) Grasslands are influenced by precipitation and even when increased, changing seasonal variability is important, and declining summer rainfall could damage grassland fauna;

(c) Mediterranean ecosystems are diverse and particularly vulnerable to changes in water conditions. Even in the range of 2 degree warming, 60-80% of species may be lost in the Southern Mediterranean, while the Cape Fynbos in South Africa may lose 65% of its species;

(d) Tundra/arctic: with greater warming at the poles, the loss of permafrost and the potential for methane release is a major concern;

(e) Mountains are seeing shortened and earlier snow and ice melt and related changes in flooding. At higher altitudes, increased winter snow can lead to the opposite problem of delayed snow melt;

(f) Wetlands will be negatively affected where there is decreasing water volume, higher temperatures and higher-intensity rainfall; and

(g) The Himalayan region is highly vulnerable to anticipated climate change because the major river systems consist of substantial contributions from the melting of snow and glaciers.

176. Specific impacts on wetlands are projected to include:

177. Initially increased productivity in some mid-latitude regions and a reduction in the tropics and sub-tropics, even with warming of a few degrees;

178. Adverse affects on coastal wetlands and coastal fisheries, e.g. mangroves are expected to decline in many coastal zones;

179. Decreased water availability in many arid- and semi-arid regions; and

180. Increased forest productivity, including that of forested wetlands, although forest management will become more difficult because of an increase in disturbances (pest outbreaks and forest fires). The implications of this on forest evapo-transpiration, and groundwater levels, is uncertain.

181. Overall, it is projected that there will be more adverse than beneficial impacts on wetlands. Inland and coastal systems are likely to experience large and early impacts. These include identifiable changes in coastal wetlands:

182. Increased levels of inundation, storm flooding, accelerated coastal erosion, seawater intrusion into fresh groundwater;

183. Encroachment of tidal waters into estuaries and river systems, and elevated sea surface temperatures and ground temperatures; and

184. Consequent impacts on wetland dependent species, including adverse impacts on marine mammal and bird species, especially migratory and nomadic bird populations that depend on coastal habitats.

185. The Millennium Ecosystem Assessment demonstrated that freshwater ecosystem services are particularly in trouble. This situation is the result of non-climate change factors. Climate change will exacerbate the problems.

186. Increased water demand for consumption and irrigation as a result of climate change will place increased pressure on inland water systems. 54% of accessible runoff is already appropriated for anthropogenic use, declining water availability in desert margins and dryland areas, such as North Africa, the Mediterranean and South-eastern Australia, will likely result in the increased exploitation of aquifers, inland waters and oases. This increased exploitation will have further negative impacts on some riparian systems. Increased irrigation water demand due to climate change in India and China are estimated to range from 1–3% by the 2020s and 2–7% by the 2070s.

187. Sea-level rise will affect a range of freshwater systems in low-lying coastal regions which may be displaced by salt-water habitats due to the combined actions of sea-level rise and larger tidal or storm surges. Salt-tolerant mangrove species could expand from nearby coastal habitats. Many inland water species will also be impacted by changes to the marine environment. For example, increased ocean temperatures are projected to cause population declines in high-Arctic breeding water birds due to fish species shifting toward the poles with cold-water fish being more restricted in their range.

188. Changing grassland functions have significant implications for soil erosion and soil water retention and groundwater (and therefore surface water) recharge and water quality; likewise for forests.

189. While hazards are normally experienced with hydrological extremes, there could be substantial risks to human activities caused by changes in average streamflow, especially in those areas that are already water-stressed. By 2050 the annual average runoff will have increased by 10-40% at high latitudes, and decreased by 10-30% over some dry regions at mid-latitudes and semi-arid low latitudes. However, in many water scarce regions, land use change and increasing levels of water resource development and use could hide the effects of climate change.

190. The response of different sections of river ecosystems to climate change will depend on their location within the river basin. Longitudinal linkages play an important role in the river functioning as an ecosystem. Upper sections of rivers are influenced more by abiotic factors and the biotic structures are better adapted to high abiotic (hydrological) variability, resistant to rapid and unexpected changes, and have a better ability to recover from stress. Down the river course, with stabilizing abiotic characteristics, biotic processes determine ecosystem dynamics, thus the lower reaches of these ecosystems will be more vulnerable to global warming. These processes will contribute to an intensification of eutrophication, a common problem already in lakes and rivers all over the world and a serious hazard for both human activities (drinking water, aquaculture, recreation etc.) and ecosystem functioning/biodiversity.

191. The impacts of climate change on multiple nutrient loading are varied depending on initial local conditions, projected climate change impacts and seasonal variability. Some studies have demonstrated that the annual changes in nutrient loading are, in fact, minimal despite significant changes in seasonal nutrient loading profiles. But in intensively cultivated watersheds, nutrient loading has been shown to decrease as flows increase. Where climate change is acting as a stressor on inland water ecosystems and multiple nutrient loading is increasing, experimental evidence suggests that the two factors will act as synergistic pressures driving algal processes. There is also evidence that increased water temperatures decrease the threshold at which nutrient loads become critical in terms of affecting the health of inland water ecosystems. Many studies suggest that increased attention should be paid to reducing multiple nutrient loading if environmental targets are to be met in inland waters under changing climatic conditions.

192. The expected overall lowering of water levels in rivers and lakes will lead to amplification of already ongoing decreases in water quality. Water reserves will become more turbid through the re-

suspension of bottom sediments and the decrease in water supply will decrease the dilution of pollutants in water resources. Salinity levels will increase with decreasing streamflow in semi-arid and arid areas; salt concentrations are predicted to increase by 13-19% by 2050 in the upper Murray-Darling Basin in Australia. Salinisation of water resources is also predicted to be a major hazard for island nations where coastal seawater intrusion is expected with rising sea levels.

193. For a landlocked country like Nepal, which relies on hydropower generation as a vital source of national income, the prospect of an eventual decrease in the discharge of rivers spells doom. For an energy-constrained economy like India, the prospect of diminishing river flows in the future and the possibility that energy potential from hydropower may not be achieved has serious economic implications. The implications for industry extend beyond the ‘energy’ argument: chemical, steel, paper and mining industries in the region that rely directly on river/stream water supply would be seriously affected. Reduced irrigation for agriculture would have ramifications for crop production leading to impacts on basic human development indices like available food supplies and malnutrition.

194. There are many cases studies showing that climate change is already having an impact on wetland species. We already know that climate change can significantly affect certain groups of species particularly sensitive to changes of temperature such as fishes, reptiles and amphibians. There remains limited robust data on these changes, with a clear bias towards birds – and in particular birds in the Artic region. The loss of aquatic biodiversity through global warming will be mostly caused by shifts of the physical characteristics of ecosystems and shrinking of suitable habitats. Other species will not be able to reach suitable habitats due to increasing disconnections and disintegration of climate and landscape. Rising water temperatures and related changes in ice cover, salinity, oxygen levels and water circulation have already contributed to global shifts in the range and abundance of algae, zooplankton and fish in high-latitude and high-altitude lakes, as well as to earlier migrations of fish in rivers.

195. Without implementation of new conservation measures, these impacts will be severe and are likely to exacerbated ongoing threats from land-use change, water use and associated habitat fragmentation. Unless strenuous efforts are made to address the root causes of anthropogenic climatic change, much current effort to conserve biodiversity will be in vain.

196. We also must ensure that less common physical habitat types, especially wetlands, continue to be protected, and should aim to increase the number of such sites within the protected area network. Nevertheless, the majority of wetland protected areas are already under threat, and many degrading, due to land and water use. It will become increasingly difficult to sustain such protected areas in the face of the additional pressures of climate change.

197. Of the various types of ecosystems, wetlands are particularly susceptible to invasions by non indigenous species due to their location at the land-water interface. Although < 6% of the earth land mass is wetland, 24% of the world most invasive species are wetland species. Climate change is likely to exacerbate invasive species problems by broadening climatic ranges and degrading wetlands, stressing native species and thereby opening up expanded opportunities for invasions.

3. Shifts in Ecosystem Services

198. The impacts of climate change on inland waters will have varied effects on ecosystem services and human well-being but overall with a predominately negative trend. Wetter conditions in parts of southern South America has increased the area affected by floods, but has also improved crop yields in the Pampas region of Argentina. In other areas flooding will increase, not only because of changing

precipitation but also as a result of the impacts of increased temperatures on ice jams. Currently, floods affect 140 million people per year on average.

199. The functions, values and ecosystem services provided to humans from the vast boreal ecosystem exert a large influence over millions of more southerly humans by altering climatic conditions, affecting atmospheric gas balances, capturing and delivering water for hydro-power, producing habitat for billions of migratory birds, partially regulating precipitation and storm patterns, producing forest products, and maintaining recreational opportunities for people. The magnitude of the influence on boreal carbon and water supplies may overshadow direct use biodiversity contributions in terms of global repercussions.

200. Drying trends have already been observed in much of Eurasia, northern Africa, Canada and Alaska. Such droughts will place increasing pressure on the water cycling services provided by inland waters and may, in fact, cause some wetlands to cease to perform these functions, at least seasonally. This is especially of concern for seasonal flows in savannah regions in sub-Saharan Africa.

201. Groundwater flow and levels in shallow aquifers are also decreasing, affected through recharge processes. This has serious implications for the billions of people dependent on groundwater for drinking and food production and for terrestrial vegetation.

202. Increased turbidity and nutrient and pathogen loadings within surface water sources will have negative impacts on freshwater access. Freshwater access is also being negatively impacted by less snow at low altitudes and earlier spring runoff as well as mountain glacier decline globally. For example, even though China is projected to experience increased annual runoff as a result of climate change, in western China, earlier spring snowmelt and declining glaciers are likely to reduce water availability for irrigated agriculture.

203. Scarcity as measured by available water per capita is forecast to get worse through non-climate change trends where the population is still growing significantly – in Sub-Saharan Africa, South Asia and some countries in South America and the Middle East. Notably, climate models show that extremes of rainfall are probably going to get worse resulting in heavier floods and more frequent droughts in regions already affected by these.

204. Among the recent extreme high-impact water-related events are: floods in Europe in 1997 and 2002, floods in China in 1996 (26 billion US$ in material damage) and 1998 (30 billion US$ in material damage). Destructive floods observed in the last decade all over the world have led to record high material damage. The costs of extreme weather events have exhibited a rapid upward trend and yearly economic losses from large events increased ten-fold between the 1950s and 1990s, in inflation-adjusted dollars. Disaster losses are mostly water related, and have grown much more rapidly than population or economic growth, suggesting a climate change factor. The relevance of this in the context this in-depth review is that almost universally such losses arise, at least in part if not often in whole, from the degradation of inland water ecosystems and subsequent loss of the disaster mitigation services that they naturally provide.

205. Anthropogenic climate change is a fundamental driver of changes in water resources and an additional stressor over and above other external driving forces. Policies and practice aimed at adaptation to, or mitigating of, climate change can have direct and indirect implications on water resources – and shifts in related ecosystem service provision. Remarkably, this is hardly ever considered.

206. Adaptation to climate change adds a critical challenge for all countries, particularly for cities in coastal zones and for developing countries that will be hit hardest and earliest, with low capacity to adapt and for almost all business sectors. The importance of water is paramount in these challenges.

4. Mitigation and influences on carbon fluxes

207. Strong evidence exists to indicate potential impacts of hydrologic trends on the "terrestrial" carbon cycle. Interactions between various stages of the carbon and water cycles can yield positive feedbacks to climate change. The rate of carbon uptake depends on hydrologic and climate conditions, as well as land use. Water plays different roles in each stage of the terrestrial carbon cycle. Soil moisture determines the proportions of carbon released to the atmosphere as carbon dioxide (CO_2) and methane (CH_4). Some hydrologic trends are expected to have serious implications for soil respiration. There is concern that permafrost degradation may cause some of these wetlands to drain and be replaced by grasslands, with important overall negative implications for the global carbon cycle and possible feedbacks to global climate change. The recent expansion of thaw lakes (14.7% increase in area between 1974 and 2000) may have resulted in a 58% increase in lake CH_4 emissions.

208. Several studies have observed marked increases in the annual fluxes of dissolved organic carbon (DOC) in many temperate and boreal streams around the world. It has been difficult to attribute all of the observed trends to any single cause, but hydrology appears to play a role in some cases through changes in groundwater drainage. The recently discovered increase in minimum flows across Northern Eurasian pan-Arctic may have important consequences for the carbon cycle. Because minimum flows generally reflect the influence of groundwater, the cause of these trends could be a reduction in the intensity of seasonal soil freezing, allowing more connectivity in subsurface drainage networks. It is conceivable that the increased flushing of the soils through groundwater, accompanied by longer growing seasons and greater microbial activity during seasons in which the soils historically have been frozen, could lead to greater mobility and loss of soil carbon.

209. There is growing evidence of the significant importance of wetlands for Greenhouse Gas mitigation. Wetlands, in particular peatlands, are significant carbon stores, and so their conservation needs to be properly considered in climate change mitigation strategies. The primary mitigation response at present continues to be avoiding the degradation of carbon rich wetlands and where feasible restoring these.

210. A significant danger lies in lack of attention to the mitigation options for wetlands and the relative benefits of doing so. Where benefits are less than those from wetland related investments, investment in alternative mitigation activities is an indirect driver not only of further wetland degradation (and loss of other wetland services besides carbon storage) but also a potential inefficient use of financing as measured against its primary objective (reduced GHG levels).

211. The relationship between climate change mitigation measures and the direct use of water is a reciprocal one because of the significant linkages between water and energy. Energy related mitigation measures can influence the quantity and condition of water resources and their management. It is important to recognize this reality when developing and evaluating mitigation options. For example: utilizing hydropower as an alternative to fossil fuel power plants would lead to more dam construction (and subsequent losses of water through evaporation, particularly in dry areas), the impacts of dams on biodiversity are already widely known; a significant amount of water is required to grow biofuels. Most of the climate change discussions have focused on mitigation strategies. This approach will continue to have serious implications for energy policy (a major water use sector), as well as other key sectors such as international trade and transportation. The net result will be an escalation of drivers of water use and consequently inland waters biodiversity loss.

212. There is obviously increasing world attention to carbon mitigation through improved forest management (in particular REDD), and interest in wetlands is growing. Despite this progress, when factoring in what may happen to ecosystems due to shifts in the water cycle, Ramsar STRP has noted that there does not appear to be any scientific basis on which the integrity of forests and wetland systems as carbon stores can be guaranteed for decades let alone centuries. For example, there is very limited attention to the implications of changing water availability (due to direct human use, let alone climate change) on the sustainability of forests. There is already evidence that unsustainable groundwater use is lowering water tables in many areas and at the continental scale. Whilst the implications of this for people is receiving some recognition, so far, it appears that dialogue has missed the fact that terrestrial vegetation (including forests) depends on the same groundwater. Likewise, localised, even regional, deforestation coupled with the over use of water are widely considered a potential driver of local/regional climate shifts (particularly reduced rainfall). The current attention to potential tipping points in the water cycle in the Amazon Basin is a case in point – with potentially far reaching regional implications.

213. Reforestation with water intensive species can also further deplete water resources – in particular reducing blue water supplies in some critical areas. The implication is that in such areas feedback mechanisms will increase the vulnerability of those forest resources which are supposed to be conserved as carbon stores. In view of the projected expanding area under increased water stress (not even considering climate change) this is a substantial potential problem regarding current mitigation efforts.

214. The conclusion is that mitigation efforts must pay more attention to wetlands and their role in both the water and carbon cycles – in order to sustain both wetland *and* land (including forest) mitigation benefits.

5. Adaptation

215. Managing water has always been about managing naturally-occurring variability. Climate change threatens to make this variability greater, and to shift and intensify the extremes. Overall, the adaptation response to risk will be to increase water storage – essentially to cater for the increased frequency and severity of both droughts and floods. This presents both significant dangers and opportunities. Many response measures to adapt to climate change, particularly physical infrastructure approaches, have significant implications for wetlands and further disruptions in the water cycle. A whole-scale business as usual engineering approach to the problem (dam, levee construction etc.) brings significant further threats of increased biodiversity loss and deteriorating ecosystem functioning – which would likely, in many cases, undermine the objective of risk reduction itself.

216. The significant opportunities are to use natural ecosystem infrastructure (including not only wetlands but related considerations for soil moisture and groundwater) more wisely in order to reduce risk and achieve more sustainable water supplies, and other advantages of improved ecosystem functioning. There are strong arguments, and a solid case-study evidence base, that this can be feasible and that the main reasons for doing so are to meet human needs – biodiversity being a co-beneficiary.

217. It is absolutely critical that climate change adaptation strategies fully recognise the central role of water, are aware of hydrological cycle and consider the problem and solutions from an ecosystem perspective. In this, natural ecosystem infrastructure is a considerable ally in achieving cost-effective and sustainable solutions. Where adaptation by infrastructure development includes the maintenance or restoration of protective ecosystem services through, for example, improved river basin management, positive outcomes can be expected for inland waters biodiversity. Where it is absent it is difficult not to foresee further substantial biodiversity loss.

218. Funding mechanisms for developing countries, where the needs are broadly about development, are woefully lacking. This is especially true for Africa, where the impacts of climate change will range from energy shortages, reduced agricultural production, worsening food security and growing malnutrition, to spreading disease, more humanitarian emergencies, growing human migratory pressures and increased risks of conflict over scarce land and water resources. The financial mechanisms providing support to developing countries need to be aware of the nature of the problems and solutions as outlined in this review. In particular, "natural infrastructure" solutions to the problems faced in such countries may be particularly promising – if for no other reason than the fact that financial resources are unavailable for capital intensive fixes.

219. A major area of concern for inland waters (including coastal wetlands) relates to adaptation to sea-level rise. There are two basic response options – let it happen and allow wetlands to adapt and move inland, or build stronger coastal defences (to some extent both are already happening worldwide). But most coastal wetlands are now surrounded by physical infrastructure and have limited room to move – or rather they will not be allowed to. For example, in the U.S.A, due to this constraint, a 0.3m sea level rise could eliminate up to 43% of coastal wetlands; most projections for sea-level rise already exceeds this. The picture emerges, in many places, of coastal wetlands being "sandwiched" in an unsustainable location. Clearly, responses to sea-level rise (and increasing severity of coastal storms) more than ever requires a more holistic ecosystem based approach. Where feasible, the flood and storm adaptation services provided by coastal wetlands need to be rehabilitated.

220. Adaptation activities in the agriculture sector may have positive or negative impacts on inland waters. If adaptation activities include fresh water withdrawal increases, pressure on inland waters can be expected to escalate.

6. Economics and financing

221. Because water is the principal medium through which changes in climate will impact upon economic, social and environmental conditions, changing water availability translates into economy-wide impacts. The Stern Review (The Economics of Climate Change) recognised that climate change presents very serious global risks - often mediated through water.

222. The levels of additional investment required to adapt water infrastructure to climate change are considerable but still only an increment to the much larger overall (non climate change) water-related investment requirements for meeting human needs (including the MDGs) factoring in population growth and changes in consumption patterns. Some of these estimate investment requirements for water infrastructure to meet drinking water and sanitation objectives alone at $ 22 trillion by 2030. Current GEF funds are several orders of magnitude too low to meet the projected environment related needs.

223. There is clear evidence supporting a relationship between climate variability and economic performance in countries heavily dependent upon agriculture for their GDP – and the major linkages occur through water related stresses on crops.

224. Across many parts of the developing world, losses associated with disasters are of a sufficient scale to undermine development and poverty reduction goals. Most disasters are water related (droughts/floods) and their existence causes a sustained 14% reduction in GDP of low-income countries. These disasters are already occurring. Few doubt that climate change will increase their frequency and severity. While infrastructure designs, agriculture investments and water management plans currently

incorporate some awareness of (natural) climate variability, actual climate risks are seldom properly considered.

225. The most significant opportunity for mobilising increased financing outcomes for "inland waters biodiversity " in relation to climate change are the same as already noted for other considerations. That is, to seek ways in which enhancing or restoring the services provided by properly functioning ecosystems can help to *reduce* the costs of achieving the same development objective through alternative means. The clearest example of this is through using or restoring natural ecosystem functioning in relation to climate change adaptation (= water related adaptation) and mitigation.

7. Progress in related matters under the Ramsar Convention

226. The most detailed information on the carbon mitigation aspects of wetlands remains in relation to peatlands. The ninth meeting of the Conference of the Parties to the CBD already considered the Global Assessment of Peatlands, Biodiversity and Climate Change (decision IX/16, section D) in these regards and invited the tenth meeting of the Contracting Parties to the Ramsar Convention to consider appropriate action in relation to wetlands, water, biodiversity and climate change. Responses of the Ramsar Convention. In response, climate change was considered in detail at the tenth meeting of the Contracting Parties to the Ramsar Convention. Ramsar COP resolution X.24 deals specifically with climate change and the entire resolution is relevant to the in-depth review of the programme of work on inland waters (as well as many other CBD programme areas). Some points made include, *inter alia*:

227. that almost all of the world’s consumption of freshwater is drawn either directly or indirectly from wetlands and wetland ecosystems are important in protecting freshwater supplies (para. 3);

228. Parties need to manage their wetlands in such a way as to increase their resilience to climate change and extreme climatic events and to ensure that in their climate change responses (such as revegetation, forest management, afforestation and reforestation) such implementation does not lead to serious damage to the ecological character of wetlands (para. 4); and

229. the increasing evidence that some types of wetlands play important roles as carbon stores, and there is concern that this is not yet fully recognized by international and national climate change response strategies, processes, and mechanisms (para. 8).

230. In relation to scientific, technical and technological matters, Resolution X.24: noted the Scientific and Technical Review Panel’s renewed attention to wetlands and climate change issues during the 2006-2008 triennium, including *inter alia*, on developing simple methods for assessing the vulnerability of different wetland types to climate-driven changes in water regimes, on the role of and opportunities for wetland restoration as a tool for climate responses, on the role and importance of different wetland types in the global carbon cycle, on assessing vulnerability of wetlands to hydro-ecological impacts, wetland restoration and climate change, and on recent key messages and recommendations concerning wetlands, water and climate change from relevant intergovernmental and international processes and initiatives. Resolution X.24 also instructed the STRP, in its more comprehensive examination of climate change and wetland issues, to review emerging information on the ways in which, *inter alia*, changes in wetland thermal and chemical regimes, hydro-patterns, and increases in water storage and conveyance infrastructure, including impoundments, potentially alter the pathways by which non-native species invade wetlands, and influence their spread, persistence and ecological impacts on native species and to investigate the potential contribution of wetland ecosystems to climate change mitigation and adaptation, in particular for reducing vulnerability and increasing resilience to climate change; and requested the Ramsar Secretariat and the STRP to use appropriate mechanisms to work with the UNFCCC and other

relevant bodies to develop guidance for the development of climate change mitigation and adaptation programmes that recognize the critical role of wetlands in relation to water and food security as well as human health; and instructed the STRP to continue its work on climate change as a high priority and, in conjunction with the Ramsar Secretariat, to collaborate with relevant international conventions and agencies, including UNFCCC, CBD, UNCCD, IPCC, UNEP, UNDP, FAO and World Bank, in the development of a multi-institutional coordinated programme of work to investigate the potential contribution of wetland ecosystems to climate change mitigation and adaptation, in particular for reducing vulnerability and increasing resilience to climate change.

8. Integration of climate change considerations into the programme of work

231. The programme of work is already designed to address the direct drivers (threats, pressures) to inland waters biodiversity and includes necessary responses. "Integrating climate change" into the programme of work therefore centres on recognising that climate change increases:

232. existing risks and vulnerability for biodiversity, ecosystem services and the humans that depend on these; and

233. the urgency of taking action in an already critical area.

234. It is also clear, and as concluded throughout this entire review, that the central role of water in climate change, in both the ecosystem and socio-economic contexts, means that the priority requirement is to integrate relevant water related considerations into all other programme areas.

H. Responses, challenges and extent of implementation of relevant activities and approaches

235. Based on the findings of this review, it is very difficult to paint a positive picture for the future of inland waters biodiversity. The current situation with water, and the biodiversity that not only relies upon it but underpins its continued availability, is dire. Projections for increasing pressures upon inland waters mean the situation will get much worse, even with improved management. Climate change, overall, simply amplifies existing problems and increases the urgency of solutions which are patently already needed. Whilst the situation in these regards differs significantly between countries, and regions within them, no countries are exempt from needing strengthened approaches. For many, this is critical; for quite a few, past critical. The scenarios for water and their implications for terrestrial biodiversity and human development, to put it mildly, present considerable challenges; arguably the main challenge to a sustainable planet.

236. The scenarios tell us not so much that better management approaches are needed (something known for decades), but rather that they are becoming unavoidable. The history of water shows that significant and intelligent improvements tend to arise from crisis. The best hope, therefore, lies in the fact that rapidly escalating crisis will force more intelligent approaches.

237. Water, and the biodiversity associated with it, cannot be managed effectively solely through managing the direct drivers of change (pressures/threats). The indirect drivers, in the social, economic, political and development arena, are what largely influence outcomes for resource use and must be addressed alongside more direct policy and management interventions. Hence, this review devotes much space to looking beyond what lives in freshwater and what directly affects it. Sustaining inland waters biodiversity requires an approach which captures this reality.

238. Many solutions to the problems exist. Harnessing these more systematically is the issue. Much is known about how water resources can be managed under conditions of change. Indeed the Millennium Ecosystem Assessment itself reviewed a wide catalogue of ‘response options’, and highlighted many viable ways forward. Key fields in which good work lies include poverty-oriented surface and groundwater management and provision, integrated water resource management and payments and negotiation for watershed services. Good solutions have been identified to make agricultural land and water use move towards sustainability. Increases in efficiency are also being achieved with industrial, energy and urban uses of resources. Business is setting the example of best practice in many areas, often voluntarily.

239. Clearly, the status and trends information tells us that collectively these good practices and approaches are not yet enough. But they are a platform upon which to build. The biggest factor of all will be the extent to which stakeholders at all levels, and across all sectors and interests, recognise how important it is to get things right with water. Water is often a very local issue and management certainly nearly always local. National policies need to describe broad principles and objectives and empower, or legislate for, local implementation according to local circumstances and needs.

240. Recommendations from other forums that target various sectors, including governmental organisations, NGOs and industry include:

241. The preservation of ecosystems must be a central focus of water and land management if ecosystem services that provide clean water and reliable water supplies are to continue.

242. This is relevant outside of the water "sector" because the preservation of ecosystems both requires efforts from many sectors, and will impact upon many sectors.

243. Efforts are necessary on several political levels, and public opinion in favour of preserving natural ecosystems is necessary for a sustainable situation.

244. Common issues are that ecosystem services describe a variety of socially-valued goods and services that society derives from natural ecosystems. However, multiple claims on ecosystems and their services, and rapid agricultural, industrial, and urban development put severe pressures on ecosystems being under threat due to water scarcity and chemical contamination.

245. Stopping and certainly reversing degradation of important ecosystem services demands major policy changes.

246. As governments seek to achieve the MDGs and IWRM plans, doors are open for a focus on ecosystem preservation to contribute to and benefit from theses related goals.

247. The recent economic crisis also brings heightened attention to opportunities for stimulating economies, where the concept of payments for ecosystem services may be introduced as an option to finance adaptation/mitigation measures, while simultaneously stimulating economic activity.

248. Governments around the world have pledged to work together to provide adequate access to clean water, sanitation, and electricity for all. The importance of ecosystems for providing basic human needs must not be forgotten while these goals are pursued.

249. As ecosystems are critical for so many of the challenges faced today, many processes have opportunities for the inclusion of discussion on ecosystems, including the UNFCCC and CSD processes.

250. Multiple international and regional frameworks (often born after a major crisis) support the protection of freshwater systems and the mitigation of impacts. These include many conventions promoting such things as water management, impact assessment and pollution mitigation, and development forums, such as the Commission on Sustainable Development. Good implementation is not rare, but is far from widespread.

1. The effectiveness of good wetland policies

251. Ramsar National Reports show that better overall status of a country's wetlands appears to be associated with: having a National Wetland Policy/equivalent; applying Strategic Environmental Assessment practices; applying Ramsar's guidance on wetland restoration; implementing programmes for raising awareness about wetland services; having greater financial resources; and providing opportunities for wetland site manager training.

2. Integrated Water Resources Management (IWRM)

252. Integrated Water Resources Management (IWRM) remains a key response to address the multiple objectives associated with the conservation and sustainable use of inland waters biodiversity. Progress is being made, but not fast enough. But external drivers and have more impact on water management than many policies championed and implemented by water managers. The most valuable evolution of IWRM could be the extension into dialogue and partnerships with water-using sectors, whose policies and strategies are governed by many other factors beyond water alone. At the technical level, the objective of IWRM, and the framework for analysis, needs to be achieving a balance in the services required from inland water ecosystems.

3. Financing and payments for environmental services

253. The "payment for environmental services" (PES) approach is increasingly recognized for financing environmental protection and conservation. Water related PES schemes work well (although not always), particularly considering that reversing the degradation of inland water ecosystems is not easy. This is because: (i) the related services are valuable and visible; and (ii) there is often already a financial mechanism in place (e.g., water supply costs) from which finances can be re-allocated. Notably, a major outcome is improved terrestrial, not just aquatic, environments. Solutions to water related problems are usually more to do with better management of land activities and outcomes for terrestrial ecosystems than for inland waters directly. PES approaches are well advanced in some other MEAs dealing with water and a model for development of approaches under the CBD.

254. Throughout this review, many examples are provided of how inland waters biodiversity can help solve water, and climate change, related problems, in a fashion that is attractive for Ministries of Finance. There are astounding projections, indeed current levels, of investments that are or will be made in the water arena to reach related MDGs, let alone resolving water problems in developed countries. Requirements to adapt water related infrastructure to climate change are also substantial, if incremental in terms of overall investment in water. Biodiversity needs mainstreaming into this source of financing and most importantly through providing cost-effective solutions to development issues. To achieve such an outcome, even minimally, eclipses any potential resources available through other means (including the GEF), and by several orders of magnitude.

4. Valuations of ecosystem services

255. Understanding how inland water ecosystems function and the values of the services provided is essential. Using their direct and more visible benefits (e.g. water supply, food production and other provisioning services) is not necessarily incompatible with sustaining other services (such as water and climate regulation and nutrient recycling). Valuing ecosystem services remains a problematic area. Values generated can be controversial. Comparative values of services are often more useful than absolute values. Wherever such approaches are taken, inland waters (wetlands) consistently generate the highest overall values. Even for many terrestrial ecosystems (such as forests) values related to water services outstrip more conspicuous and stylish benefits (such as timber products and carbon storage). For example, *The Economics of Ecosystems and Biodiversity* (TEEB) has published examples of the values of ecosystem services provided by tropical forests. The water related services listed include: water provisioning, regulation of water flows, waste treatment/water purification and erosion prevention. These collectively account for a value of up to $US 7236 per hectare per year; more than 44% of the total value of forests, and exceeding the combined value of climate regulation, food, raw materials, and recreation and tourism.

256. Valuations of water related ecosystem services provide good comparative indicators of where priorities should lie and have led to increased national attention to inland waters, but in too few cases. With attention turning to climate change risks and vulnerabilities, a greater incentive is in place for valuation studies concerning inland water ecosystems. For example, one study in the U.S.A. values the extreme weather mitigation services provided by one hectare of wetland at US$ 33,000 for a single storm event (not including other services provided).

5. Water quality – mitigating pollution

257. There are signs of progress in the way pollution and risks are addressed in and across different sectors. The ‘polluter pays’ principle has stimulated changes in attitudes towards the pollution problem. The issue is not just "environment"- there is well-documented evidence that the costs of inaction are high. The OECD reports evidence of increasing investments in "Change in Production Process" technologies (CPP). There is a steady growth of companies seeking certification through ISO. The globalisation of the economy can contribute to cleaner production even with the delocalisation of polluting activities to countries with lower environmental standards. Many multinational enterprises apply high environmental standards to their activities worldwide, introducing environmental management systems to increase environmental performance, thus contributing to the globalisation of better corporate practices. In the industrial sector, a combination of subsidies, higher water prices and environmental regulations have encouraged industries to improve processes and reduce withdrawals. There are clear indications that the global business community is devoting increasing attention to water – and solving problems. The international competitiveness of a company and its products in the global market is enhanced by its commitment to Best Environmental Practices. "Water footprints" are an increasingly important parameter in this. This contributes to pollution reduction and improved efficiency of the water used. At the national level, there are now a growing number of companies introducing clean production processes – often for pollution reduction – that result in significant water savings, with return-on-investment times seldom exceeding two years. In emerging and agricultural economies the scope for progress through the introduction of clean processes is even greater, since production processes are generally poor compared with worldwide standards. Progress is also being made in some places in reducing soil erosion; although there is considerable scope for expansion.

6. Progress in achieving environmental sustainability

258. Ensuring ecosystem integrity while meeting the demands of a growing and increasingly affluent population has emerged as one of the world's primary resource issues. Scientists are becoming increasingly engaged in the development of environmental flow recommendations needed to sustain river ecosystems. Environmental flows evolved in the context of water releases from dams, where there is general agreement that managed flows need to exhibit patterns of natural variability necessary to support a functioning riverine ecosystem. But the e-flows concept is evolving and being targeted more at reversing trends that disconnect ecosystems from livelihoods and sustainable development. E-flow adoption and implementation has been particularly strong where national legislation and policies placed e-flows as a priority within an IWRM framework, and where it was also integrated into natural resource management plans at the basin scale.

259. The approach of Integrated Flood Management (IFM) considers the positive as well as the negative aspects of flood waters and considers the valuable resource that is represented by the flood plains that these waters, on occasions, occupy and re-invigorate. Rehabilitation of wetlands can also be a powerful force in recovery from socio-political crises. The destruction of the Iraqi Marshlands, the consequent displacement of its indigenous Marsh Arab population, and subsequent restoration efforts is a shining example. Win-win scenarios are also being promoted through Security and Crisis Prevention. Water is emerging as a strategic resource in that it underpins many of the other dimensions of security. Many interventions at local, regional or global level that are designed as direct responses to insecurity can have benefits for water – and potentially generate multiplied human security benefits in the long term. Inter-regional cooperation around shared waters can help promote peace-building and trust among countries.

260. The so called "Green Revolution" enabling massive increases in food production during the 1960's and 70's was fuelled largely by the expansion of irrigation (and less so through increases in cultivated area). Broadly speaking, limits have already been reached (there are regional exceptions). It is water, not land, which constrains further agricultural production. Most commentators agree that there will be no second green revolution to save the day. From now on, it is tough going. The Comprehensive Assessment of Water Management in Agriculture (2007) concludes that potential exists at the global level to produce enough food and other agricultural products to meet demand while reducing the negative impacts of water use in agriculture. From its scenario analysis, this assessment also noted there are significant local opportunities and options – in rainfed, irrigated, livestock and fisheries systems – for preserving, even restoring, healthy ecosystems. But gains require significant changes in the way in which water is managed.

261. One solution to solving the problem of the uneven global availability of water is to increase food production in water abundant areas and trade in the products (a process known in water terms as trading in virtual water). Policies to achieve national food security are a significant driver of water use, particularly in more arid regions. There is evidence of national policies moving away from being over-focused on food independence.

262. Awareness is growing. Following the 2008 Davos meeting, there are calls for a minimum water impact alongside a minimum carbon footprint.

263. There are many good examples of sustainable groundwater management practices, e.g. in many European countries, where groundwater has been used for decades as a safe, high quality source for drinking water supply, without any degradation. These highly valued and well-protected groundwater

resources are key factors for social and economic development, environmental sustainability and biodiversity conservation. Economic pressure for high-quality groundwater will likely enhance regulation and protection with greater stakeholder involvement in most post-industrial economies. Some intermediate countries are also likely to follow suit if able to prioritize their efforts, but at the same time numerous opportunities for conservation of high-quality resources have already disappeared and few countries have the financial resources for wholesale remediation of aquifers. Groundwater reservoirs add persistency and stability to the terrestrial hydrological systems and provide unique opportunities for humans, fauna and flora to bridge extended dry periods of time and survive. This underlines the potential role of groundwater in coping with increasing water scarcity due to global change. At the same time, because of strong interdependence between groundwater and surface water, the overall resource is difficult to quantify. Despite its importance for river baseflow and wetlands *(and vice versa)*, groundwater is frequently ignored in water balance calculations. For longer term evaluations such as associated with global changes, groundwater resources are of utmost importance, since groundwater has a buffer function for short term climatic variations and is at the base of important adaptation strategies.

7. Private sector responses

264. There are many examples from the private sector illustrating how production can be increased whilst reducing water footprints. Private-sector awareness of the centrality of sustainable water management is clearly increasing. Recent initiatives in the business community to support sustainable water management include the CEO Water Mandate launched at the 2007 UN Global Leadership Forum; the World Economic Forum’s call for a “coalition” of businesses to engage in water management partnerships, and development by the World Business Council for Sustainable Development of a water diagnostic tool and water scenario planning support. Examples of successes in creating social marketing campaigns around water issues can be found in almost all countries.

265. Tourism is a growing sector of the economy. Water is the chief natural resource used and impacted by tourism. There is increasing evidence that win-win scenarios between tourism and water are possible.

8. Hazards versus opportunities

266. The revision of management strategies in response to potential climate change threats represents an opportunity to implement policies and practice that will lead to more sustainable use of available resources. These strategies could include, but would not be limited to, improved observation networks, increased integration in the use of groundwater and surface water supplies (including artificial recharge), improved early warning and forecasting systems for hazardous events, improved risk-based approaches to management and the raising of community awareness of sustainable water resource use and individual responses to water related hazards.

Biotechnology

267. Biotechnology is believed to have a valuable role in addressing water scarcity and quality challenges in both developed and developing countries, particularly in regard to agricultural needs. The development of drought resistant crops or those with lower water demands is one example. Likewise, the application of nanotechnology shows particular promise in regard to water resources, especially for developing countries; namely desalinization, water purification, wastewater treatment, and monitoring.

9. Reaching the Millennium Development Goals

268. One critical need is to recognise that water is the key mechanism linking the various MDGs. Water is a primary reason why "environmental sustainability" targets were incorporated into the MDGs originally. This is why the environmental sustainability target (#1) is rather oddly included under MDG7 together with the target (#3) for drinking water and sanitation. This opened the door for the latter incorporation of the 2010 biodiversity target itself under the same MDG7 (as target 2). The importance of water, therefore, is historically why the 2010 target was eventually recognised as also relevant. But history seems to have been somewhat forgotten. The MDGs too often are looked at independently. "Water" is a lens through which the MDGs should be viewed. Managing water better helps us manage the MDGs better. And in this context it is absolutely critical to understand and recognise the biodiversity link. The availability of water is an ecosystem service, and biodiversity underpins this. Achieving the MDGs sustainably and collectively is not possible without sustaining "inland waters biodiversity" and the services it provides; nor is it possible without trading, balancing and compromising on those various services.

10. Climate change

269. Climate change is cross-cutting. It is expressed mainly through additional influences on existing direct and indirect drivers of change. Responses to it largely centre on incorporating climate change into existing responses and recognising that it adds further urgency for action.

270. One challenge to addressing climate change impacts for inland waters is that there is evidence that change has occurred already; in most cases not due directly to climate change (e.g., reduced water flows due to abstraction), whereas for a few climate change alone is implicated (e.g., increasing lake water temperatures), but for most it is probably a combination of both (e.g., combined pressures of abstraction and changing rainfall). Climate projections indicate that substantial future change may occur, but for most considerations, but not all, these impacts are likely to be secondary to impacts already arising and projected through increasing demand on, and the over- and mis- use of, water. Without some modifications, current inland water management plans and practices are likely to have difficulty coping with the full range of future climate impacts on water supply reliability, flood risk, health, energy, and aquatic ecosystems. Society needs to build its capacity to both respond to existing needs and adapt to the additional challenges that climate change will bring.

271. Adapting to climate change is mainly about adapting water. The climate change adaptation dialogue needs to refocus from "what to do about the world getting warmer?" to "what is happening with water?". The sense of urgency for climate change adaptation and recognition of the centrality of water therein have not yet permeated the political world and are not systematically reflected in national plans or international investment portfolios for adaptation. It is not enough to mention "water", nor indeed recognise it as "important" – it is central. This must be explicitly stated and recognised. All 26 U.N. agencies and programmes dealing with water agree on this point.

272. The role of inland water ecosystems (wetlands) in this context is paramount. They provide services of enormous value and directly relevant to responding to climate change. There is much scope for improved outcomes for biodiversity, water resources and human well-being. Many promising solutions to the problems exist and many centre on using "biodiversity" related ecosystem services to solve water related needs – including in response to climate change.

273. *The Economics of Ecosystems and Biodiversity* (TEEB) prepared a brief for UNFCCC COP 15 which concludes, *inter alia,* that:

274. "There is a compelling cost-benefit case for public investment in **ecological infrastructure** (especially restoring and conserving forests, mangroves, river basins, wetlands, etc.), particularly because of its significant potential as a means of adaptation to climate change"; and

275. "The carbon cycle and the water cycle are perhaps the two most important large-scale bio-geological processes for life on Earth".

276. In most regions, including the developed world, the most promising strategy is to enhance the adaptive potential of inland waters biodiversity in order to achieve better human development outcomes. There is a clear opportunity to switch to a more positive dialogue – to offer better solutions to water resources problems.

277. Some specific measures that would enhance the adaptive capacity of inland waters biodiversity include:

278. Identifying those species and ecosystems that are particularly vulnerable to the negative impacts of climate change;

279. Enhancing and/or restoring the connectivity of inland water ecosystems to allow for natural migration of species;

280. Consider, under extreme circumstances and appropriate risk analysis, assisted migration;

281. In particular, restoring the functions and services of degraded inland water ecosystems, many of which are required for meeting climate challenges; and

282. Expanding the network of protected areas incorporating better inland water ecosystem coverage and incorporating improved attention to inland water ecosystems within terrestrial protected areas.

283. Such adaptation activities present opportunities for the further conservation and sustainable use of inland waters biodiversity by raising the awareness of the ecosystem goods and services provided by inland waters and by mobilizing additional financial and technical resources for the activities already included in the programme of work.

11. The Way Forward

284. Tested approaches available to water managers that show promise lie within the fields of:

285. Water policy and planning processes that are currently not fully developed, and where incremental change that secures alignment with the real-world outcomes in the use of water will be most effective;

286. Institutional development, through continuing reforms which create institutions that are better attuned to today’s current and future challenges, considering decentralization, stakeholder participation and transparency, increased corporatisation wherever feasible and implementable in fairness, partnerships and coordination (public-private, public-public, public-civil society), and new administrative systems based on shared benefits of water, especially when water crosses statutory boundaries or political borders;

287. Water law, both formal and customary, including regulations within other sectors that bear influence upon the management of the water resource;

288. Consultation with stakeholders and developing accountability in planning, implementation and management; building trust, as effective management relies more and more upon pluralistic governance and interactions among parties with different vested interests;

289. Developing appropriate solutions through innovation and research; and

290. Institutional and human capacity development.

291. Traditional practice has it that planners locate land uses and design land cover and then hand over to engineers the task of directing water flows. Instead, water considerations should be incorporated in determining the location of land uses, their layout and topography, the distribution of pervious and impervious land cover, and the use of Best Management Practices (BMPs). This approach includes improving water quality and supply by passing it through wetlands.

292. Increasing a demand-driven research capacity in developing countries is essential because a critical mass of individuals in research and development is needed to facilitate economic development. The Paris Declaration also stressed that developing countries must become more capable of solving their own problems, therefore requiring research capacities which also will facilitate their ability to absorb and utilize existing knowledge from other sources and countries.

293. Reliable and accurate water resources information and data provides a means by which decision-makers can attempt to convert uncertainty regarding water resources into more reliable assessments of water risks (the latter being more manageable from a political perspective). There is considerable room for improvement and urgency for this. Many of the critical data/information needs centre of understanding and managing the water cycle (essentially – hydrological data). But this must be accompanied by better information on the role of ecosystems (wetlands). Wetland/ecosystem/environment specialists must gather, package and disseminate relevant information that is pertinent to assisting better land and water management, particularly where there are cost savings. And they need to move beyond "conservation" data. Funding agencies must recognise that investments in environment related information is investment in more sustainable development.

294. Effective legal and political frameworks are necessary to develop, carry out and/or enforce the agreed rules and regulations that fundamentally control human water uses. Water policy operates within a context of local, domestic, regional and global policy and legal frameworks, all of which must be supportive of sound water management goals. Legitimate, transparent and participatory processes can be effective ways of gathering support for the design and implementation of water resources policy, as well as creating a major deterrent to corruption. There is no one size-fits-all approach to establishing a fair and functioning institutional framework.

295. The bottom-up approach to water resources management was recognized in the Dublin and Rio de Janeiro processes. Such coordination is facilitated by a legislative and regulatory framework. Processes which strengthen water (and land) governance and include more holistic approaches can be expected to have desirable outcomes for the conservation and sustainable use of inland waters biodiversity.

I. Information contained in CBD national reports regarding implementation of the programme of work

296. CBD national reports continue to provide limited information by which to assess implementation of the programme of work – certainly by comparison with other sources of information, many of which include detailed assessments of many relevant activities at national level. Regarding MEA national reports, and as recognised in CBD decision VII/4, para. 2, Ramsar National reports remain a much more substantial information source. This difference might be expected (the Ramsar Convention is more focussed on specific inland water/wetland related issues). But CBD national reports provide limited reciprocal information on relevant subjects in other programme areas, or information which is difficult to interpret or quantify. It is activities in these other programme areas that chiefly influence outcomes for inland waters. In particular, there is a conspicuous absence of systematic and organised reporting on water use and influences on the hydrological cycle (as relating to biodiversity considerations) through other programmes of work.

297. Some indications from CBD third national reports are:

298. the level of priority accorded to the programme of work on inland waters varies significantly between Parties, but overall it is medium priority; among the thematic programmes of work forest biodiversity is ranked as a high priority by 70% of reporting countries; the programmes of work on agricultural biodiversity and marine and coastal biodiversity are in second and third place;

299. an under-emphasis on inland water protected area sites;

300. implementation of the programme of work into NBSAPs is incomplete – but more significantly, very few Parties have integrated the programme of work into in policies, strategies, and plans related to development; it is unlikely that the majority of Parties do not recognise the role of water in development, but, according to third national reports, it is clear that the role of the programme of work is not reflected in this context;

301. despite the reliance of Cities on services provided by inland water ecosystems, and their impacts upon these downstream, only one Party mentioned activities in urban areas;

302. responses that a large number of Parties had integrated the programme of work into IWRM and water efficiency plans (as required by 2005 under the Johannesburg Plan of Implementation of the WSSD) conflict with findings of independent reviews that at the time reports were submitted, most Parties very likely did not have such plans;

303. incorporation of the objectives and relevant activities of the programme of work into enhanced coordination and cooperation between national actors is reported as relatively high but few Parties mentioned coordination at the local level;

304. some Parties referred to a legislative framework but among these, there is a bias of EU member states mentioning the Water Framework Directive;

305. only 9 Parties had taken comprehensive measures for joint implementation between the Ramsar Convention and CBD; and

306. data generation for inland waters continues to be dominated by technical and biological interests whereas socioeconomic data are clearly still weak - about 50% of Parties had taken steps to improve national data on goods and services provided by inland water ecosystems, 60 to 65% had taken

steps to improve hydrological data but only 38% of Parties had taken steps to improve national data on the uses and related socioeconomic variables of goods and services provided by inland water ecosystems; likewise, data generation on threats is also a weak area.

307. The responses to target related questions are conflicting. According to the responses on the section on the 2010 target, overall more than 60% of Parties report that they have established targets for this programme of work (although the figures vary between sub-targets). However, according to the same question in the inland waters section - only 29.7% of Parties have established outcome oriented targets for this programme of work. Less than 20% of reporting Parties had established relevant targets and identified priority actions to achieve them.

308. Implementation of the programme of work is not linked linearly with economic status as assessed by country groupings (developed, economies in transition, developing, least developed, SIDS). Developed countries show a generally high level of engagement in the programme of work, but not always. Developing countries often "outperform" them and the total scores are only marginally different between these two groupings. Countries with economies in transition are ranked third overall (and their total score is more aligned to least developed countries than either developed or developing countries). This supports the long held paradigm that countries experiencing more rapid economic growth (in transition) tend to give less attention to the environment, particularly freshwater related resources, despite the increasing capacity to do so. Notably, engagement in the programme of work is consistently by far the lowest amongst Small Island Developing States (SIDS). This may be influenced by capacity considerations. But very likely a factor is that islands may focus on marine and coastal areas, climate change, and for many also forests. However, there are no grounds to assume that inland waters are less important on islands. In fact, there are strong arguments that they can be more important. Neither could any case be made that freshwater needs are lower in countries with economies in transition.

309. There are also interesting differences with regards to target setting. Least developed countries rank highest in the ideal scenario of having targets and identified activities to achieve them. They are approaching three times better on this point than developed countries. Even developing countries "out perform" developed countries in this area. Developed countries rank highest only where priorities have been identified but no targets established. LDCs are second highest (after developed) in integrating the programme of work into NBSAPs. Better progress is reported by all groups (except SIDS) than developed countries in enhancing cooperation between national actors (suggesting this is a continued area of weakness in developed countries). Developed countries rank highest in those areas which clearly require a high degree of technical capacity (for example, taxonomy, identifying threats and hydrological aspects of water supply as they relate to maintaining ecosystem function).

310. Developing countries are doing "better" than developed in areas relating to attention to goods and services provided by inland water ecosystems and the uses and related socioeconomic variables of such goods and services. This may reflect the more obvious relevance of some of those goods and services to developing countries (e.g., direct use for food, disaster, e.g. flood, mitigation etc.) – although the goods and services provided by inland waters (collectively) are in reality probably of equal importance amongst country groupings.

311. Main challenges identified by many countries for implementing this work programme are unchanged from previous or other related assessments and include:

312. Lack of mainstreaming inland waters ecosystem management into broader relevant policy frameworks;

313. Limited capacities for inland waters ecosystem management;

314. Lack of adequate information, monitoring, technical standards and practices for inland waters ecosystem management;

315. Lack of financial, human and technical resources;

316. Inadequate policy and legislative frameworks and weak enforcement capacities; and

317. Lack of inter-sectoral coordination or synergies.

318. There are a few challenges rated as high by a considerable number of countries – including weak law enforcement capacity, in particular for the programme of work on inland waters biodiversity.

319. A comparison of second and third national reports suggests that the majority of the national sectoral plans for conservation and sustainable use of inland water ecosystems are developed independent of the programme of work. Intuitively, the third national reports suggest much improved engagement in and attention to inland waters since the second report but this cannot clearly be attributed to the existence of the programme of work. It remains difficult to assess for particular activities whether these are (i) in response to the programme of work itself, or (ii) they are activities which would in any case be carried out but are consistent with the programme of work and therefore reported against it. There are few clear examples of Parties in the first category although the level of influence of the programme of work no doubt varies amongst these. It is highly likely that a considerable proportion of Parties fall into the second category, in particular the developed countries. This uncertainty makes it difficult to assess the impact of the implementation of the programme of work on the achievement of the 2010 target.

320. Assessing progress between the second and third national reports is difficult because the questions differ, as does the status of development of the programme of work, and the response rate for the second national report relatively low. Following trends through to the fourth national report is even more difficult due to its quite different format.

J. Assessment of implementation of climate change elements in the inland waters programme of work by Parties

321. The extent to which Parties have implemented the climate change elements of the inland waters programme of work has been assessed based on an analysis of fourth national reports to the CBD and second, third and fourth national communications to the UNFCCC.

322. Examples of activities reported by Parties include:

323. Assessments of the vulnerability of inland waters to the negative impacts of climate change (including the establishment of long-term monitoring programmes);

324. Programmes for the restoration of degraded wetlands;

325. Halting development in flood plains;

326. Improved fisheries management;

327. The development of water resource management plans for threatened wetlands;

328. Improved water management including the establishment of catchment or river basin management plans;

329. Reducing threats to people and livelihoods from the negative impacts of climate change on inland water ecosystems;

330. The expansion of protected areas networks for inland water ecosystems; and

331. Analysing the role of inland water ecosystems in climate change mitigation.

332. The vast majority of Parties reported on adaptation activities and vulnerability and impact assessments with only 4 Parties reporting on activities linking climate change mitigation to inland waters biodiversity although a number of additional Parties did recognize the need to enhance this link.

333. These reports are not inconsistent with the observation made earlier that the centrality of water is not systematically reflected in national plans. Mentioning water in some relevant areas is a good start, but it is not placing water centrally.

334. Parties identified a number of barriers that are preventing the further implementation of the climate change elements of the inland waters programme of work. These include:

335. The need for enhanced international cooperation in inland waters management, especially when considering trans-boundary water ways and migratory pathways;

336. The need for further financial and technical resources, including capacity building;

337. The need for better information on the projected impacts of climate change on inland waters biodiversity; and

338. The need for a better understanding of the links between inland waters biodiversity and climate change mitigation.

339. A number of Parties have already integrated the conservation and sustainable use of inland waters as a part of national adaptation programmes. While some Annex 1 countries are already reporting on emissions from land use change in inland waters, there are also proposals on ways and means to promote the conservation and restoration of inland waters in developing countries as a contribution to climate change mitigation.

K. Work of selected non-governmental organizations

340. A snapshot has been provided of current NGO work on conservation of freshwater ecosystems, based on some of the activities conducted by Conservation International (CI), the International Union for Conservation of Nature (IUCN), The Nature Conservancy (TNC), Wetlands International (WI) and the World Wide Fund For Nature (WWF). Because of their experience in practical implementation, their perspectives on constraints, priorities and successes and failures are extremely valuable for the purposes of the in-depth review of the CBD programme of work on inland waters. Examples of approaches are successfully demonstrated through 50 NGO case studies included in this review.

341. The establishment of partnerships is their main strategy, along with the use of cutting edge science. Governments, local communities and indigenous peoples are considered strategic partners. A high interrelation among their other different areas of work is also a common characteristic of these organizations, which is the result of applying an “ecosystem approach” to biodiversity conservation.

342. Conservation-livelihoods-poverty reduction linkages are a strong theme throughout. There is a clearly discernible shift in historical emphasis of the five NGOs from a "conservation" to a "people"

focussed approach, which mirrors the evolution of such emphasis with the CBD itself. This is particularly so for freshwaters, or is at least clearly demonstrable there. This is likely driven by the long experience that people need to be considered as integral to effective conservation, but probably more so by the recognition that effective management of freshwater ecosystems, balancing both conservation and sustainable use, is essential to achieve sustainable human development.

343. They concur that the main threats to these ecosystems are the alteration of river flows due to dams, reservoirs and water abstraction, water pollution resulting mainly from agricultural run-off and industrial discharges, invasive alien species, land change caused by agriculture and urbanization, over-harvesting of freshwater species and climate change. They also generally and broadly agree that the best strategy to tackle the various threats to freshwater ecosystems is the application of the ecosystem approach, which in the case of water resources is articulated more often as "Integrated Water Resource Management" (IWRM) or similar terminology. Environmental flow assessment is an increasingly conspicuous tool in the design of an integrated river management plan for a basin. Implementation of IWRM projects is successfully influencing water policy and strengthening water governance at different levels. Positive results have been more evident in projects where governmental institutions had an active participation and where the decision for integrated water management was a result of political will (often prompted by crisis). Through their IWRM projects, these NGOs are also acting towards climate change adaptation. One aspect that requires more attention, however, is considering the impact of climate change on river flows, especially when conducting environmental flow assessments that are the base for developing IWRM plans. This has started to be taken into account by including climate change vulnerability assessments.

344. In general, many projects focus on establishing a water management authority (in the form of water users' associations or integrated river basin councils, etc.) with representatives of relevant stakeholders groups. Institutional reform is a strong theme.

345. Based on the strong relationships among climate change, forest and freshwater ecosystem services, projects are evolving based on payment for ecosystem services and carbon market mechanisms, with conservation agreements as the main tool. The creation of an innovative water-related certification programmes is expected to have major impacts on the protection of water and freshwater ecosystems. Wetlands International is taking advantage of carbon mechanisms to implement a Global Peatland Fund.

346. Notably, whilst the brief overview of activities of these NGOs looked specifically for outcomes for inland waters, a considerable number of highly relevant and beneficial projects are not dealing with water directly. This reflects the fact that the main drivers of inland waters biodiversity (and ecosystem services) loss arise through land-based activities. Many projects and programmes therefore deal with land-based interventions, with a strong focus on cross-sectoral and institutional coordination. This supports a related finding of this in-depth review that the major solutions to addressing the needs under this programme of work rely on building relevant approaches in and across other programme areas.

THE STATUS AND TRENDS OF INLAND WATERS BIOLOGICAL DIVERSITY

A. Relevance of Ramsar monitoring & assessment processes to CBD inland waters programme targets and activities

347. "Wetlands" encompass a broader range of ecosystems than is often realised. Article 1.1 of the Ramsar Convention defines them as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres". Some are forested, some are agricultural land, some human-made, and some even underground.

348. Wetlands occur in all biomes and are potentially influenced by all sectoral activities. Appropriate management of land and water, using the Ecosystem Approach of the CBD, is required to achieve the goals of both Conventions. Hence the cooperation arrangements between Ramsar and the CBD are relevant to several of the CBD's thematic programmes and cross-cutting issues, if not all. This has also been recognised by CBD COP Decision VII/4, which refers to the presence of inland water ecosystems within ecosystems addressed by the other programmes of work, and encourages cross-referencing and coherence among the programmes in this respect.

349. There is no CBD-adopted definition of "inland waters", but the term is interpreted as defining the complementarity between this thematic area and the "marine and coastal" thematic area. "Wetland" *sensu* Ramsar relates to both programmes, though excludes offshore deep water marine areas. In ecological terms there is usually no clear boundary between what is inland and what is coastal. Coastal zone wetlands falling in the categories defined under Ramsar (see Ramsar Convention, 1999-2008) come within the ambit of the CBD's inland waters programme rather than the marine and coastal programme to the extent that their surface area in any given instance lies landward of the high water mark.

350. The assessment and indicator processes of some other bodies have addressed themselves to "freshwater" biodiversity, but that is not coincident with the scope of the present report, since both it and the CBD programme are broader - "inland waters" encompasses systems with a wide range of water salinities, including some that are extremely saline and some where salinity varies seasonally. (Conversely, some waters off large river outflows may remain "fresh" for some distance out to sea).

351. It is also important to recognise that the definition of "biological diversity" in the CBD (Article 2) includes the diversity of ecosystems. Hence all assessment and indicator processes addressing inland wetlands at the level of habitats or ecosystems are as relevant to the present review as those dealing with species/organisms.

352. In common with other Conventions, much of the information generated by monitoring and reporting activity under the Ramsar Convention relates to processes and actions; but a proportion of it does relate to the status and trends of wetlands themselves as well. Some of this concerns the reporting of actual or potential change in the ecological character of Ramsar sites (those wetlands of international importance designated by national governments for the Ramsar list), under Article 3.2 of the Convention. A description of this aspect, including the process for presenting overview reports to the COP, is given in Ramsar COP10 Information Document DOC27 (section 13 and Annex 2), available at http://www.ramsar.org/cop10/cop10_doc27_e.htm .

353. For each Ramsar site, Parties also provide a Ramsar Information Sheet which becomes lodged in a central database (the Ramsar Sites Information Service, RSIS, accessible on-line at http://ramsar.wetlands.org/). Under Resolution VI.13 these sheets should be updated at least every six years; providing (in theory, at least) another device for tracking changes in site status from one period to the next.

354. National reports to COPs provide another key information source: the data from these are also stored in a database, and a summary overview of any emerging trends is presented for each Ramsar region in documents tabled as COP Information Documents. Issues such as numbers of site designations, for which there may be no specific targets or indicators, are nonetheless monitored and reported in a *de facto* way in reports such as these and on the Convention website, and Ramsar site coverage of different wetland types and of certain defined categories of interest feature can be queried on-line via the RSIS (see URL above).

355. The Ramsar Strategic Plan (current version covering the period 2009-2015 and adopted as the Annex to Resolution X.1, available at http://www.ramsar.org/res/key_res_x_01_e.doc) contains "Key Result Areas" which offer a basis for monitoring progress with the Convention's global wetland conservation and sustainable use goals (although only a few of these address ecological outcomes). The strategies to which these relate also underpin the structure of the national report format, a "data and information needs framework" (Resolution X.14, http://www.ramsar.org/res/key_res_x_14_e.doc) and a further progress monitoring process mandated to the STRP for assessing the performance of the Convention in ways designed to complement the ecological effectiveness indicators.

356. The implementation of the Ramsar Convention is organised according to three "pillars": (i) listing and protecting wetlands of international importance (Ramsar sites); (ii) promoting the "wise use" of all wetlands ("wise use" is seen as synonymous with "sustainable use"); and (iii) international cooperation (over shared wetland resources, but more widely too). Hence although in some quarters the Convention is particularly well known for its site network dimension, that is just one of the three pillars, and as will be clear from the paragraphs above, many of the Convention's status and trends assessment processes address wetland ecosystems/biodiversity as a whole.

357. On the basis of these various processes, the Ramsar Convention can therefore be regarded as delivering a major part of the CBD's own wetland status and trends assessment/reporting needs (for the inland waters programme, and also for elements of the other programmes).

358. To provide some particulars of this, Table 1 relates the inland waters programme provisional targets (only some of which, of course, concern wetland status or trends) to the main target equivalents or indicators being monitored under the Ramsar Convention; while Table 2 shows where information provided by Ramsar Parties in response to relevant questions among the 66 questions in the National Report Format for Ramsar's COP10 may relate to the 62 "activities for Parties" listed in the CBD inland waters programme. Cross-references to relevant Ramsar indicators and sections of the present report are also given.

359. The correspondences identified in these tables vary from a close match to a partial overlap of relevance, and this is merely a rough indication of the scope of harmonised interests. Analysis of the identified national report data or effectiveness indicator data may nonetheless offer a way of shedding light on actual implementation of elements of the programme of work, as opposed to data on the existence of programmes which may merely aim to implement it.

360. Actual wordings are reproduced (though not all of the subsidiary sub-headings etc of items which have them) so that if these tables are used for cross-matching pursuant to a given specific line of enquiry,

a judgement can be made as to the degree of similarity being sought in the particular case. In Table 2, matches with the "goals" are included as well as the activities, since sometimes these are a closer "fit" with the Ramsar measures concerned.

361. The tables refer to Ramsar national report questions, indicators and Key Result Areas. It should be borne in mind that in some cases too, although not shown here, Ramsar COP Resolutions or Recommendations may give Parties a mandate or encouragement to undertake actions which correspond even more closely/specifically to the CBD items listed here; and again for any further more detailed lines of enquiry these may also be worth taking into account. Analysis methods for this would involve a more intricate process than is possible to show in the present report; but an impression of the possibilities might be gained from the results of a (different) exercise done in 2007 for the Ramsar Standing Committee, and viewable in the document SC35-12 at http://www.ramsar.org/sc/35/key_sc35_doc12.htm .

362. It should further in general be noted that all of these "hooks" for tracking progress are "samples" of the total effort, and they cannot pretend to provide a means of comprehensive all-inclusive assessment.

Table 1: CBD Inland waters programme targets, cross-matched to equivalent measurables adopted by the Ramsar Convention

CBD inland waters biodiversity targets, for achievement by 2010 (from Decision VIII/15 Annex IV)	Ramsar ecological outcome indicators of effectiveness (from Resolution X.1 Annex D)	Ramsar National Report Format questions (for reports to COP10, 2008)	Key Result Areas in Ramsar Strategic Plan, for achievement by 2015 (Resolution X.1, Annex)
Focal area 1: Protect the components of biodiversity **Goal 1**. Promote the conservation of the biological diversity of ecosystems, habitats and biomes			
Target 1.1 At least 10% of known inland water ecosystem area effectively conserved and under integrated river or lake basin management.	-	-	
Target 1.2 275 million hectares of wetlands of particular importance to biodiversity protected, including representation and equitable distribution of areas of different wetland types across the range of biogeographic zones.	**Indicator H** (under development): "the proportion of candidate Ramsar sites designated so far for wetland types/features" will assist with the second part of this	-	**2.1.iii**: At least 2,500 Ramsar sites designated worldwide, covering at least 250 million hectares.
Goal 2. Promote the conservation of species diversity			
Target 2.1 Reduce the decline of, maintain or restore populations of species of selected taxonomic groups dependent upon inland water ecosystems.	**Indicator F**: "trends in the status of waterbird biogeographic populations" **Indicator G**: "changes in threat status of wetland taxa"	-	

CBD inland waters biodiversity targets, for achievement by 2010 (from Decision VIII/15 Annex IV)	Ramsar ecological outcome indicators of effectiveness (from Resolution X.1 Annex D)	Ramsar National Report Format questions (for reports to COP10, 2008)	Key Result Areas in Ramsar Strategic Plan, for achievement by 2015 (Resolution X.1, Annex)
Target 2.2 The world's known threatened inland water ecosystem dependent species of plants and animals conserved, with particular attention to migratory, transboundary and endemic species and populations.	**Indicator I** (under development): "coverage of wetland-dependent bird populations by designated Ramsar sites" should provide a partial contribution to this	**2.5.2** Is effective cooperative management in place for shared wetland systems (including regional site and waterbird flyway networks)?	**3.5.i**: Where appropriate, all Parties to have identified their shared wetlands, river basins and migratory species, and Parties to have identified collaborative management mechanisms with one another for those shared wetlands and river basins. **3.5.iii**: Regional site networks and initiatives in place for additional wetland-dependent migratory species
Goal 3. Promote the conservation of genetic diversity			
Target 3.1 Known genetic diversity of crops, livestock, and of harvested species of trees, fish and wildlife and other valuable species dependent upon inland water ecosystems is conserved, and associated indigenous and local knowledge is maintained.	-	-	
Focal Area 2: Promote sustainable use **Goal 4**. Promote sustainable use and consumption			
Target 4.1.1: Products from inland water ecosystem biological diversity derived from sustainable sources.	-	-	
Target 4.1.2: Aquaculture areas in inland water ecosystems managed consistent with the conservation of inland water biological diversity.	-	-	
Target 4.3 No species of wild flora or fauna dependent upon inland water ecosystems endangered by international trade.	-	-	
Focal area 3: Address threats to biodiversity **Goal 5**. Pressures from habitat loss, land-use change and degradation, and unsustainable water use, reduced			

CBD inland waters biodiversity targets, for achievement by 2010 (from Decision VIII/15 Annex IV)	Ramsar ecological outcome indicators of effectiveness (from Resolution X.1 Annex D)	Ramsar National Report Format questions (for reports to COP10, 2008)	Key Result Areas in Ramsar Strategic Plan, for achievement by 2015 (Resolution X.1, Annex)
Target 5.1 Rate of loss and degradation of inland water ecosystem biological diversity, especially through unsustainable water use, are decreased.	**Indicator A(i)**: "status and trends in wetland ecosystem extent" addresses the "loss" component **Indicator A(ii)**: "trends in conservation status of wetlands - qualitative assessment" addresses the "degradation" component **Indicator B**: "trends in the status of Ramsar site ecological character - qualitative assessment" addresses the "degradation" component for designated wetlands of international importance **Indicator C**: "trends in water quality" and Indicator K (under development): "trends in water quantity" could also be relevant **Indicator D**: "the frequency of threats affecting Ramsar sites" should shed some light on the "unsustainable water use" component, for designated wetlands of international importance, depending on what degree of disaggregation of individual threat types is achieved	**1.1.3** Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **1.1.4** If the answer is "Yes" in 1.1.3, does this information indicate that the need to address adverse change in the ecological character of wetlands is now greater, the same, or less than in the previous triennium, for: (a) Ramsar sites (b) wetlands generally. **2.4.3** If applicable, have actions been taken to address the issues for which Ramsar sites have been listed on the Montreux Record?	
Goal 6. Control threats from invasive alien species			
Target 6.1 Pathways for major potential invasive alien species in inland water ecosystems controlled.	-	**1.6.1** Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented?	**1.9.iii**: National invasive species control and management policies or guidelines in place for wetlands.

CBD inland waters biodiversity targets, for achievement by 2010 (from Decision VIII/15 Annex IV)	Ramsar ecological outcome indicators of effectiveness (from Resolution X.1 Annex D)	Ramsar National Report Format questions (for reports to COP10, 2008)	Key Result Areas in Ramsar Strategic Plan, for achievement by 2015 (Resolution X.1, Annex)
Target 6.2 Management plans in place and implemented for invasive alien species that are considered to present the greatest threat to inland water ecosystems, habitats or species.	-	**1.6.1** Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented?	
Goal 7. Address challenges to biodiversity from climate change, and pollution			
Target 7.1 Maintain and enhance resilience of the components of inland water ecosystem biodiversity to adapt to climate change.	-	**1.5.1** Have wetland restoration/rehabilitation programmes or projects been implemented? **1.5.2** Has the Convention's guidance on wetland restoration (Annex to Resolution VIII.16; Wise Use Handbook 15, 3rd edition) been used/applied in designing and implementing wetland restoration/rehabilitation programmes or projects?	**1.7.iii**: National policies or guidelines enhancing the role of wetlands in mitigation and/or adaptation to climate change in progress or completed **1.8.i**: All Parties to have identified priority sites for restoration; restoration projects underway or completed in at least half the Parties.
Target 7.2 Substantially reduce pollution and its impacts on inland water ecosystem biodiversity.	**Indicator C**: "trends in water quality" **Indicator D**: "the frequency of threats affecting Ramsar sites" may also shed some light, for designated wetlands of international importance, depending on what degree of disaggregation of individual threat types is achieved	**1.4.1** Has the Convention's water-related guidance (see Resolution IX.1. Annex C) been used/applied in decisionmaking related to water resource planning and management? **2.3.1** Have the measures required to maintain the ecological character of all Ramsar sites been defined and applied?	
Focal area 4: Maintain goods and services from biodiversity to support human well-being **Goal 8**. Maintain capacity of ecosystems to deliver goods and services and support livelihoods			
Target 8.1 Capacity of inland water ecosystems to deliver goods and services maintained or enhanced.	-	**1.3.1** Has an assessment been conducted of the ecosystem benefits/services provided by Ramsar sites? **1.5.1** Have wetland	**1.4.i**: Development and implementation of wetland programmes and projects that contribute to poverty eradication objectives and food and water security plans at

CBD inland waters biodiversity targets, for achievement by 2010 (from Decision VIII/15 Annex IV)	Ramsar ecological outcome indicators of effectiveness (from Resolution X.1 Annex D)	Ramsar National Report Format questions (for reports to COP10, 2008)	Key Result Areas in Ramsar Strategic Plan, for achievement by 2015 (Resolution X.1, Annex)
		restoration/rehabilitation programmes or projects been implemented? **1.5.2** Has the Convention's guidance on wetland restoration (Annex to Resolution VIII.16; Wise Use Handbook 15, 3rd edition) been used/applied in designing and implementing wetland restoration/rehabilitation programmes or projects? **2.3.1** Have the measures required to maintain the ecological character of all Ramsar sites been defined and applied?	local and national levels. **1.7.v**: Parties to have formulated plans to sustain and enhance the role of wetlands in supporting and maintaining viable farming systems. **1.8.i**: All Parties to have identified priority sites for restoration; restoration projects underway or completed in at least half the Parties.
Target 8.2 Inland water biological resources that support sustainable livelihoods, local food security and health care, especially of poor people, maintained and, where depleted, restored.	-	**1.3.2** Have wise use wetland programmes and/or projects that contribute to poverty alleviation objectives and/or food and water security plans been implemented?	**1.4.i**: Development and implementation of wetland programmes and projects that contribute to poverty eradication objectives and food and water security plans at local and national levels.
Focal area 5: Protect traditional knowledge, innovations and practices **Goal 9**. Maintain socio-cultural diversity of indigenous and local communities	-		
Target 9.1 Measures to protect traditional knowledge, innovations and practices associated with the biological diversity of inland water ecosystems implemented, and the participation of indigenous and local communities in activities aimed at this promoted and facilitated.	-	**1.3.4** Has national action been taken to apply the guiding principles on cultural values of wetlands (Resolutions VIII.19 and IX.21)? **4.1.2** Have traditional knowledge and management practices in relation to wetlands been documented and their application encouraged? **4.1.5** Have cultural values of wetlands been included in the management	**1.4.iii**: The socio-economic and cultural heritage value of wetlands fully taken into account in wetland wise use and management. **4.1.iii**: All Parties to have established practices that ensure the participation in the development and implementation of wetland management plans of stakeholder groups with cultural or economic links to

CBD inland waters biodiversity targets, for achievement by 2010 (from Decision VIII/15 Annex IV)	Ramsar ecological outcome indicators of effectiveness (from Resolution X.1 Annex D)	Ramsar National Report Format questions (for reports to COP10, 2008)	Key Result Areas in Ramsar Strategic Plan, for achievement by 2015 (Resolution X.1, Annex)
		planning of Ramsar sites and other wetlands?	wetlands or those communities that depend on the wetlands for their livelihoods.
Target 9.2 Traditional knowledge, innovations and practices regarding biological diversity of inland water ecosystems respected, preserved and maintained, the wider application of such knowledge, innovations and practices promoted with the prior informed consent and involvement of the indigenous and local communities providing such traditional knowledge, innovations and practices, and the benefits arising from such knowledge, innovations and practices equitably shared.	-	**1.3.4** Has national action been taken to apply the guiding principles on cultural values of wetlands (Resolutions VIII.19 and IX.21)? **4.1.2** Have traditional knowledge and management practices in relation to wetlands been documented and their application encouraged? **4.1.5** Have cultural values of wetlands been included in the management planning of Ramsar sites and other wetlands?	**1.4.iii**: The socio-economic and cultural heritage value of wetlands fully taken into account in wetland wise use and management.
Focal area 6: Ensure the fair and equitable sharing of benefits arising out of the use of genetic resources **Goal 10**. Ensure the fair and equitable sharing of benefits arising out of the use of genetic resources			
Target 10.1 All access to genetic resources derived from inland water ecosystems is in line with the Convention on Biological Diversity.	-	-	
Target 10.2 Benefits arising from the commercial and other utilization of genetic resources derived from inland water ecosystems shared with the countries providing such resources.	-	-	
Focal area 7: Ensure provision of adequate resources **Goal 11**. Parties have improved financial, human, scientific, technical and technological capacity to implement the Convention			
Target 11.1 New and additional financial resources are transferred to developing country Parties, to allow for the		**4.5.1** [For Contracting Parties with development assistance agencies only] Has funding support been	**3.3.i**: Parties with bilateral donor agencies to have encouraged those agencies to give

CBD inland waters biodiversity targets, for achievement by 2010 (from Decision VIII/15 Annex IV)	Ramsar ecological outcome indicators of effectiveness (from Resolution X.1 Annex D)	Ramsar National Report Format questions (for reports to COP10, 2008)	Key Result Areas in Ramsar Strategic Plan, for achievement by 2015 (Resolution X.1, Annex)
effective implementation of their commitments for the programme of work on the biological diversity of inland water ecosystems under the Convention, in accordance with Article 20.	-	provided from the development assistance agency for wetland conservation and management in other countries? **4.5.2** [For Contracting Parties in receipt of development assistance only] Has funding support been mobilized from development assistance agencies specifically for incountry wetland conservation and management?	priority for funding for wetland conservation and wise use projects in relation to poverty eradication and other relevant international targets and priorities.
Target 11.2 Technology is transferred to developing country Parties, to allow for the effective implementation of their commitments for the programme of work on the biological diversity of inland water ecosystems under the Convention, in accordance with its Article 20, paragraph 4.	-	-	

Table 2: CBD Inland waters programme activities for Parties, cross-matched to equivalent measurables adopted by the Ramsar Convention

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
PROGRAMME ELEMENT 1: CONSERVATION, SUSTAINABLE USE AND BENEFIT-SHARING		
Goal 1.1. To integrate the conservation and sustainable use of biological diversity into all relevant sectors of water-resource and river-basin management, taking into account the ecosystem approach.	**H**. How can Ramsar Convention implementation be better linked with the implementation of water policy/strategy and other strategies in the country (e.g., sustainable development, energy, extractive industry, poverty reduction, sanitation, food security, biodiversity)? **1.4.1**. Has the Convention's water-related guidance (see Resolution IX.1. Annex C) been used/applied in	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	decisionmaking related to water resource planning and management? **4.4.3**. Have actions been taken to communicate and share information cross-sectorally on wetland issues amongst relevant ministries, departments and agencies?	
1.1.1. Assess current management approaches and strategies with regard to their integration of the ecosystem approach and sustainable use principles and adjust them as needed.	(None)	
1.1.2. Develop effective management strategies to maintain or improve the sustainability of inland water ecosystems, including those identified as most stressed and facilitate a minimum water allocations to the environment to maintain ecosystem functioning and integrity. In so doing, consideration should also be given to the likely impacts of climate change and desertification, and factor in suitable mitigation and adaptive management approaches.	**1.2.1**. Is a National Wetland Policy (or equivalent instrument) in place? **1.2.3**. Have wetland issues been incorporated into national strategies for sustainable development (including National Poverty Reduction Plans called for by the WSSD and water resources management and water efficiency plans)? **1.2.4**. Has the quantity and quality of water available to, and required by, wetlands been assessed? **1.4.1**. Has the Convention's water-related guidance (see Resolution IX.1. Annex C) been used/applied in decisionmaking related to water resource planning and management? **1.4.4**. Have the implications for wetland conservation and wise use of national implementation of the Kyoto Protocol been assessed? **2.3.1**. Have the measures required to maintain the ecological character of all Ramsar sites been defined and applied? **2.3.2**. Have management plans/strategies been developed and implemented at all Ramsar sites?	**Indicator E**: Wetland sites with successfully implemented conservation or wise use management plans
1.1.3. Identify and remove the sources, or reduce the impacts, of water pollution (chemical, thermal, microbiological or physical) on the biological diversity of inland waters.	**1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **1.2.4**. Has the quantity and quality of water available to, and required by, wetlands been assessed? **1.4.1**. Has the Convention's water-	**Indicator C**: Trends in water quality

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	related guidance (see Resolution IX.1. Annex C) been used/applied in decisionmaking related to water resource planning and management?	
1.1.4. Promote effective collaboration among scientists, local stakeholders, planners, engineers, and economists, and including indigenous and local communities with their prior informed consent (both within and among countries) in the planning and implementation of development projects to better integrate the conservation and sustainable use of inland water biological diversity with water resource developments.	**1.2.3**. Have wetland issues been incorporated into national strategies for sustainable development (including National Poverty Reduction Plans called for by the WSSD and water resources management and water efficiency plans)? **1.2.5**. Are Strategic Environmental Assessment practices applied when reviewing policies, programmes and plans that may impact upon wetlands? **1.3.1**. Has an assessment been conducted of the ecosystem benefits/services provided by Ramsar sites? **2.3.3**. Have cross-sectoral site management committees been established at Ramsar sites? **4.1.1**. Has resource information been compiled on local communities' and indigenous people's participation in wetland management? **4.1.2**. Have traditional knowledge and management practices in relation to wetlands been documented and their application encouraged? **4.1.3**. Does the Contracting Party promote public participation in decision-making (with respect to wetlands), especially with local stakeholder involvement in the selection of new Ramsar sites and in Ramsar site management? **4.2.1**. Is the private sector encouraged to apply the wise use principle in activities and investments concerning wetlands? **4.4.3**. Have actions been taken to communicate and share information cross-sectorally on wetland issues amongst relevant ministries, departments and agencies?	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	4.5.1. [For Contracting Parties with development assistance agencies only] Has funding support been provided from the development assistance agency for wetland conservation and management in other countries? **4.5.2**. [For Contracting Parties in receipt of development assistance only] Has funding support been mobilized from development assistance agencies specifically for incountry wetland conservation and management? **4.8.2**. Is a National Ramsar/Wetlands cross-sectoral Committee (or equivalent body) in place and operational?	
1.1.5. Contribute to, and participate in, as appropriate, the River Basin Initiative (RBI) by sharing case-studies, experiences and lessons learned on: **(a)** Examples of watershed management that incorporate the conservation and sustainable use of inland water biological diversity with special reference to examples that use the ecosystem approach to meet water management goals; and **(b)** Examples of water resource development projects (water supply and sanitation, irrigation, hydropower, flood control, navigation, groundwater extraction) that incorporate consideration of the conservation and sustainable use of biological diversity.	**1.3.2**. Have wise use wetland programmes and/or projects that contribute to poverty alleviation objectives and/or food and water security plans been implemented? **1.4.2**. Have CEPA expertise and tools been incorporated into catchment/river basin planning and management?	
1.1.6. Introduce into regional, national, catchment, watershed and river-basin level, and local water and land-use planning and management, adaptive management and mitigation strategies to combat and prevent, where possible, the negative impacts of climate change, El Niño, unsustainable land-use practices and desertification, noting the ongoing work of the Ad Hoc Technical Expert Group on Biodiversity and Climate Change and the programme of work on dry and sub-humid lands.	**1.2.4**. Has the quantity and quality of water available to, and required by, wetlands been assessed? **1.4.4**. Have the implications for wetland conservation and wise use of national implementation of the Kyoto Protocol been assessed?	
1.1.7. Provide to the Executive Secretary advice on national experiences and approaches to promoting and implementing adaptive management and mitigation strategies for combating the impacts of climate change, El Niño and desertification.	(None)	
1.1.8. Use, where appropriate, all available information on dams in order to ensure that biodiversity considerations are fully taken into account in decision-making on large dams.	**1.1.2**. Is the wetland inventory data and information maintained and made accessible to all stakeholders? **1.2.4**. Has the quantity and quality of water available to, and required by,	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	wetlands been assessed? (**1.2.5**. Are Strategic Environmental Assessment practices applied when reviewing policies, programmes and plans that may impact upon wetlands?) **1.4.1**. Has the Convention's water-related guidance (see Resolution IX.1. Annex C) been used/applied in decisionmaking related to water resource planning and management? **2.4.1**. Are arrangements in place for the Administrative Authority to be informed of changes or likely changes in the ecological character of Ramsar sites, pursuant to Article 3.2?	
1.1.9. Assess the linkages between inland water ecosystems and climate change and the management options for mitigation of and adaptation to climate change.	**1.4.4**. Have the implications for wetland conservation and wise use of national implementation of the Kyoto Protocol been assessed? **2.3.1**. Have the measures required to maintain the ecological character of all Ramsar sites been defined and applied?	
Goal 1.2: To establish and maintain comprehensive, adequate and representative systems of protected inland water ecosystems within the framework of integrated catchment/watershed/river-basin management.	(See specific questions below)	**Indicator H**: The proportion of candidate Ramsar sites designated so far for wetland types/features **Indicator I**: Coverage of wetland-dependent bird populations by designated Ramsar sites *(Not covered in report)*
1.2.1. Provide, as appropriate, to the Executive Secretary, examples of protected-area establishment and management strategies that are supporting the conservation and sustainable use of inland water ecosystems.	**2.1.1**. Have a strategy and priorities been established for any further designation of Ramsar sites, using the Strategic Framework for the Ramsar List? **2.3.2**. Have management plans/strategies been developed and implemented at all Ramsar sites? **2.3.3**. Have cross-sectoral site	

Inland waters programme “activities for Parties” (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	management committees been established at Ramsar sites? **2.3.4**. Has any assessment of Ramsar site management effectiveness been carried out?	
1.2.2. Undertake the necessary assessments to identify priority sites for inclusion into a system of protected inland water ecosystems, applying in particular the guidance on operationalizing annex I of the Convention on Biological Diversity and its harmonized application with the criteria for identifying Wetlands of International Importance under the Ramsar Convention (see activity 3.2.3).	**1.1.1**. Does your country have a comprehensive National Wetland Inventory? **2.1.1**. Have a strategy and priorities been established for any further designation of Ramsar sites, using the Strategic Framework for the Ramsar List?	
1.2.3. As part of activity 1.2.2 above, identify sites important for migratory species dependent on inland water ecosystems.	**2.1.1**. Have a strategy and priorities been established for any further designation of Ramsar sites, using the Strategic Framework for the Ramsar List?	
1.2.4. Develop incrementally, as the availability of resources and national priorities determine, and as part of an integrated catchment/watershed/river basin management approach, protected area systems (aquatic reserves, Ramsar sites, heritage rivers, etc.), which can contribute in a systematic way to the conservation and sustainable use of biological diversity, and to maintaining overall ecosystem function, productivity and “health” within each drainage basin. In undertaking activity 1.2.4, those Parties to the Convention on Biological Diversity that are also Parties to the Ramsar Convention should harmonize this work with the development of national networks of wetlands of international importance, which are comprehensive and coherent in line with the Ramsar strategic framework for the future development of the List of Wetlands of International Importance and taking into account ecological connectivity*/ and the concept, where appropriate, of ecological networks, in line with the programme of work on protected areas (decision VII/28). (*The concept of connectivity may not be applicable to all Parties)	**2.1.1**. Have a strategy and priorities been established for any further designation of Ramsar sites, using the Strategic Framework for the Ramsar List? **2.3.4**. Has any assessment of Ramsar site management effectiveness been carried out? **2.5.2**. Is effective cooperative management in place for shared wetland systems (including regional site and waterbird flyway networks)?	**Indicator H**: The proportion of candidate Ramsar sites designated so far for wetland types/features **Indicator I**: Coverage of wetland-dependent bird populations by designated Ramsar sites *(Not covered in this report)*
1.2.5. As appropriate, work collaboratively with neighbouring Parties to identify, have formally recognized and managed, transboundary protected inland water ecosystems.	**2.5.1**. Have all transboundary/shared wetland systems been identified? **2.5.2**. Is effective cooperative management in place for shared wetland systems (including regional site and waterbird flyway networks)?	
Goal 1.3: To enhance the conservation status of inland water biological diversity through rehabilitation and restoration of degraded ecosystems and the recovery of threatened species.	**1.5.1**. Have wetland restoration/rehabilitation programmes or projects been implemented? **1.5.2**. Has the Convention’s guidance on wetland restoration (Annex to	(Not specifically; but see Indicator A)

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	Resolution VIII.16; Wise Use Handbook 15, 3rd edition) been used/applied in designing and implementing wetland restoration/rehabilitation programmes or projects?	
1.3.1. Provide, as appropriate, to the Executive Secretary case-studies, national experiences and any relevant local, national or regional guidance relating to the successful rehabilitation or restoration of degraded inland water ecosystems, and the recovery of threatened species.	**1.5.1**. Have wetland restoration/rehabilitation programmes or projects been implemented? **1.5.2**. Has the Convention's guidance on wetland restoration (Annex to Resolution VIII.16; Wise Use Handbook 15, 3rd edition) been used/applied in designing and implementing wetland restoration/rehabilitation programmes or projects?	
1.3.2. Identify nationally priority candidate inland water ecosystems and/or sites for rehabilitation or restoration and proceed to undertake such works, as resources allow. In identifying potential candidate sites, consider the relative conservation status of the threatened species involved, and the potential gains for the overall ecosystem functioning, productivity and "health" within each drainage basin (see activity 1.2.4).	**1.5.1**. Have wetland restoration/rehabilitation programmes or projects been implemented? **1.5.2**. Has the Convention's guidance on wetland restoration (Annex to Resolution VIII.16; Wise Use Handbook 15, 3rd edition) been used/applied in designing and implementing wetland restoration/rehabilitation programmes or projects?	
1.3.3. Identify nationally and then act, as appropriate, to improve the conservation status of threatened species, including migratory species, reliant on inland water ecosystems, (see activities 1.2.3 and 1.2.4), taking into account the programme of work on restoration and rehabilitation of degraded ecosystems being developed by the Conference of the Parties as part of its multi-year programme of work up to 2010.	**1.6.1**. Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented? **1.6.2**. Have such policies, strategies and management responses been carried out in cooperation with the focal points of other conventions and international organisations/processes? **2.3.1**. Have the measures required to maintain the ecological character of all Ramsar sites been defined and applied? **2.4.3**. If applicable, have actions been taken to address the issues for which Ramsar sites have been listed on the Montreux Record?	**Indicator F**: Overall population trends of wetland taxa **(i)** trends in the status of waterbird biogeographic populations **Indicator G**: Changes in threat status of wetland taxa **(i)** trends in the status of globally-threatened wetland-dependent birds; **(ii)** trends in the status of globally-threatened wetland-dependent amphibians

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
Goal 1.4: To prevent the introduction of invasive alien species, including exotic stocks that potentially threaten the biological diversity of inland water ecosystems, and to control and, where possible, eradicate established invasive species in these ecosystems.	**1.6.1**. Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented? **1.6.2**. Have such policies, strategies and management responses been carried out in cooperation with the focal points of other conventions and international organisations/processes?	(Not specifically, but see Indicator D)
1.4.1. Promote and implement relevant guidelines and/or guiding principles in relation to invasive alien species making use of the expert guidance available such as through the "toolkit" of the Global Invasive Species Programme (GISP), the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions (ICSU), and other sources referred to under the heading "Supporting activities" below.	**1.6.1**. Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented? **1.6.2**. Have such policies, strategies and management responses been carried out in cooperation with the focal points of other conventions and international organisations/processes?	
1.4.2. Provide the Executive Secretary, as appropriate, with examples of the impacts of invasive alien species and of programmes used to control their introduction and mitigate negative consequences on inland water ecosystems, especially at the catchment, watershed and river-basin levels.	**1.6.1**. Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented? **1.6.2**. Have such policies, strategies and management responses been carried out in cooperation with the focal points of other conventions and international organisations/processes?	
1.4.3. Raise awareness, as part of communication, education and public awareness-raising activities (see goal 2.4) of the possible problems and costs associated with the deliberate or accidental introduction of alien species, including exotic stocks and alien genotypes and genetically modified organisms that potentially threaten aquatic biological diversity, taking into consideration the Cartagena Protocol on Biosafety to the Convention on Biological Diversity.	**1.6.1**. Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented? **1.6.2**. Have such policies, strategies and management responses been carried out in cooperation with the focal points of other conventions and international organisations/processes?	
1.4.4. Within the context of transboundary catchments, watershed and river-basin management, and especially in relation to inter-basin water transfers, provide appropriate mechanisms to prevent the spread of invasive alien species.	**1.6.1**. Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented?	
1.4.5. Prevent the introduction of invasive alien species and restore, where appropriate, indigenous wild-capture fisheries stocks in preference to other aquaculture developments.	**1.6.1**. Have national policies, strategies and management responses to threats from invasive species, particularly in wetlands, been developed and implemented?	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
PROGRAMME ELEMENT 2: INSTITUTIONAL AND SOCIO-ECONOMIC ENABLING ENVIRONMENT		
Goal 2.1: To promote the integration of conservation and sustainable use of the biological diversity of inland water ecosystems into relevant sectoral and cross-sectoral plans, programmes, policies and legislation.	**H**. How can Ramsar Convention implementation be better linked with the implementation of water policy/strategy and other strategies in the country (e.g., sustainable development, energy, extractive industry, poverty reduction, sanitation, food security, biodiversity)? **1.2.3**. Have wetland issues been incorporated into national strategies for sustainable development (including National Poverty Reduction Plans called for by the WSSD and water resources management and water efficiency plans)? **1.3.1**. Has an assessment been conducted of the ecosystem benefits/services provided by Ramsar sites? **1.3.2**. Have wise use wetland programmes and/or projects that contribute to poverty alleviation objectives and/or food and water security plans been implemented? **3.1.1**. Are mechanisms in place at the national level for collaboration between the Ramsar Administrative Authority and the focal points of other multilateral environmental agreements (MEAs)? **4.4.3**. Have actions been taken to communicate and share information cross-sectorally on wetland issues amongst relevant ministries, departments and agencies? **4.8.2**. Is a National Ramsar/Wetlands cross-sectoral Committee (or equivalent body) in place and operational?	**Indicator L**: Legislative amendments implemented to reflect Ramsar provisions *(Not covered in this report)*
2.1.1. Undertake reviews and introduce reforms to policies, legal and administrative frameworks as necessary, in order to integrate the conservation and sustainable use of inland water biodiversity into the mainstream of government, business, and societal decision-making.	**G**. How can national implementation of the Ramsar Convention be better linked with implementation of other multilateral environmental agreements (MEAs), especially those in the "Biodiversity cluster" (Ramsar,	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	Convention on Biological Diversity (CBD), Convention on Migratory Species (CMS), CITES, and World Heritage Convention), and UNCCD and UNFCCC? **H**. How can Ramsar Convention implementation be better linked with the implementation of water policy/strategy and other strategies in the country (e.g., sustainable development, energy, extractive industry, poverty reduction, sanitation, food security, biodiversity)? **1.2.1**. Is a National Wetland Policy (or equivalent instrument) in place? **4.3.1**. Have actions been taken to promote incentive measures which encourage the conservation and wise use of wetlands? **4.3.2**. Have actions been taken to remove perverse incentive measures which discourage conservation and wise use of wetlands? **4.8.1**. Has a review of national institutions responsible for the conservation and wise use of wetlands been completed?	
2.1.2. Apply, as urged by decision VI/7, the guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation and/or processes (see goal 3.3) and in strategic environmental assessment.	**1.2.5**. Are Strategic Environmental Assessment practices applied when reviewing policies, programmes and plans that may impact upon wetlands? **2.4.1**. Are arrangements in place for the Administrative Authority to be informed of changes or likely changes in the ecological character of Ramsar sites, pursuant to Article 3.2?	
2.1.3. Review institutional arrangements (policies, strategies, focal points and national reporting approaches) for national implementation of relevant multilateral environment agreements (see objective (c) above) and introduce reforms to streamline and, where appropriate, integrate implementation.	**G**. How can national implementation of the Ramsar Convention be better linked with implementation of other multilateral environmental agreements (MEAs), especially those in the "Biodiversity cluster" (Ramsar, Convention on Biological Diversity (CBD), Convention on Migratory Species (CMS), CITES, and World Heritage Convention), and UNCCD and UNFCCC? **1.2.2**. Does the National Wetland Policy (or equivalent instrument) incorporate any World Summit on	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	Sustainable Development (WSSD) targets and actions? **3.1.1**. Are mechanisms in place at the national level for collaboration between the Ramsar Administrative Authority and the focal points of other multilateral environmental agreements (MEAs)? **3.1.2**. Are the national focal points of other MEAs invited to participate in the National Ramsar/Wetland Committee?	
2.1.4. Provide the Executive Secretary with case-studies and information on lessons learned from policy, legal and institutional review and reform processes relating to inland water biodiversity and ecosystems, including measures taken to harmonize national implementation of the relevant multilateral environment agreements.	**G**. How can national implementation of the Ramsar Convention be better linked with implementation of other multilateral environmental agreements (MEAs), especially those in the "Biodiversity cluster" (Ramsar, Convention on Biological Diversity (CBD), Convention on Migratory Species (CMS), CITES, and World Heritage Convention), and UNCCD and UNFCCC? **3.1.1**. Are mechanisms in place at the national level for collaboration between the Ramsar Administrative Authority and the focal points of other multilateral environmental agreements (MEAs)? **3.1.2**. Are the national focal points of other MEAs invited to participate in the National Ramsar/Wetland Committee? **4.8.1**. Has a review of national institutions responsible for the conservation and wise use of wetlands been completed?	**Indicator L**: Legislative amendments implemented to reflect Ramsar provisions *(Not covered in report)*
Goal 2.2: To encourage the development, application and transfer of low-cost appropriate technology, non-structural and innovative approaches to water resource management and the conservation and sustainable use of the biological diversity of inland water ecosystems, taking into account any decision taken by the Conference of the Parties at its seventh meeting on technology transfer and cooperation.	**3.2.1**. Have networks, including twinning arrangements, been established, nationally or internationally, for knowledge sharing and training for wetlands that share common features?	
2.2.1. Make available to the Executive Secretary information on appropriate technologies and effective approaches to managing biodiversity of inland water ecosystems for transfer to other Parties.	(None)	
2.2.2. Encourage the use of low-cost (appropriate)	**4.1.2**. Have traditional knowledge and	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
technology, non-structural and innovative approaches, and, where appropriate and through prior informed consent in accordance with national laws traditional or indigenous practices for inland water biodiversity assessment and to meet watershed management goals, such as using wetlands to improve water quality, using forests and wetlands to recharge groundwater and maintain the hydrological cycle, to protect water supplies and using natural floodplains to prevent flood damage, and to use, whenever possible, indigenous species for aquaculture.	management practices in relation to wetlands been documented and their application encouraged?	
2.2.3. Encourage the development of preventative strategies such as cleaner production, continual environmental improvement, corporate environmental reporting, product stewardship and environmentally sound technologies to avoid degradation and promote maintenance, and, where applicable, restoration of inland water ecosystems.	**4.2.1**. Is the private sector encouraged to apply the wise use principle in activities and investments concerning wetlands? **4.3.1**. Have actions been taken to promote incentive measures which encourage the conservation and wise use of wetlands?	
2.2.4. Emphasize more effective conservation and efficiency in water use, together with non-engineering solutions. Environmentally appropriate technologies should be identified, such as low-cost sewage treatment and recycling of industrial water, to assist in the conservation and sustainable use of inland waters.	(None)	
Goal 2.3: To provide the appropriate incentives and valuation measures to support the conservation and sustainable use of inland water biological diversity, and to remove, or reform appropriately, any perverse incentives opposing such conservation and sustainable use of ecosystems, as it relates to biodiversity conservation*. (*Implementation of this programme of work should not promote incentives that negatively affect the biodiversity of other countries)	**4.3.1**. Have actions been taken to promote incentive measures which encourage the conservation and wise use of wetlands? **4.3.2**. Have actions been taken to remove perverse incentive measures which discourage conservation and wise use of wetlands?	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
2.3.1. Apply to inland water ecosystems the proposals for the design and implementation of incentive measures, including identification and removal or mitigation of perverse incentives, as endorsed by the Conference of the Parties in decision VI/15 and taking into account land-tenure systems. In particular: **(a)** Review the range and effectiveness of national incentives, subsidies, regulations, and other relevant financial mechanisms, which can affect inland water ecosystems, whether adversely or beneficially; **(b)** Redirect, as appropriate, financial support measures that run counter to the objectives of the Convention regarding the biological diversity of inland waters; **(c)** Implement targeted incentive and regulatory measures that have positive impacts on the biological diversity of inland waters; **(d)** Develop the policy research capacity needed to inform the decision-making process in a multidisciplinary and sectorally integrated manner; **(e)** Encourage the identification of the interdependence between conservation and sustainable use of inland water ecosystems and sustainable development; **(f)** At appropriate levels (regional, national, subnational and local), encourage the identification of stressed inland waters, the allocation and reservation of water for the maintenance of ecosystem functions, and the maintenance of environmental flows as an integral component of appropriate legal, administrative and economic mechanisms.	(Re (f)) - **1.4.1**. Has the Convention's water-related guidance (see Resolution IX.1. Annex C) been used/applied in decisionmaking related to water resource planning and management? **4.3.1**. Have actions been taken to promote incentive measures which encourage the conservation and wise use of wetlands? **4.3.2**. Have actions been taken to remove perverse incentive measures which discourage conservation and wise use of wetlands?	
2.3.2. In accordance with decision VI/15, submit case-studies, lessons learned and other information on positive or perverse incentives, land-use practices and tenure relating to inland water biodiversity to the Executive Secretary. Include within this submission national experiences and guidance in relation to water rights, markets and pricing policies.	**4.3.1**. Have actions been taken to promote incentive measures which encourage the conservation and wise use of wetlands? **4.3.2**. Have actions been taken to remove perverse incentive measures which discourage conservation and wise use of wetlands?	
2.3.3. Undertake comprehensive valuations of the goods and services of inland water biodiversity and ecosystems, including their intrinsic, aesthetic, cultural, socio-economic and other values, in all relevant decision-making across the appropriate sectors (see also goal 3.3 in relation to environmental, cultural and social impact assessments).	**1.3.1**. Has an assessment been conducted of the ecosystem benefits/services provided by Ramsar sites?	
Goal 2.4: To implement the programme of work for the Global Initiative on Communication, Education and Public Awareness (as adopted by the Conference of the Parties to the Convention on Biological Diversity in its decision VI/19), giving	**4.4.1**. Has a mechanism for planning and implementing wetland CEPA (National Ramsar/Wetland Committee or other mechanism) been established with both CEPA Government and	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
particular attention to matters relating to the conservation and sustainable use of the biological diversity of inland water ecosystems.	NGO National Focal Point (NFP) involvement? **4.4.2**. Has a National Action Plan (or plans at the subnational, catchment or local level) for wetland CEPA been developed? **4.4.4**. Have national campaigns, programmes, and projects been carried out to raise community awareness of the ecosystem benefits/services provided by wetlands?	
2.4.1. Review the Global Initiative on Communication, Education and Public Awareness (CEPA) contained in decision VI/19 with a view to identifying how best to promote its application for supporting the implementation of the programme of work on inland water biological diversity, as appropriate, taking into account the second CEPA programme adopted by the Conference of the Contracting Parties to the Ramsar Convention at its eighth meeting.	(None specifically)	
2.4.2. In undertaking activity 2.4.1, identify case-studies and best practices and provide these to the Executive Secretary to be made available to other Parties.	**4.4.4**. Have national campaigns, programmes, and projects been carried out to raise community awareness of the ecosystem benefits/services provided by wetlands? **4.4.5**. Have World Wetlands Day activities in the country, either government and NGO-led or both, been carried out?	
2.4.3. Ensure effective working linkages between the focal points for the Convention on Biological Diversity, and the Ramsar (government and non-government) focal points for wetlands communication, education and public awareness, including the amalgamation, at a national level, of communication, education and public awareness (CEPA) programmes under both conventions.	(None specifically; but see G, 3.1.1, 3.1.2)	
2.4.4. Identify key national, catchment/river basin and local-level decision makers and stakeholders and establish appropriate communication and awareness raising mechanisms to ensure they are all informed of, and supporting through their actions, the implementation of this programme of work.	(None specifically; but see 4.1.3)	
2.4.5. Undertake suitable initiatives to enhance awareness of the knowledge held by indigenous and local communities and the appropriate procedures, such as prior informed consent, for accessing such knowledge in accordance with national legislation on access to traditional knowledge.	**4.1.2**. Have traditional knowledge and management practices in relation to wetlands been documented and their application encouraged?	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
2.4.6. Review, and as necessary reform, formal educational curricula to ensure they are operating to inform and educate about the conservation and sustainable use of the biological diversity of inland water biological diversity. See also activity 3.1.5 in relation to the communication of research findings.	(None specifically; but see eg 4.4.2).	
Goal 2.5: Promote the effective participation of indigenous and local communities and relevant stakeholders in the conservation and sustainable use of biological diversity of inland water ecosystems in accordance with national laws and applicable international obligations.	**4.1.3**. Does the Contracting Party promote public participation in decision-making (with respect to wetlands), especially with local stakeholder involvement in the selection of new Ramsar sites and in Ramsar site management?	
2.5.1. Promote effective participation of indigenous and local communities in accordance with Article 8(j) in the development of management plans and in the implementation of projects that may affect inland water biological diversity.	**4.1.3**. Does the Contracting Party promote public participation in decision-making (with respect to wetlands), especially with local stakeholder involvement in the selection of new Ramsar sites and in Ramsar site management?	
2.5.2. Implement Article 8(j) as related to inland water biological diversity.	(None specifically; but see above)	
2.5.3. Promote the full and effective participation and involvement of indigenous and local communities and relevant stakeholders as appropriate, in policy-making, planning and implementation in accordance with national laws.	**4.1.3**. Does the Contracting Party promote public participation in decision-making (with respect to wetlands), especially with local stakeholder involvement in the selection of new Ramsar sites and in Ramsar site management?	
2.5.4. Implement capacity-building measures to facilitate the participation of indigenous and local communities and the application of traditional knowledge favourable to the conservation of biodiversity, with their prior informed consent in accordance with national laws, in the management, conservation and sustainable use of biological diversity of inland water ecosystems.	(None specifically; but see above)	
PROGRAMME ELEMENT 3: KNOWLEDGE, ASSESSMENT AND MONITORING		
Goal 3.1: To develop an improved understanding of the biodiversity found in inland water ecosystems, how these systems function, their ecosystem goods and services and the values they can provide.	**1.1.1**. Does your country have a comprehensive National Wetland Inventory? **1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **1.3.1**. Has an assessment been conducted of the ecosystem benefits/services provided by Ramsar	**Indicator A**: The overall conservation status of wetlands: **(i)** Status and trends in wetland ecosystem extent **(ii)** Trends in conservation status – qualitative assessment **Indicator B**: The

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	**Ramsar COP10 national report questions**	**Ramsar indicators; and sections of the present report**
	sites?	status of the ecological character of Ramsar sites
3.1.1. Encourage, and where possible support, applied research to gain an improved understanding of the status, trends, taxonomy and uses of biological diversity in inland water ecosystems, including transboundary systems where applicable.	(None specifically; but see 4.10.1)	
3.1.2. Promote research to improve the understanding of the social, economic, political and cultural drivers within civil society that are directly impacting on the conservation and sustainable use of the biological diversity of inland waters.	(None)	
3.1.3. In line with the Global Taxonomy Initiative (GTI) encourage studies aimed at improving the understanding of the taxonomy of the biological diversity of inland water ecosystems.	(None)	
3.1.4. Support efforts to achieve international consistency and interoperability of taxonomic nomenclature, databases and metadata standards, as well as data-sharing policies.	(None)	
3.1.5. As part of national communication, education and public awareness activities/programme (see goal 2.4), provide mechanisms for disseminating research findings to all relevant stakeholders, in a form which will be most useful to them. Make this same information available to the Executive Secretary for sharing with other Parties.	**4.4.3**. Have actions been taken to communicate and share information cross-sectorally on wetland issues amongst relevant ministries, departments and agencies?	
Goal 3.2: To develop, based on inventories, rapid and other assessments applied at the regional, national and local levels, an improved understanding of threats to inland water ecosystems and responses of different types of inland water ecosystems to these threats.	**1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **1.1.4**. If the answer is "Yes" in 1.1.3, does this information indicate that the need to address adverse change in the ecological character of wetlands is now greater, the same, or less than in the previous triennium, for: a) Ramsar sites b) wetlands generally? **2.3.1**. Have the measures required to maintain the ecological character of all Ramsar sites been defined and applied? **2.3.4**. Has any assessment of Ramsar site management effectiveness been carried out? **2.4.2**. Have all cases of change or likely change in the ecological character of Ramsar sites been	**Indicator D**: The frequency of threats affecting Ramsar sites

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	reported to the Ramsar Secretariat, pursuant to Article 3.2? **2.4.3**. If applicable, have actions been taken to address the issues for which Ramsar sites have been listed on the Montreux Record?	
3.2.1. In accordance with the priorities set down in national biodiversity strategies and action plans, undertake comprehensive national inventories and assessments of inland water biological diversity, which may be regarded as important in accordance with the terms of Annex I of the Convention. Furthermore, undertake assessments of threatened habitats and species, and conduct inventories and impact assessments of alien species in inland water ecosystems using the guidelines adopted by the Conference of the Parties in decision VI/7 A. The transboundary nature of many inland water ecosystems should be fully taken into account in assessments, and it may be appropriate for relevant regional and international bodies to contribute to such assessments.	**1.1.1**. Does your country have a comprehensive National Wetland Inventory? **1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **1.1.4**. If the answer is "Yes" in 1.1.3, does this information indicate that the need to address adverse change in the ecological character of wetlands is now greater, the same, or less than in the previous triennium, for: a) Ramsar sites b) wetlands generally? **2.2.1**. Have all required updates of the Information Sheet on Ramsar Wetlands been submitted to the Ramsar Secretariat? **2.5.1**. Have all transboundary/shared wetland systems been identified?	
3.2.2. Identify the most cost-effective approaches and methods to describe the status, trends and threats of inland waters and indicate their condition in functional as well as species terms.	**1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **2.4.1**. Are arrangements in place for the Administrative Authority to be informed of changes or likely changes in the ecological character of Ramsar sites, pursuant to Article 3.2?	**Indicator A**: The overall conservation status of wetlands: **(i)** Status and trends in wetland ecosystem extent **(ii)** Trends in conservation status – qualitative assessment **Indicator B**: The status of the ecological character of Ramsar sites **Indicator C**: Trends in water quality

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
		Indicator D: The frequency of threats affecting Ramsar sites **Indicator F**: Overall population trends of wetland taxa **(i)** trends in the status of waterbird biogeographic populations **Indicator G**: Changes in threat status of wetland taxa **(i)** trends in the status of globally-threatened wetland-dependent birds; **(ii)** trends in the status of globally-threatened wetland-dependent amphibians

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
3.2.3. Adopt an integrated approach in the assessment, management and, where possible, remedial actions of inland water ecosystems, including associated terrestrial and in-shore marine ecosystems. It should be noted that: **(a)** Assessments should involve all stakeholders, including indigenous and local communities, should be cross-sectoral and should make full use of indigenous knowledge based on prior informed consent; **(b)** Suitable organisms should be identified as being particularly important in the assessment of inland water ecosystems. Ideally, such groups (taxa) should meet the following criteria: - The group should contain a reasonable number of species with varied ecological requirements; - The taxonomy of the group should be reasonably well understood; - The species should be easy to identify; - The group should be easy to sample or observe so that density - absolute or as indices - can be assessed, used objectively and treated statistically; - The group should serve as indicators of overall ecosystem health or indicators of the development of a key threat to ecosystem health;* **(c)** In view of the great economic importance of some groups (e.g. inland water fish species and aquatic macro-invertebrates), and of the large gaps in taxonomic knowledge for many species, capacity-building in taxonomy should focus on inland water biodiversity of economic as well as ecological importance. *(See decision IV/4, annex I, paragraph 15)	**1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **2.1.1**. Have a strategy and priorities been established for any further designation of Ramsar sites, using the Strategic Framework for the Ramsar List? **2.3.1**. Have the measures required to maintain the ecological character of all Ramsar sites been defined and applied? **2.3.3**. Have cross-sectoral site management committees been established at Ramsar sites? **4.1.2**. Have traditional knowledge and management practices in relation to wetlands been documented and their application encouraged?	
3.2.4. Apply the rapid assessment guidelines for national circumstances and adapt these as necessary to suit current and emerging priorities. In accordance with SBSTTA recommendation II/1, endorsed by the Conference of the Parties in decision III/10, assessments should be simple, inexpensive, rapid and easy to use. Such rapid assessment programmes will never replace thorough inventories.	(None)	
3.2.5. Seek the resources, opportunities and mechanisms to build national capacity for undertaking assessments and inventories.	(None specifically; but see 4.10.2)	
3.2.6. Promote the development of criteria and indicators for the evaluation of the impacts on inland water ecosystems from both physical infrastructure projects and watershed activities, including, inter alia, agriculture, forestry, mining and physical alteration, taking into consideration the natural variability of water conditions.* *(See decision IV/4, annex I, paragraph 9 (e) (ii))	(None specifically; but see 2.3.1)	
3.2.7. Promote, in close cooperation with indigenous and local communities, the development of global	(None)	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
social indicators in accordance with decision VII/30 relevant to the implementation of the programme of work on inland water biological diversity and their review through the Ad Hoc Open-ended Inter-Sessional Working Group on Article 8(j) and Related Provisions.		
3.2.8. Develop means of identifying and protecting groundwater recharge areas, groundwater aquifers, and surface waters fed by groundwater discharges.	**1.2.4**. Has the quantity and quality of water available to, and required by, wetlands been assessed? **1.4.1**. Has the Convention's water-related guidance (see Resolution IX.1. Annex C) been used/applied in decisionmaking related to water resource planning and management?	
3.2.9. Assessments should be carried out with a view to implementing other articles of the Convention and, in particular, to addressing the threats to inland water ecosystems within an appropriate framework such as that included in paragraphs 39-41 of the note by the Executive Secretary on options for implementing Article 7 of the Convention prepared for the third meeting of the Conference of the Parties (UNEP/CBD/COP/3/12). Of particular importance is the undertaking of environmental impact assessments on biological diversity of development projects involving inland water ecosystems.	**1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? (See also 1.2.5)	
Goal 3.3. To ensure projects and actions with the potential to impact negatively on the biological diversity of inland water ecosystems are subjected, in accordance with national legislation and where appropriate, to suitably rigorous impact assessments, including consideration of their potential impact on sacred sites and on lands and waters traditionally occupied or used by indigenous and local communities.	(None specifically; but see 1.2.5)	

Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
3.3.1. Taking into account decision VI/7 A of the Conference of the Parties to the Convention on Biological Diversity, on guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation and/or processes and in strategic environmental assessment, and decision VII/16, on Article 8(j) and related provisions, including the annex, decision VII/16, containing the Akwé: Kon Voluntary Guidelines for the Conduct of Cultural, Environmental, and Social Impact Assessment Regarding Developments Proposed to Take Place on, or which are Likely to Impact on, Sacred Sites and on Lands and Waters Traditionally Occupied or used by Indigenous and Local Communities: **(a)** Apply environmental impact assessments on water-development projects, aquaculture and watershed activities, including agriculture, forestry and mining, and best predictions with well designed sampling schemes that can adequately distinguish the effects of anthropogenic activities from natural processes; **(b)** Strengthen efforts to apply environmental impact assessments, not only of individual proposed projects, but also taking into account effects of existing and proposed developments on the watershed, catchment or river basin; and **(c)** Incorporate, where appropriate, environmental flow assessments into impact assessment processes for any projects with the potential to have negative effects on inland water ecosystems, and also undertake baseline ecosystem assessments in the planning phase to ensure that the necessary basic data will be available to support the environmental impact assessment process and the development of effective mitigation measures if necessary.	(None specifically; but see 1.2.5 and - for item (c) - 1.2.4)	
3.3.2. Apply the recommendations for the conduct of cultural, environmental, and social impact assessments regarding developments proposed to take place on, or which are likely to impact on, sacred sites and on lands and waters traditionally occupied or used by indigenous and local communities.	(None specifically; but see 1.3.4 and 4.1.5)	
3.3.3. For transboundary inland water ecosystems, undertake, where feasible and appropriate and by agreement between the Parties concerned, collaborative impact and environmental flow assessments when applying the Convention's guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation and/or processes and in strategic environmental assessment.	(None)	
Goal 3.4. To introduce and maintain appropriate monitoring arrangements to detect changes in the status and trends of inland water biodiversity.	**1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or	

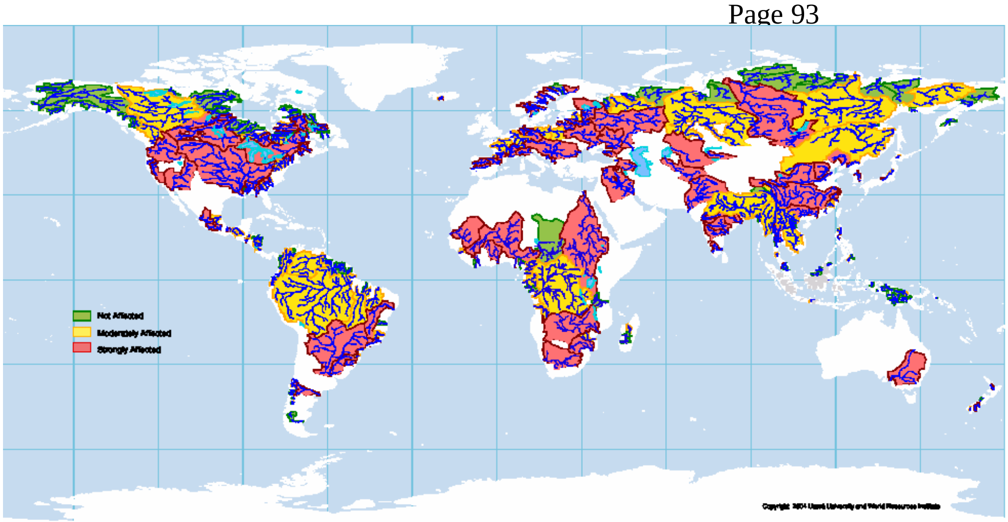
Inland waters programme "activities for Parties" (From Decision VII/4, 2004)	Ramsar COP10 national report questions	Ramsar indicators; and sections of the present report
	wetlands generally)? **2.4.1**. Are arrangements in place for the Administrative Authority to be informed of changes or likely changes in the ecological character of Ramsar sites, pursuant to Article 3.2?	
3.4.1. Introduce appropriate monitoring regimes based on the Convention on Biological Diversity and other guidance for priority inland water biodiversity and ecosystems in the first instance, taking into account the implementation of decisions VI/7 A-C on identification, monitoring, indicators and assessments and possible adoption by the Conference of the Parties at its seventh meeting of principles for developing and implementing national-level monitoring and indicators.	**1.1.3**. Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)? **2.4.1**. Are arrangements in place for the Administrative Authority to be informed of changes or likely changes in the ecological character of Ramsar sites, pursuant to Article 3.2?	

B. Status & trends information: overview

363. A previous report on "Status and trends of biodiversity of inland water ecosystems" was published by the CBD Secretariat in 2003 (Revenga and Kura, 2003) and was characterised as a joint effort between CBD and Ramsar. This provided a fairly extensive overview of information available at that time on relevant taxonomic groups. Information on the distribution and extent of inland water ecosystems and on threats including modification of river systems, water scarcity, invasive alien species, fisheries exploitation and effects of climate change was also summarised. The report's caveats concerning weaknesses of baseline data (for aspects such as the global extent of wetlands) still apply today, and it also noted that while some groups such as birds are better covered, "in general, information on biodiversity at the species level in most freshwaters (sic) is poor". The present report aims not to reiterate the material in the 2003 review, but to build upon it with information generated subsequently, in particular through work undertaken within the ambit of the Ramsar Convention.

364. One particular aspect of the 2003 report which is however worth mentioning is that relating to data on river fragmentation, based on data from Dynesius and Nilsson (1994) and Nilsson et al. (2000). Of the 227 large river basins they assessed, 37% were strongly affected by fragmentation and altered flows, 23% were moderately affected and 40% were unaffected. Nilsson and others then published a further analysis in 2005, this time covering 292 large river systems (representing 60% of the world's river runoff) and recording that over 50% of the systems assessed were affected by dams, and more than one-third, representing over half of the river basin area, were strongly affected by river fragmentation/flow regulation, with only 12% by area being unaffected (Nilsson et al., 2005, cited in CBD Secretariat, 2006). (A tabulated comparison of the two sets of figures is not given here, because they were not comparably derived and this could be misleading). Regional differences in fragmentation are shown in Figure 2.

Figure 2: Fragmentation and flow regulation of the world's large river systems (Nilsson et al., 2005)



365. The Ramsar STRP in 2004-5 examined options for developing an indicator to track this issue, with suggestions including assessment of the percentage of tributary kilometres impounded in the area of attention (e.g. river basin). This has so far not been developed further at global level, although potentially relevant methods are in use by The Nature Conservancy, the International Water Management Institute and the European Environment Agency, and it appears that the latter may be intending to publish data for Europe later in 2009 (European Environment Agency, 2007a).

366. CBD Parties have also had available to them the second edition of the Global Biodiversity Outlook (GBO2), which was launched at COP8 in 2006 (CBD Secretariat, 2006) and which presents data according to 14 headline indicators for assessing progress towards the 2010 target. In addition, Revenga et al. (2005) reviewed a range of different measures for monitoring freshwater ecosystems in relation to the 2010 target.

367. Many of the results for the indicators in the main GBO report are aggregated across themes and biomes, and do not provide a specific treatment of inland waters issues. One exception is the section on "Water quality in aquatic ecosystems", which is a headline indicator in its own right. According to GBO2 while water quality in rivers (measured by Biological Oxygen Demand or BOD) has improved since the 1980s in Europe, North America, Latin America and the Caribbean, it has deteriorated over the same period in Africa and in the Asia-Pacific region. The report also notes however that many countries have stopped or reduced the monitoring of BOD in freshwater ecosystems in recent years.

368. A few other examples of inland waters data are given in GBO2 (including the intriguing statistic that "2.2% of lake systems are protected"); but since the report as a whole draws on sources such as the Millennium Ecosystem Assessment, which is treated separately here below, the GBO2 is not discussed further as a source in the present review.

369. The Millennium Ecosystem Assessment (MA) itself drew for its inland waters information substantially on Revenga and Kura's 2003 status and trends report for the CBD. Some notable headlines from the MA are mentioned below, and they draw on some sources that post-date Revenga and Kura's document; but since CBD Parties have been provided with the 2003 report, the present review will for the most part avoid repeating material that is already presented there.

370. The MA material referred to here is derived from the Assessment's "Wetlands and Water Synthesis Report" (Finlayson et al., 2005) (the generic parts of which relate to both inland and marine and

coastal wetlands), and the chapter on “Inland Water Systems” in the report of the MA Working Group on Condition and Trends (Finlayson and D’Cruz, 2005).

371. The MA begins by recording that the prevailing estimate of the global extent of wetlands, of over 1,280 million hectares, is certain to be an underestimate: good data are lacking on some geographic areas and on some wetland types.

372. Where data do exist, it is apparent that more than 50% of specific types of wetlands in parts of North America, Europe, Australia, and New Zealand have been destroyed during the twentieth century, and many others in many parts of the world have been degraded. There is also ample evidence of the dramatic loss and degradation of many individual significant wetlands and wetland types, such as tropical and sub-tropical swamp forests. On a global scale however there is insufficient information on the extent of specific inland water habitats, especially those of a seasonal or intermittent nature, to quantify the full extent of habitat losses.

373. The Assessment has nonetheless confirmed that rates of degradation and loss are worse for wetlands than for other ecosystems. The consequences of this include a reduced capacity of wetlands to support life and provide services that are of critical importance to humans; such as provision of sufficient amounts and quality of water, the natural ability of floodplains to regulate flooding, and a range of sustainable productive uses. Effects will increasingly be felt by, among others, the more than 50 million people estimated to be involved directly in inland fisheries, and the almost 50% of the world’s population who depend on rice as a staple food item (projected to increase and reach a figure of some 4 billion by 2020).

374. While terrestrial and marine ecosystems support a larger percentage of the known species of the world, inland water ecosystems, relative to their area, have on average a higher species richness. Levels of endemism are particularly high in inland wetlands too. There are about 100,000 described freshwater animal species worldwide; with half of these being insects and some 20,000 being vertebrates. About 25-30% of all vertebrate species diversity is concentrated close to or in inland waters. Some 40% of known species of fish inhabit inland waters (more than 10,000 species out of 25,000 species globally). It is anticipated that the number of aquatic animals is in truth far higher than current estimates, given a lack of information about some taxa - for example, about 200 new species of freshwater fish are described every year.

375. There is increasing evidence of a rapid and continuing widespread decline in many populations of wetland-dependent species. Even among the less well-known faunal groups such as invertebrates, assessments show species being subject to significant threats of extinction. As with the wetland ecosystems themselves, the rates of decline in status of wetland-dependent species (inland waters species in particular, and coastal waterbirds too) are worse than those dependent on other ecosystems. In fact an earlier study, in 2000, had already come to the conclusion that the biodiversity of freshwater ecosystems was in far worse condition than that of forest, grassland or coastal ecosystems (World Resources Institute et al., 2000). Examples are provided in Table 3.

Table 3: Examples of status data for some of the more well-studied groups of fauna dependent on inland waters. Source: Millennium Ecosystem Assessment wetland synthesis report (Finlayson et al., 2005).

Waterbirds	Of the 1,138 waterbird biogeographic populations whose trends are known, 41% are in decline. Of the 964 bird species that are predominantly wetland-dependent, 203 (21% of total) are extinct or globally threatened. The status of globally threatened birds dependent on freshwater wetlands and, even more so, that of coastal seabirds has deteriorated faster since 1988 than the status of birds dependent on other (terrestrial) ecosystems.

Wetland-dependent mammals	Over one third (37%) of the freshwater-dependent species that were assessed for the IUCN Red List are globally threatened; these include groups such as manatees, river dolphins, and porpoises, in which all species assessed are listed as threatened.
Freshwater fish	Approximately 20% of the world's 10,000 described freshwater fish species have been listed as threatened, endangered, or extinct in the last few decades.
Amphibians	Nearly one third (1,856 species) of the world's amphibian species are threatened with extinction, a large portion of which (964 species) are from fresh water, especially flowing freshwater habitats. In addition, the population sizes of at least 43% of all amphibian species are declining, indicating that the number of threatened species can be expected to rise in the future. By comparison, just 12% of all bird species and 23% of all mammal species are threatened.
Turtles	At least 50% of the 200 species of freshwater turtles have been assessed in the IUCN Red List as globally threatened and more than 75% of freshwater turtle species in Asia are listed as globally threatened, including 18 that are critically endangered, with one being extinct.
Crocodiles	Of the 23 species of crocodilians that inhabit a range of wetlands including marshes, swamps, rivers, lagoons, and estuaries, 4 are critically endangered, 3 endangered, and 3 vulnerable.

376. While habitat loss is the primary cause of extinction of freshwater species, the introduction of non-native invasive species is the second most important cause of decline. The effects of climate change on wetland taxa are generally considered to be additive to the impacts of direct drivers such as habitat degradation.

377. Modifications to water regimes have drastically affected the migration patterns of birds and fish and the composition of riparian zones, opened up access to invasive alien species and contributed to an overall loss of freshwater biodiversity and inland fishery resources. Habitat loss and degradation are by far the greatest threat to amphibians, affecting over 70% of species; although newly recognised fungal diseases are also seriously affecting an increasing number of species. Land use change and habitat loss, along with the deterioration and degradation of both breeding and non-breeding wetland habitats, are widely recognised as the major causes of the widespread pattern of declines in waterbird populations and species.

378. The degradation and loss of inland wetlands and species has been driven by infrastructure development (such as dams, dikes, and levees), land conversion, excessive water withdrawals, pollution, salinisation, eutrophication, overharvesting and overexploitation, and the introduction of invasive alien species. The water requirements of aquatic systems are in competition with human demands, and increased human use of fresh water has reduced the amount available to maintain the ecological character of many inland water systems.

379. Conversion (clearing or transformation) or drainage for agricultural development has been the biggest single cause of inland wetland loss worldwide. It is estimated that by 1985, 56-65% of suitable inland water systems had been drained for intensive agriculture in Europe and North America, 27% in Asia, and 6% in South America. The construction of dams and other structures along rivers has resulted in fragmentation and flow regulation of almost 60% of the large river systems in the world. Over the past

four decades, excessive nutrient loading has also emerged as one of the most important direct drivers of ecosystem change in inland (and coastal) wetlands.

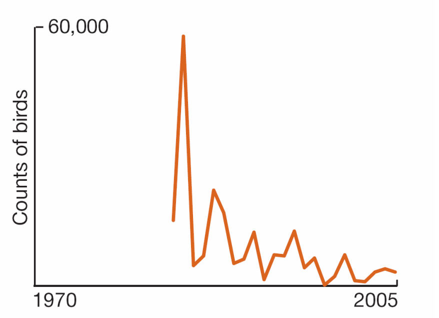
380. Global climate change and nutrient loading are projected to become increasingly important drivers in the next fifty years. Climate change is expected to exacerbate the loss and degradation of many wetlands that is already occurring as a result of other causes, and the loss or decline of their species, and hence to cause further harm to the human populations dependent on the services provided by these ecosystems.

381. Overall, there is evidence that the changes being made, and growing pressures from multiple direct drivers, are increasing the likelihood of nonlinear and potentially abrupt changes in ecosystems, which can be large in magnitude, difficult, expensive, or impossible to reverse, and likely to have important consequences for human well-being. There is however insufficient quantitative analysis to tease out readily the relative individual and combined effects of these factors.

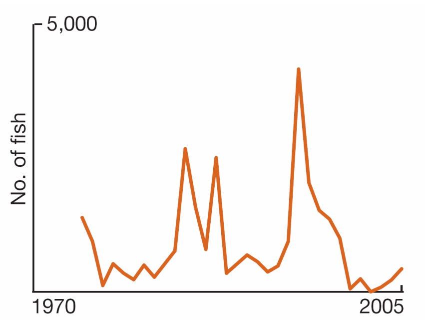
382. Another global picture is provided by the "Living Planet Index" reports, which have been published by the World Wide Fund for Nature at two-yearly intervals since 2000. The index (LPI) is an indicator which tracks trends in nearly 5,000 populations of 1,686 vertebrate species across all regions of the world. It is also one of two sub-indicators used by the Biodiversity Indicators Partnership (http://www.twentyten.net/) in their work supporting the CBD headline 2010 indicator on "Trends in abundance and distribution of selected species". (The other sub-indicator is the Global Wild Bird Index from BirdLife International's "State of the World's Birds" assessments, which are referred to in several other places in the present report).

383. Examples of some of the inland wetland species data underpinning the Index are shown in Figure 3. These address populations in particular areas and so do not necessarily represent the picture for each species as a whole.

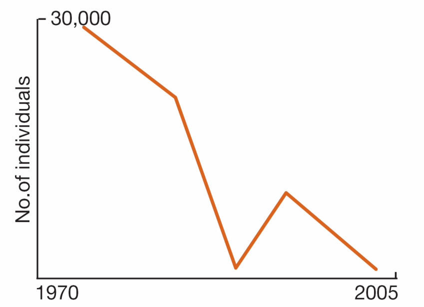
Figure 3: Examples of trend data used to compile the Living Planet Index for freshwater species (from Humphrey et al., 2008).



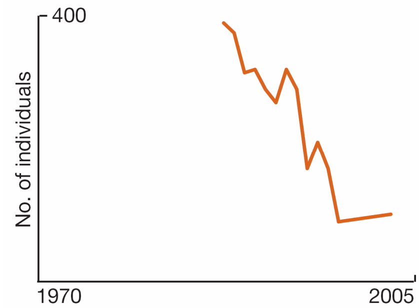
Black-winged stilt, eastern Australia



Coho salmon (*Onchorhynchus kisutch*), Yukon River, Alaska, USA



Hippopotamus (*Hippopotamus amphibius*), Democratic Republic of Congo



Diamondback terrapin, (*Malaclemys terrapin*), Kiawa River, South Carolina, USA

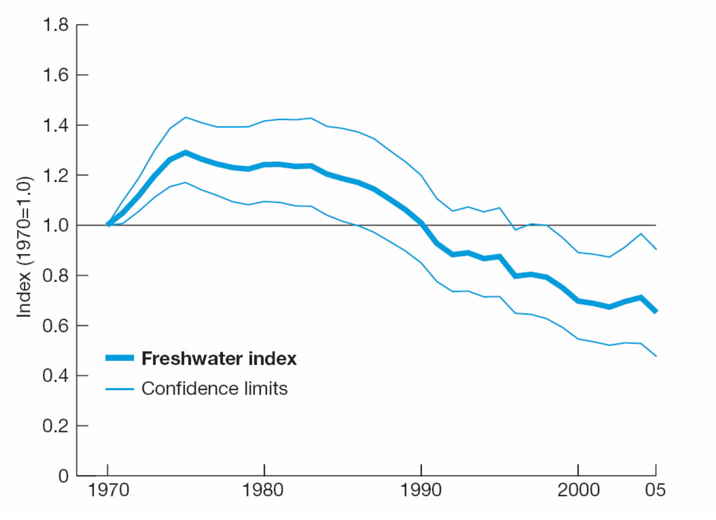
384. The “freshwater LPI” (Figure 4) is calculated as the average of two indices which separately measure trends in tropical and temperate populations of vertebrate species of (broadly speaking) inland waters. In the 2008 report (Humphrey et al., 2008) this was based on 1,463 populations of 458 species.

385. To derive the LPI, changes in the population numbers of each of the species are calculated from a variety of published and unpublished data sources. These sources vary to some extent from one reporting period to the next, and a gradually increasing number of species and populations has been encompassed in each successive biennial assessment, so comparisons must be made with caution. The most species-rich parts of the world unfortunately have the least data - information from the Nearctic and Palearctic realms predominates in the freshwater index, but the method of calculation compensates for this to some extent by giving equal weight to data from all realms (Revenga et al., 2005).

386. Annual data points are interpolated where necessary, and the average rate of change in each year across all species is calculated and shown relative to 1970, which is given an index value of 1.0. (Note that aggregated indices such as the LPI potentially mask a variety of different up/down/stable etc trends among the individual species and populations which go to make them up, and care in constructing statements of findings, and applying them to responses, is required - for example a species group which as a whole is increasing may include individual species or populations which are in critical decline).

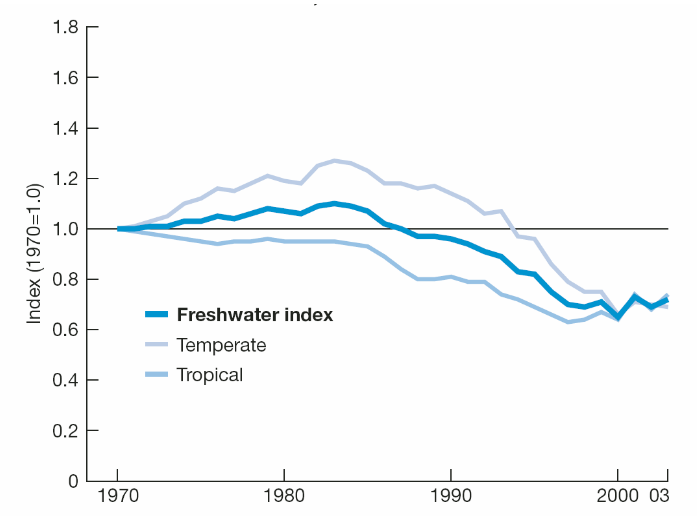
387. The results in the 2008 report show an average decrease in the populations of the inland waters/freshwater species studied of 35% over the years 1970-2005 (with 95% confidence limits ranging from 10% to 52%). According to these results, inland water species have an overall worse status than the terrestrial and marine species studied (for which the index figures show average declines of 33% and 14% respectively over the same assessment period).

Figure 4: Freshwater Living Planet Index, 1970-2005 (Humphrey et al., 2008)



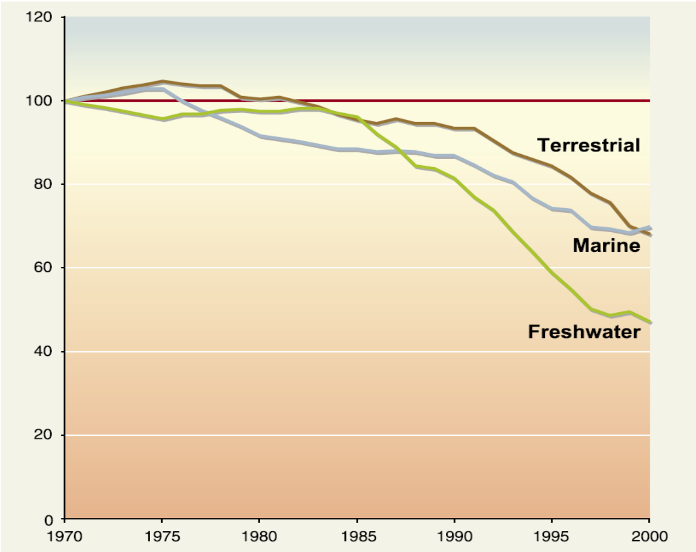
388. In the global index for species from all groups, the overall decline (30%) for the 1970-2005 period is made up of markedly different results for tropical populations (down 51%) and temperate populations (up 6%). In the freshwater species group there has also been a contrast between temperate and tropical populations, but in this case the difference diminished during the 1990s and both groups were showing similar average degrees of decline by 2000 (see Figure 5).

Figure 5: Temperate and tropical freshwater Living Planet Index results, 1970-2003. From Loh et al., 2006 (ie the 2006 report - these figures are not provided in the 2008 report).



389. The comparison between freshwater results and those for marine and terrestrial species has been mentioned above. The differences have narrowed in recent years, however - in the 2004 report, which presents trends up to 2000, the freshwater decline figure (for 1970-2000) was 50%, compared to 30% for the marine index and 30% for the terrestrial index (Figure 6; Loh and Wackernagel, 2004). The inclusion of additional species from one period to the next may be one explanation for this; but whatever the reason, it is clear that some of the most serious conservation problems depicted by the LPI relate to species inhabiting inland water systems.

Figure 6: Trends in freshwater, marine and terrestrial Living Planet Indices, 1970-2000 (from Finlayson et al., 2005, based on Loh and Wackernagel, 2004)



390. The Living Planet Index team produced an additional report in 2008, the scope of which was tailored to the interests of the Convention on Migratory Species (Latham et al., 2008). A similar approach could in principle be envisaged in future to cover the scope of the Ramsar Convention or the CBD inland waters programme of work, to give more targeted attention to wetland and inland waters species groups respectively.

391. The Biodiversity Indicators Partnership (BIP, at (http://www.twentyten.net/) has already been mentioned above. This GEF-funded initiative has brokered consortium activities for generating indicator information on progress towards the 2010 target, for various end-users including the CBD and other Conventions. Around 20 headline indicators are at various stages of development, some divided into sub-indicators; and the list overall has been designed to match more or less closely the headline 2010 indicators defined by the CBD.

392. Some of the BIP indicators in turn are linked to the Ramsar indicators of effectiveness, and others could conceivably be analysed in such a way as to separate out a wetland or inland waters "cut" of the results. These relationships are summarised later.

393. Much of the emphasis of the BIP's work so far has been on technical development and on capacity-building at regional and national scales. In terms of results, in the main its function at present is in providing a form of clearing-house for relevant products from BIP partner activities that relate to the headline indicators, for example the Living Planet Index reports. Other available results that are relevant to the present report are discussed in the framework of their relationship to corresponding Ramsar indicators, discussed later.

394. BirdLife International has produced occasional reports on the "State of the World's Birds" (see http://www.biodiversityinfo.org/sowb/default.php?r=sowbhome ; the latest report was published as BirdLife International, 2008a), based on monitoring information contained in their World Bird Database. Issues related specifically to inland waters are in general not presented separately, but some may be

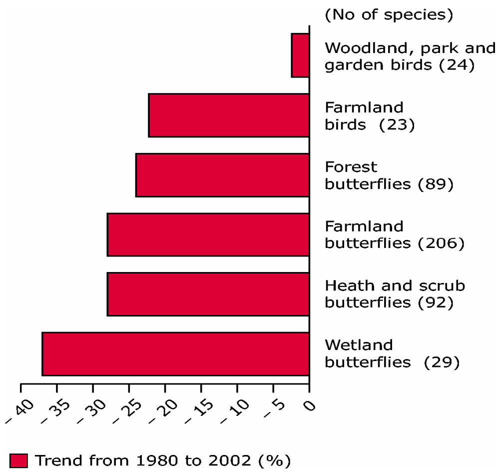
inferred, in respect of indicators of trends in waterbird populations and certain categories of pressures and threats. In both cases these are addressed under the relevant headings in the Ramsar indicators sections of the present report.

395. A number of sub-global assessments are also producing relevant results, and while these largely lie beyond the scope of the present review, one or two examples are worth mentioning. In Europe, the European Environment Agency (EEA) adopted a core set of 37 indicators in 2004 designed *inter alia* to support biodiversity status and trends monitoring by the European Union and to feed in to wider indicators initiatives. Results have been published in state of the environment reports (latest: European Environment Agency, 2007b) and at http://themes.eea.europa.eu/indicators .

396. Also launched in 2004, and closely linked, is the "Streamlining European 2010 Biodiversity Indicators" initiative (SEBI2010 - see http://biodiversity-chm.eea.europa.eu/information/indicator/F1090245995), a pan-European collaboration for monitoring 26 indicators related specifically to the (global and European) 2010 targets. Results have been published in European Commission (2008).

397. EEA core indicator 009 on "species diversity" links population trends of 295 butterfly species and 47 bird species in 25 countries to the trends in extent of 5 different habitat types deriving from land cover change analysis. A wetland-related picture is not presented for the birds, but it is for the butterflies, and shows that the 37% decline in these species from 1980-2002 (data used in fact relate to the period 1972/73-1997/98) is worse than that for all the other groups (Figure 7).

Figure 7: Trends in bird and butterfly populations in 25 EU countries (% decline). From European Environment Agency (2007b).



398. This decline is associated with direct habitat loss as well as habitat degradation through fragmentation and isolation. Mires, bogs and fen habitats were shown to have the strongest decline in area (-5%) across the 25 countries between 1990-2000; a trend based on detecting changes bigger than 25 hectares (though note that the area of "inland surface water" increased over the same period) (see Figure 8). Nearly 80% of conversions of wetlands were to forest and semi-natural areas (see Figure 9).

Figure 8: Land cover change from 1990 to 2000 expressed as % of the 1990 level, aggregated into EUNIS habitat categories. From European Environment Agency (2007b).

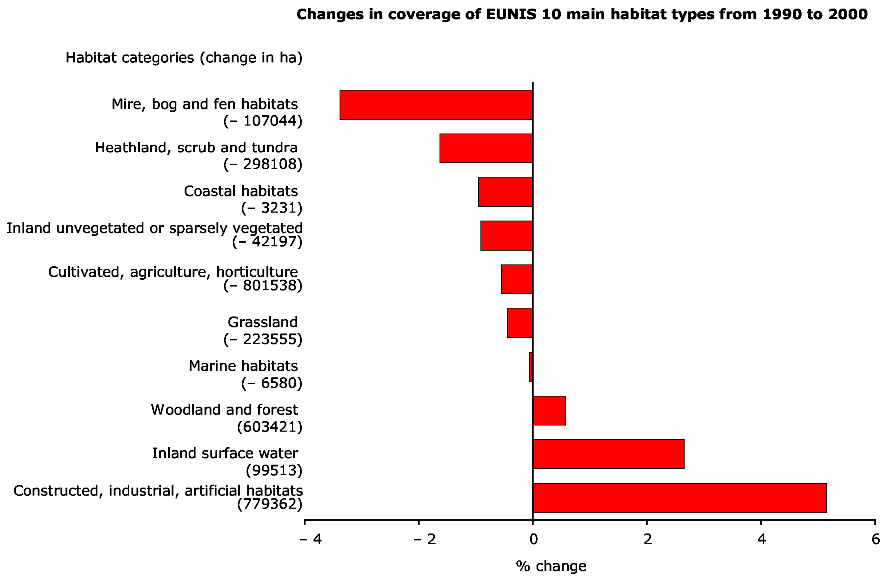
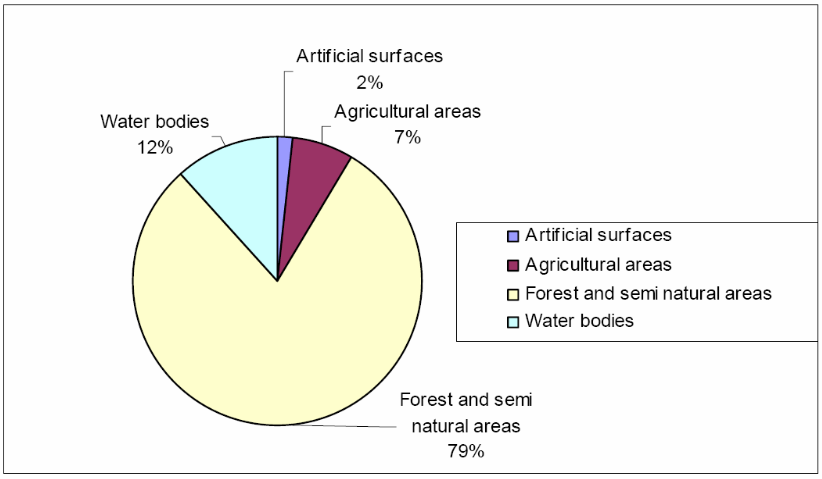


Figure 9: Conversion of wetlands into other land cover classes, 1990-2000. From European Commission (2008).

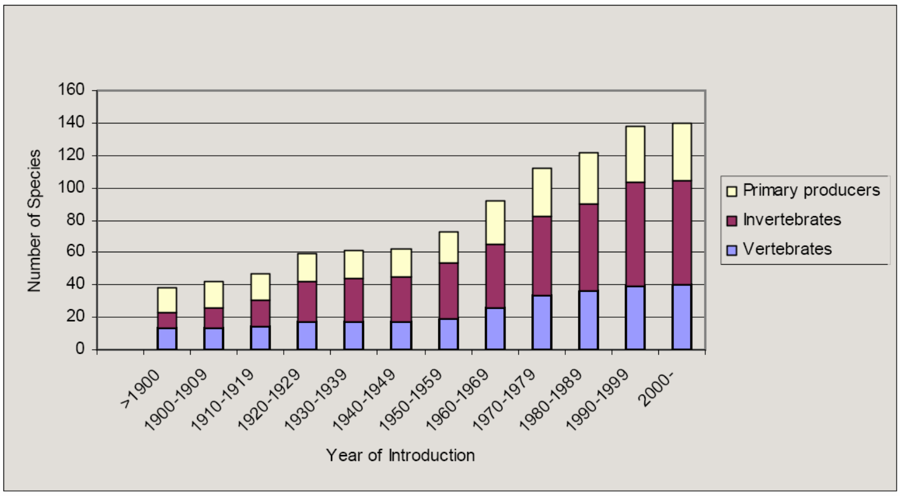


399. The European Commission has also published figures for assessments made by EU Member States of the conservation status of habitats listed in Annex I of the 1992 EU Habitats and Species Directive. (Trend information is not available in most cases). Around 70% of remaining bogs and freshwater habitats are classed as being in "unfavourable" conservation status (meaning that their range and quality are in decline or do not meet specified quality criteria). (European Commission, 2008).

400. Other wetland-specific indicator findings published by the Commission include the beginnings of a dataset on the spread of freshwater alien species. This covers just five Nordic counties at present, but coverage is planned to broaden in future, and in any event as it stands it is thought to be fairly representative of the picture for the European area as a whole (European Commission, 2008). It shows

how the cumulative number of alien species introduced has been constantly increasing since the 1900s (Figure 10).

Figure 10:. Cumulative number of alien species established in the freshwater environment. (From European Commission, 2008).



401. All other issues at global level on which relevant results are (or are becoming) available are dealt with in the later sections relating to the Ramsar indicators of effectiveness. In a few cases, some further examples of linked regional analyses are referred to as well. These report sections feature the particular Ramsar indicators which are the most advanced so far in terms of generating actual findings; but others are at different stages of development.

C. Ramsar indicators: introduction

402. The Ramsar Conference of Parties at its 9th meeting (COP9, in 2005) agreed an initial set of eight ecological "outcome-oriented" indicators for assessing the effectiveness of selected aspects of the Convention's implementation, following a request from COP8 in 2002. Parties were then urged to make good use of the indicators as appropriate. This forms part of a general integrated updating of monitoring, assessment and reporting processes under the Convention.

403. The text of the relevant decision (Resolution IX.1 Annex D) can be found at http://www.ramsar.org/res/key_res_ix_01_annexd_e.htm. The indicator specifications and additional background information are given in COP9 Information paper 18, available at http://www.ramsar.org/cop9/cop9_doc18_e.htm . A list of the indicator titles is given in Table 4 cross-referred as appropriate to global biodiversity indicators, inland waters programme targets and sections of the present report.

404. The eight initial indicators were considered to be those that are currently feasible to implement with existing, or readily collectible, data and information. There is always a trade-off between precision and ease of use. Throughout this process, a conscious decision has been made to err in favour of pragmatism. It has been shown for example that much useful information can be generated by qualitative

knowledge-based assessments; and the results being collated for the Ramsar indicators are drawing fruitfully *inter alia* on data from Contracting Party national reports to COPs.

405. Some of the indicators are designed to operate at supranational level and to be coordinated internationally, and others are designed for use at site, basin/catchment or national scale. Broad-scale measures may of course rely on local information; and some small-scale measures can be aggregated for analysis at larger scales.

406. These indicators provide a central component of the present status and trends review, because (in contrast to some other Convention evaluation endeavours that have similar aims) their emphasis is on "science-based" ecological outcomes, rather than institutional processes. While it remains important to track the latter, and careful regard has been given to for example coherence with the "Key Result Areas" defined in the Ramsar Strategic Plan 2009-2015, the focus in the Ramsar effectiveness indicators is intended to be on the state of the wetland environment itself.

407. Furthermore, Ramsar's purpose has been not simply to show the status and trends of wetland variables (albeit the prime focus of the present report), but rather to show whether the Ramsar Convention is being effectively implemented - i.e. whether it is making a difference in the way intended.

408. Giving an outcome statement about the status of wetlands might allow a number of reasonable inferences to be drawn about the impact made by Ramsar. The approach being adopted for the proposed individual indicator reports is to present information first on the "wetland outcome", and then to relate this outcome to a number of "Ramsar inputs" (also referred to as "process indicators" or "co-variates"). Effectiveness concerns the relationship between the inputs and the outcomes. The present report naturally focuses on information which comprises the "wetland outcome" material: but one example of an analysis of co-variates is given later to show how the dimension of "responses" might be brought in to the CBD use of this work.

409. Obviously indicators provide an indication, not a full assessment, and hence aim only to illuminate some particularly useful examples of implementation issues. They generate "headlines" about a sample of the stories that make up the overall picture; but cannot themselves purport to be that overall picture, nor to be a comprehensive conclusion about Ramsar effectiveness or about inland waters biodiversity status and trends as a whole.

410. Strictly speaking, indicators of effectiveness of the Convention might best be defined in relation to targets for effectiveness; but since the Ramsar Parties have not so far adopted targets of this kind, for the time being the targets at issue are effectively the objectives of the Convention itself, i.e. to stem the progressive encroachment on and loss of wetlands now and in the future, according to the General Objectives adopted (in the Strategic Plan) for each of Ramsar's three "pillars" (wise use of wetlands; conservation of internationally important sites; and international cooperation).

411. For each of the indicators, as they become properly operational, summary results reports are being compiled by a working group of the Ramsar Scientific & Technical Review Panel. At the time of writing, these are "living" documents evolving as a dialogue among specialist collaborators and operating under on-going oversight from the Convention's Standing Committee, with information being drawn out and applied to a variety of different end-uses as required. No published "final" product yet exists from this, but production of appropriate first outputs is envisaged (for some of the issues) later in 2009-2010.

412. The target audience for the main reports includes Ramsar Contracting Parties, technical experts, other Convention Secretariats and Parties, other global and regional indicator and conservation

assessment initiatives, wetland and water resources managers, donors and funding agencies. Additional communication materials will be generated from time to time for wider publics.

413. Integral to the process also, but not addressed in the present report, is the drawing-out of lessons learned, and the identification of action steps to take (e.g. adjustments in the way the Convention is implemented).

414. Identification of the data and information needs for the effectiveness indicators has reinforced the importance of Parties in particular maintaining effective and up-to-date information sources, including conscientiously completing National Reports for COPs, maintaining good information on Ramsar sites in the Ramsar Sites Information Service, and improving the availability of information on the status and trends of the ecological character of Ramsar sites (in line with various Ramsar COP Resolutions on these issues).

415. Ramsar indicator information contributes to the assessment of progress towards targets adopted by the wider international community, such as the Millennium Development Goals and the CBD/WSSD target of significantly reducing the rate of loss of biodiversity by 2010.

416. Synergy and compatibility between respective streams of work on biodiversity indicators is assured in particular through the Ramsar-CBD cooperation frameworks referred to above, and through Ramsar's participation in the GEF-funded 2010 Biodiversity Indicators Partnership also referred to above (see also UNEP-WCMC, 2008). Where the question being asked in each place is more or less the same, work need only be done once, collaboratively, to serve multiple interests. This is the approach taken to the individual indicator accounts given in the present report.

Table 4: Ramsar effectiveness indicators; related to CBD inland waters programme targets and to BIP global biodiversity indicators (additional non-matching CBD targets and BIP indicators are not shown)

Ramsar - effectiveness indicators: 1st tranche, for initial implementation	CBD - inland waters programme targets	Biodiversity Indicators Partnership - headline indicators
Indicator A: The overall conservation status of wetlands: **(i)** Status and trends in wetland ecosystem extent **(ii)** Trends in conservation status – qualitative assessment	**Target 5.1** Rate of loss and degradation of inland water ecosystem biological diversity, especially through unsustainable water use, are decreased.	Trends in extent of selected biomes, ecosystems and habitats Connectivity/fragmentation of ecosystems
Indicator B: The status of the ecological character of Ramsar sites **(i)** Trends in the status of Ramsar site ecological character – qualitative assessment	**Target 5.1** Rate of loss and degradation of inland water ecosystem biological diversity, especially through unsustainable water use, are decreased.	
Indicator C: Trends in water quality **(i)** Trends in dissolved nitrate (or nitrogen) concentration **(ii)** Trends in Biological Oxygen Demand (BOD)	**Target 5.1** Rate of loss and degradation of inland water ecosystem biological diversity, especially through unsustainable water use, are decreased. **Target 7.2** Substantially reduce pollution and its impacts on inland	Water Quality

	water ecosystem biodiversity.	
Indicator D: The frequency of threats affecting Ramsar sites **(i)** The frequency of threats affecting Ramsar sites – qualitative assessment	**Target 5.1** Rate of loss and degradation of inland water ecosystem biological diversity, especially through unsustainable water use, are decreased. **Target 7.2** Substantially reduce pollution and its impacts on inland water ecosystem biodiversity.	(Nitrogen Deposition) (Invasive Alien Species)
Indicator E: Wetland sites with successfully implemented conservation or wise use management plans **(i)** Wetland sites with successfully implemented conservation or wise use management plans		Coverage of protected areas (management effectiveness sub-indicator)
Indicator F: Overall population trends of wetland taxa **(i)** Trends in the status of waterbird biogeographic populations	**Target 2.1** Reduce the decline of, maintain or restore populations of species of selected taxonomic groups dependent upon inland water ecosystems	Trends in abundance and distribution of selected species
Indicator G: Changes in threat status of wetland taxa **(i)** trends in the status of globally-threatened wetland-dependent birds; **(ii)** trends in the status of globally-threatened wetland-dependent amphibians	**Target 2.1** Reduce the decline of, maintain or restore populations of species of selected taxonomic groups dependent upon inland water ecosystems	Change in status of threatened species
Indicator H: The proportion of candidate Ramsar sites designated so far for wetland types/features **(i)** coverage of the wetland resource by designated Ramsar sites	**Target 1.2** 275 million hectares of wetlands of particular importance to biodiversity protected, including representation and equitable distribution of areas of different wetland types across the range of biogeographic zones.	Coverage of protected areas
Ramsar - effectiveness indicators: 2nd tranche, for possible future development	**CBD - inland waters programme targets**	**Biodiversity Indicators Partnership - headline indicators**
Indicator I: Coverage of wetland-dependent bird populations by designated Ramsar sites	**Target 2.2** The world's known threatened inland water ecosystem dependent species of plants and animals conserved, with particular attention to migratory, transboundary and endemic species and populations	(Coverage of protected areas)
Indicator J: The economic costs of unwanted floods and droughts		
Indicator K: Trends in water quantity		
Indicator L: Legislative amendments implemented to reflect Ramsar provisions		
Indicator M: Wise use policy		? Proportion of products derived from sustainable sources? ? Health and well being of communities?

417. The individual indicators featuring in the next sections of this report are those for which a crystallisation of findings is the most advanced to date, namely:

- Indicator A(ii) - Trends in wetland conservation status – qualitative assessment
- Indicator F(i) - Trends in the status of waterbird biogeographic populations
- Indicator C - Water quality (sub-indicators on nitrate and BOD were proposed, but for the present report a slightly different approach has been taken)
- Indicator D - The frequency of threats affecting Ramsar sites.

418. Comments are presented later on planned analyses which will cover other issues in future; for example the use of earth observation and other data for Indicator A(i) on wetland extent, management effectiveness data for Indicator E and the use of the Red List Index for Indicator G.

1. Ramsar Indicator results: wetland status

419. The first of the adopted Ramsar effectiveness indicators concerns "the overall conservation status of wetlands", and is made up of two sub-indicators; one of which (A(ii), the subject of this section of the present report) is entitled "Trends in conservation status - qualitative assessment". This aims to show how the conservation status of wetlands in general is changing. (The extent of wetlands, the status of Ramsar sites, wetland biodiversity and some of the other individual components of conservation status are dealt with elsewhere in the indicator set).

420. "Wetland status" may be interpreted as referring to the ecological condition of a wetland, or perhaps to the degree of intactness of its ecological character. The broader concept of "conservation status" is a combination of the state of the ecosystem, the pressures affecting (or threatening) it and the actions taken (responses) to conserve it.

421. While ultimately quantitative information would provide the best dataset for this indicator, qualitative assessments can be highly illuminating, and can be fully adequate both for comparisons between areas and between time-periods (given consistency of assessment methods), and as a basis for strategic decision-making. They also tend to be simpler, quicker and less costly to undertake.

422. Any effectiveness indicator should relate to a target or objective. In the Ramsar Convention text the objective of "conservation" is applied to Ramsar sites (Article 3.1) and nature reserves (Article 4.1), rather than to wetlands as a whole, to which the objective of "wise use" is applied instead. However "wise use" has been redefined in recent times to centre on the "maintenance of the ecological character" of all wetlands, which suggests some convergence with a concept of conservation. Moreover, in the most recently adopted Ramsar Strategic Plan (for 2009-2015 - see Resolution X.1), the Mission of the Convention has been stated as the "conservation and wise use of all wetlands". This three-step rationale provides the basis for indicator A(ii).

423. The question being asked by Indicator A(ii) therefore is whether there is evidence to verify a proposition that "effective implementation of the Ramsar Convention results in the overall conservation status of wetlands as a whole improving over time". (Improvement is the correct target by which to judge the Convention's effectiveness, rather than maintenance of a *status quo*, since maintenance of the ecological character of wetlands relates to a long-term context that includes the situation described in the preamble to the Convention as "the progressive encroachment on and loss of wetlands").

424. The Indicator A(ii) question also requires an examination of which aspects of "effective implementation of the Convention" may have caused the observed result (i.e., the relationship between

the “wetland outcome” and a given “Ramsar input”, as described above; but this aspect, although central to the Ramsar process, is for the most part not addressed here, since the present report focuses only on the status and trends of the wetlands themselves (i.e, the “outcome” part of the equation). One exception to this, simply to illustrate the role of response actions in contributing to wetland status, is the information briefly discussed below.

425. There would be several ways in which one could validly define a qualitative measure of the overall conservation status of wetlands. The primary measure chosen for the Ramsar process is “reduced need to address adverse change in the ecological character of wetlands”. (Including the word “reduced” in the definition makes it a measure of effectiveness in relation to the stated objective, rather than simply a free-standing measure of need). A positive trend would represent an overall improvement in the ecological condition of wetlands and in conservation actions, and a reduction in pressures. The chosen measure in principle covers all three of these elements, although the balance of emphasis between them in the data is not known.

426. The method for generating this information was to ask Ramsar Contracting Party governments to answer a standard question on the subject in the National Reports they submit to the COP, beginning with the reports for COP10 in 2008.

427. The COP10 National Report questionnaire asked the following two-part question:

- “1.1.3 Does your country have information about the status and trends of the ecological character of wetlands (Ramsar sites and/or wetlands generally)?

  (if “Yes”, please indicate in Additional implementation information below, from where or from whom this information can be accessed)

- “1.1.4 If the answer is “Yes” in 1.1.3, does this information indicate that the need to address adverse change in the ecological character of wetlands is now greater, the same, or less than in the previous triennium, for:

  - Ramsar sites

  - wetlands generally.”

(The parts of these questions that refer to Ramsar sites are relevant to Indicator B, and are therefore not considered further in the analysis of Indicator A(ii), which concentrates on answers to question 1.1.4b).

428. A total of 141 Parties submitted COP10 reports (out of a possible maximum of 158), and of these, 123 answered “yes” or “for some sites” to question 1.1.3 and were therefore in principle able to give some answer to question 1.1.4b (in practice only 91 did so, plus a further 6 who unexpectedly did so even though they had answered “no” to 1.1.3: only the 91 responses have been used in the Ramsar Secretariat’s analysis). The global total results were as follows and are shown in **Error! Reference source not found.**:

Number of Parties reporting that the need to address adverse change in the ecological character of wetlands in 2005-2008 was:

- greater than in the previous triennium:	46	(51%)
- the same as in the previous triennium:	42	(46%)
- less than in the previous triennium:	3	(3%)

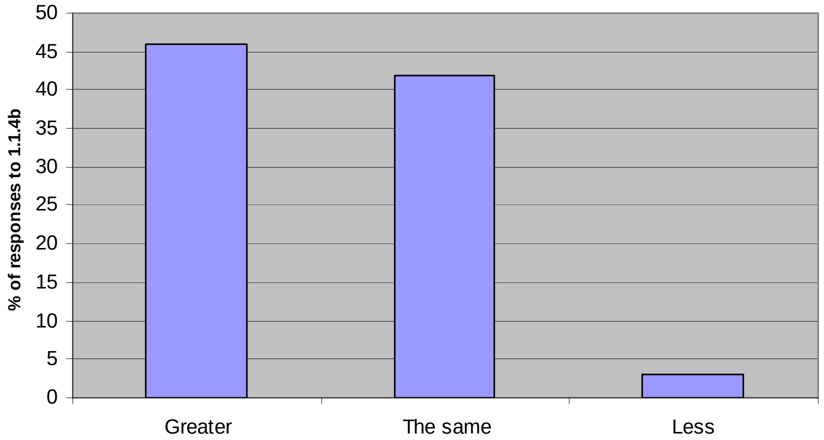


Figure 11: Proportions of respondents to Ramsar national report question 1.1.4b indicating degree of perceived need to address adverse change in wetland ecological character in 2005-2008 compared with 2002-2005.

429. The story this tells is that the overall need to address adverse change in the ecological character of wetlands was in 2005-2008 nearly everywhere at least the same, and in a majority of responding countries greater, than in the 2002-2005 triennium - in other words a net deterioration in wetland conservation status.

430. For making comparisons in future between one reporting period and another, and between regions within one reporting period, Ramsar indicator reports will present this information in the form of an index. To generate this, scores have been assigned to the "less/same/more" responses, and the index expresses the total scores as a proportion of the theoretical maximum possible total (the theoretical maximum would refer to a position where 100% of those countries answering "yes" or "for some sites" to question 1.1.3 answered "less" to question 1.1.4b). Scores were assigned to the 1.1.4b responses as follows:

"greater"	= score 0
"the same"	= score 1
"less"	= score 2

("no response" results excluded).

431. The theoretical maximum total score from the 91 relevant respondents in the COP10 dataset is (91x2) = 182. The actual total score from those 91 respondents was: (3x2) + (42x1) + (46x0) = 48, which as a proportion of the possible maximum gives an "Indicator A(ii) effectiveness index" for 2005-2008 of 0.26 (where "perfect effectiveness", ie a perfectly reduced need to address adverse change in the ecological character of wetlands, is always 1.0).

432. In future reporting cycles it will be possible, from this baseline, to construct a finding that the index of overall global effectiveness in the conservation of wetland status has either improved or declined (for example at the time of COP11, compared with the time of COP10). Since the index is itself a trend indicator (comparing one period to another), this approach is directly relevant to assessments of progress in relation to the 2010 biodiversity target.

433. With the dataset that exists already from a single COP's comparison of two triennia (2005-2008 *vs* 2002-2005 at COP10), it is possible to break down the figures to show geographical differences, for

example between individual Parties, as in Figure 12, or Ramsar regions, as in Table 5and Figure 13. (When index scores based on reports to future COP are added to this, it will be possible to compare areas in terms of changes over time too).

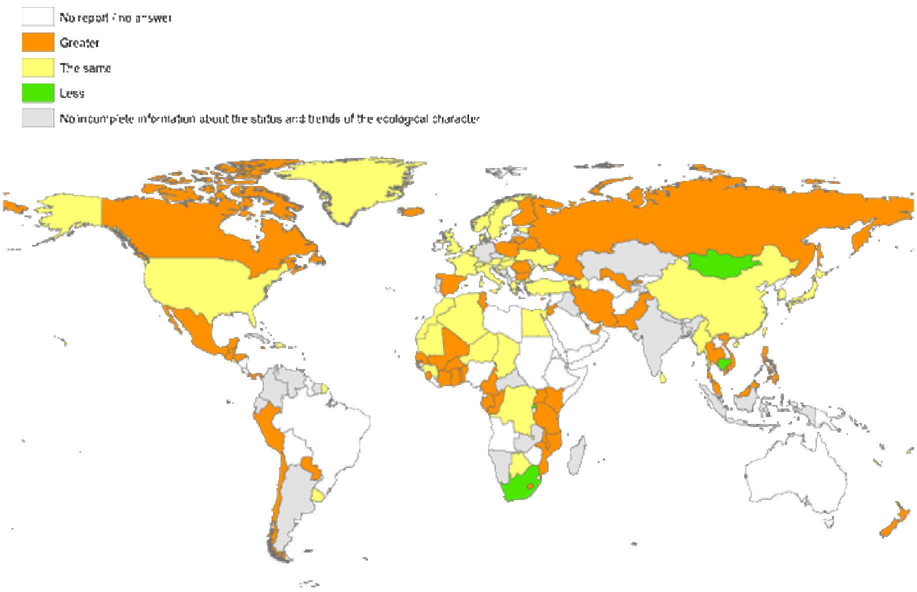


Figure 12: Parties reporting that the need to address adverse change in the ecological character of wetlands in general was greater, the same or less in 2005-2008 than in the previous triennium.

Table 5: Wetland conservation status index: comparison between regions.

	Number of Parties reporting that the need to address adverse change in the ecological character of wetlands in 2005-2008 was:			
	greater than in the previous triennium	**the same** as in the previous triennium	**less** than in the previous triennium	**Index**
Africa	16	10	2	0.25
Asia	8	7	1	0.28
Europe	11	18	0	0.31
Neotropics	8	5	0	0.19
North America	2	1	0	0.17
Oceania	1	1	0	0.25
Global	46	42	3	0.26

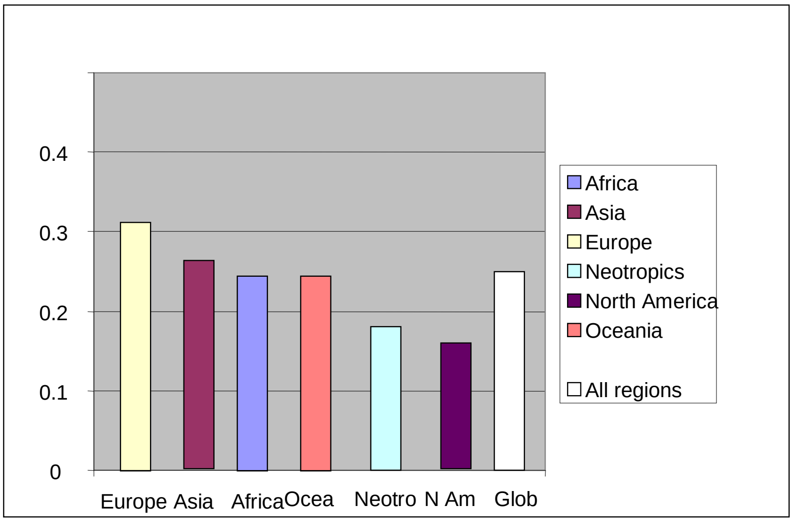


Figure 13: Wetland conservation status index, 2005-2008 vs 2002-2005: comparison between Ramsar regions. (Vertical axis = overall index score per region

434. These comparisons should be interpreted with some caution, in light of the fact that the number of countries per region varies considerably, and the number of responses forming the basis of index calculations in some region is small (e.g., 3 in North America and 2 in Oceania).

435. That apart, the story these data tell is twofold. First, in three out of six Ramsar regions in 2005-2008 (Africa, Neotropics, North America) a majority of Parties perceived that the need to address adverse change in the ecological character of wetlands in general had increased compared with the previous triennium. In Europe a majority of countries perceived the need as unchanged, and in Asia and Oceania the picture was more equivocal.

436. Second, scores for the index of overall effectiveness in the conservation of wetland status are above the global average in Europe and Asia, while the Neotropics and North America score least. (Any individual country's result, of course, may differ from the trend for their region).

437. In summary for Indicator A(ii), (and bearing in mind that although it is already a trend indicator, it will acquire an additional dimension when a further cycle's report data in 2012 allows comparisons between trend periods), the 2008 findings suggest a net deterioration in the conservation status of wetlands in general between 2005 and 2008. Regions differ, and in Europe the need to address problems remained on average at the same level over this period. However, since these problems include biodiversity declines, this implies that declines continued to the same degree; so even in this "best" region the result amounts to a failure to record achievements in the direction required for meeting the 2010 target.

438. Although the analysis of correlations with Ramsar implementation "inputs" is not a subject for the present report, it may be noted in passing that recent work by the STRP indicates that better overall status of a country's wetlands, as evaluated from the same Indicator A(ii) dataset discussed here, appears to be associated with:

- having a National Wetland Policy/equivalent;
- applying Strategic Environmental Assessment practices;
- applying Ramsar's guidance on wetland restoration;
- implementing programmes for raising awareness about wetland services;
- having greater financial resources; and
- providing opportunities for wetland site manager training.

439. Ramsar Indicator B, on "Trends in the status of Ramsar site ecological character - qualitative assessment" take a comparable approach to that summarised above for Indicator A(ii), but is restricted to designated Wetlands of International Importance (Ramsar sites). As well as producing findings for the sub-set of wetlands that comprise the global network of Ramsar sites in their own right, the analysis of Indicator B also allows an exploration of whether, country-by-country, status of Ramsar sites is correlated with the status of wetlands more generally. As this work is still in progress at the time of writing, Indicator B results are not presented in the present report; but they will become available at a later date.

440. An example of a wetland status qualitative assessment at a sub-global level is the one conducted by the Ramsar Secretariat for the area covered by the MedWet (Mediterranean Wetland) Initiative (Stark et al., 2004). This was based on 156 responses (covering site, national and supranational perspectives) to a questionnaire survey of experts closely associated with wetland sites or issues in the region. Although not done on the same basis as that described for Indicator A(ii) above, some examples of the results are included here since they shed additional light on the status question.

441. The survey recorded expert judgements on the "current state of health of wetlands" (involving both status and trends) in categories of "good/improving", "good/stable", "good/deteriorating", "poor/improving", "poor/stable" and "poor/deteriorating"; and on the perceived change in the state of health of wetlands from 1991 to 2004 in categories of "major improvement", "improvement", "no significant change", "deterioration", and "serious deterioration". (The year 1991 was used because it marked the holding of the Grado Conference on the future of Mediterranean Wetlands, which was the springboard for the development of the MedWet Initiative).

442. Results were analysed in terms of (a) current status, (b) current trends, (c) change from 1991-2004, and then a comparison between (b) and (c). Comparisons were also made between southern Mediterranean countries and northern Mediterranean countries; and between inland wetlands and coastal wetlands.

443. Concerning current status, 65% of responses categorised the current status of Mediterranean wetlands overall as "good" and 35% as "poor" (see Figure 14). There was no significant difference between results for the northern and southern parts of the Basin. There was however a difference between

inland and coastal wetlands, with inland wetlands regarded as having appreciably better status (showing both more “good” scores and fewer “poor” scores than coastal wetlands - see Figure 15).

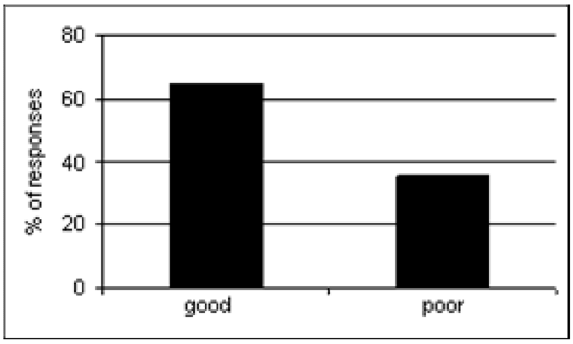


Figure 14: Summary of “current status” scores for Mediterranean wetlands overall. (From Stark et al., 2004).

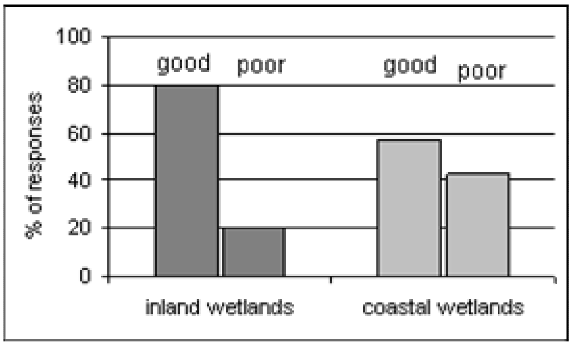


Figure 15: Comparison of “current status” scores for inland and coastal Mediterranean wetlands. (From Stark et al., 2004).

444. The responses for current trends gave a worse picture than for current status, dividing equally between perceptions of trends that were “deteriorating” and those that were “stable or improving” (Figure 16).

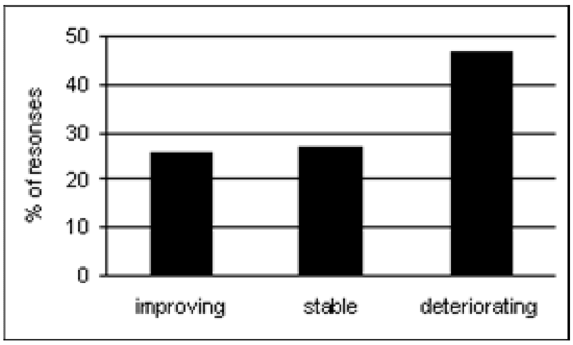


Figure 16: Summary of “current trends” scores for Mediterranean wetlands overall. (From Stark et al., 2004).

445. Differences in current trends between northern and southern countries were apparent, (even though, as described above, there was little difference in terms of current status) - more deterioration than improvement was perceived in the north, and more improvement than deterioration in the south (Figure 17). There were also differences between inland and coastal situations, mainly in the southern countries, where more deteriorating trends were noted for coastal wetlands than for inland wetlands.

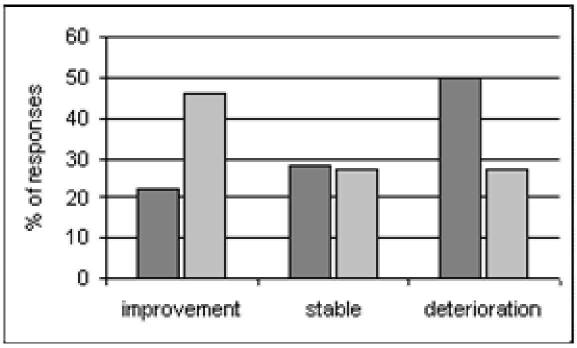


Figure 17: Comparison of "current trends" scores for wetlands in northern (dark grey) and southern (light grey) Mediterranean countries. (From Stark et al., 2004).

446. Concerning changes from 1991-2004, for the Mediterranean basin as a whole there were roughly equal proportions of responses recording improvements and deteriorations (see Figure 18). Note that this does not mean the situation overall is stable: it means that there are both significant deteriorations (needing attention) and significant improvements; and in fact a minority (only one fifth) of responses recorded situations perceived as stable.

447. Responses also indicate a worse trend in the north of the Mediterranean basin than in the south. Deterioration was recorded for a significantly higher proportion of wetlands in the north (43% of reports) than in the south (21%), and for improvements the converse was found (36% in the north and 59% in the south) (see Figure 19). This is consistent with the findings for current trends discussed above.

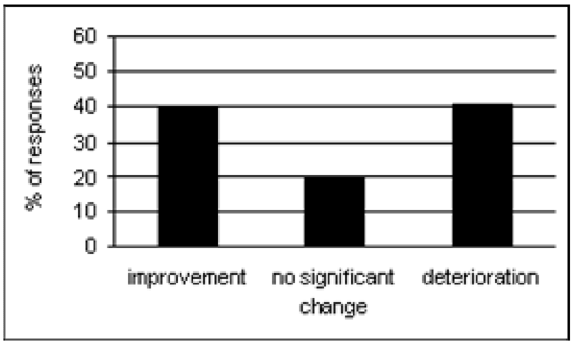


Figure 18: Summary of perceived changes from 1991-2004, for Mediterranean wetlands overall. (From Stark et al., 2004).

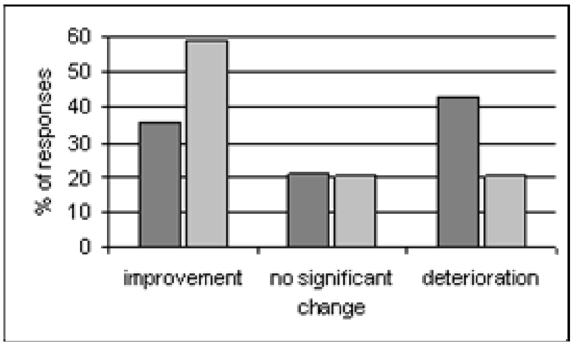


Figure 19: Comparison of perceived changes from 1991-2004 for wetlands in northern (dark grey) and southern (light grey) Mediterranean countries. (From Stark et al., 2004).

448. Not so much difference was noted in respect of changes from 1991-2004 between inland and coastal wetlands. There were some indications of a higher proportion of perceived improvements in the status of inland wetlands, but the proportion of perceived deteriorations was about the same for both inland and coastal wetlands.

449. An overall comparison of the "current (2004) trends" and "1991-2004 trends" is shown in Figure 20. The "deteriorating" proportion as judged for 2004 is higher than as judged for the preceding 13 years; while the "improving" proportion is lower. This suggests a worsening over time of the status of Mediterranean wetlands as a whole.

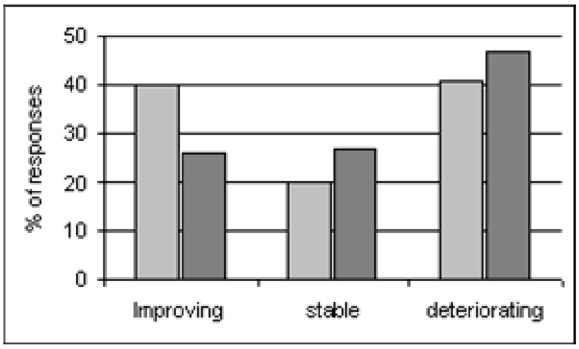


Figure 20: Comparison of perceived trends in Mediterranean wetland status judged for 2004 (dark grey) with trends judged for 1991-2004 (light grey). (From Stark et al., 2004).

2. Ramsar Indicator results: trends in waterbird populations

450. Ramsar effectiveness indicator F is entitled "Overall population trends of wetland taxa", and in the first instance, efforts under this heading have been directed primarily towards the sub-indicator covering "Status and trends of waterbird biogeographic populations", and it is this sub-indicator to which the present section refers. Attention will be given to other taxa in due course, but in the meantime waterbirds boast some of the most extensive of all global biodiversity datasets, with some good time-series information as a basis for trend assessments.

451. No definitive list of species and subspecies considered to be "waterbirds" for these purposes has been adopted. Article 1.2 of the Ramsar Convention text however defines "waterfowl" as "birds ecologically dependent on wetlands", and subsequent guidance (Ramsar Convention, 1999-2008) equates "waterfowl" to "waterbirds" and gives a list of 14 taxonomic orders which this definition "especially" includes. For some geographic regions, BirdLife International has compiled lists of "wetland birds", defined as "any species for which a significant proportion of its numbers uses wetland habitat for breeding, feeding, roosting and/or moulting", where "wetland habitat" is in turn interpreted by reference to the Ramsar Convention's Classification System for Wetland Type.

452. Many individual species and biogeographical populations of species make use of both inland wetlands and coastal or marine wetlands in the course of their life cycles and seasonal cycles, and hence there is no easily rational basis on which to split an overall list according to the two relevant CBD thematic Programmes of Work. It should be noted therefore that the analyses below are based on data that relate to inland waters and marine/coastal situations combined.

453. Waterbirds are widely regarded as useful indicators of wetland ecological status. Migratory species in particular can be a basis for measures that offer integrated indicators of ecosystems along a flyway; and the congregatory habits of many species make their population numbers particularly responsive to land management and other influences.

454. The primary data source is the long-running International Waterfowl Census (IWC), coordinated by Wetlands International. Begun in 1967, it now covers more than 100 countries, where around 2000 volunteers count millions of waterbirds each year at selected sites during a fixed period in mid-January. Additional censuses take place in July in Africa and in other parts of the southern hemisphere. Data from the counts are entered into the IWC database, which is updated annually. Population data are published by Wetlands International in periodic "Waterbird Population Estimates" (WPE) publications (the latest being the 4th edition, released in 2006, covering 878 species in 33 families) (Wetlands International, 2006), and are used by the Ramsar Convention, the Convention on Migratory Species, the African-Eurasian Migratory Waterbird Agreement, IUCN's Red List assessments and the European Union's Species Action Plans.

455. Most estimates in WPE are "best expert assessments" rather than being statistically generated, so it is not possible to express confidence limits on trend information. For some taxa (ducks, geese, swans and shorebirds) and some regions (the Western Palearctic and North America) however, the IWC does have more statistically robust datasets. In addition, populations do not each have their status updated consistently from one period to the next, so for example some estimates (and associated trend statements) for a given population at the time of a given WPE publication may simply be carried forward from the previous publication, without being re-verified by new field data (this is referred to further below). Care in analysis is therefore required.

456. Bearing these caveats in mind (and others mentioned below), it is nonetheless possible to generate fairly robust findings concerning the current trends of populations, changes in these trends from one period to another, and comparisons between different taxonomic groups and different geographic areas. On particular review has been undertaken of the results of the 3rd edition of the Waterbird Population Estimates (WPE3); and current work in the context of the Ramsar effectiveness indicator F is drawing further and more in-depth findings from the datasets lying behind the 4th edition (WPE4). These analyses are each summarised in turn below.

457. A review of status and trends information based on WPE3 (Wetlands International, 2002) and some other sources was published in Davidson and Stroud (2006). WPE3 covers 762 populations of 33 waterbird families, but trend estimates were available for only half of these populations, with coverage

varying widely between taxa and regions/flyways, and few trend estimates being available for populations in the Neotropics and Oceania in particular.

458. Nonetheless, based on the data available it was possible to conclude that throughout the world, considerably more waterbird populations were decreasing than were increasing. Regional ratios were as follows: in Oceania 3.8 times as many populations decreasing as increasing; in Asia, 3.7 times as many; in Africa, 2.8 times; in the Neotropics, 2.2 times; and in North America, 1.1 times as many.

459. Concerning taxonomic groups, 48% of shorebird populations with known trend were in decline, in contrast to just 16% that were increasing (International Wader Study Group, 2003). For those in Africa-Eurasia, three times as many populations were decreasing as were increasing, and more were in long-term decline than in long-term increase. Moreover the trend status of the majority of populations seemed not to have changed significantly over the preceding 10-20 years. 54% of shorebird populations in North America were in statistically significant or persistent decline with only 3% showing significant increases, and as many as 80% of populations in this region showed evidence of some degree of decline (Morrison et al., 2001). Shorebird trend status in other regions was less well known, having (at the time of WPE3) not been assessed since the 1980s.

460. Overall proportions of populations in decline for other waterbird groups showed a similarly negative picture, including divers (67% of populations of known trend decreasing), cranes (47%), rails (50%), skimmers (60%), darters (71%), ibises and spoonbills (48%), storks (59%), and jacanas (50%). Only gulls (18%), flamingos (18%) and cormorants (20%) appeared to have relatively low proportions in decline; with other groups having intermediate positions.

461. More detailed analysis of the Africa-Eurasia region showed that some trends here were markedly worse than the global average, for example 70% of this region's rail populations and 61% of its crane populations were decreasing. A preponderance of declines was also seen in populations dependent on certain flyways (such as the the Black Sea/Mediterranean and West Asian/East African flyways), certain areas (such as Africa in general but especially its islands, and West Asia/the Middle East), and certain key migratory staging areas (notably the Wadden Sea).

462. Flyway-scale analyses of the Africa-Eurasia region's shorebirds (International Wader Study Group 2003; Stroud et al., 2004, Stroud et al., 2006) reveal a similar story. In this region overall, almost three times as many migratory wader populations were declining as were increasing. In the Black Sea/Mediterranean Flyway, 65% of populations are decreasing, while in the West Asian/East African Flyway the figure is 53% (see Figure 21). The East Atlantic Flyway is the "least bad" case, with 37% of its shorebird populations in decline. A comparison with 1990s population trends indicated that more populations were in long-term decline by 2002 than were in long-term increase (8 compared to 3).

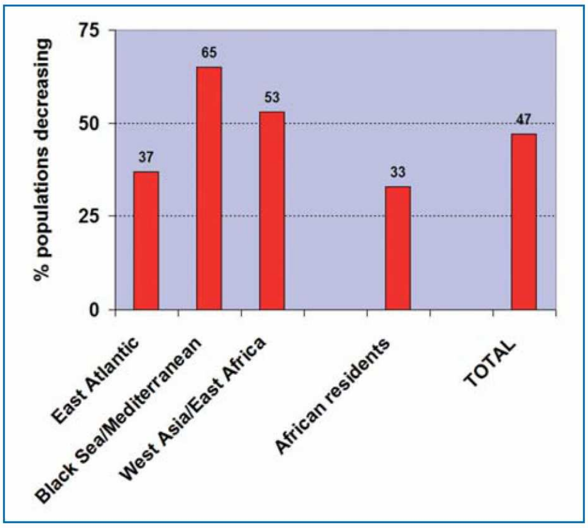


Figure 21: The status of wader populations on different flyways in the African-Western Eurasian region, expressed as the percentage of biogeographic populations of known trend in decline. The status of African resident populations is also shown. The number above each bar is the percentage of decreasing populations in the flyway concerned. (From Davidson and Stroud (2006), using data in Wetlands International (2002)).

463. A preliminary analysis for Anatidae (ducks, geese and swans) in the same region suggested that declines were similarly widespread among these groups. Overall, 43% of the 121 African-Western Eurasian Anatidae populations were decreasing, while only 33% were increasing. Migratory ducks (44% of populations decreasing, 31% increasing) and especially their non-migratory counterparts (45% decreasing and only 14% increasing) showed a worse picture than swans (25% decreasing, 75% increasing) and migratory geese (23% decreasing, 50% increasing).

464. As mentioned above, 70% of the rail populations and 61% of the crane populations in the Africa-Eurasia region were found to be in decline, with figures for other groups coming in at 45% for terns, 40% for ibises and spoonbills and 40% for herons. Only grebes and gulls (each with 9% of populations decreasing) showed relatively low proportions in decline.

465. Analyses of common characteristics of populations in decline can help to point towards likely sources of the problem, and hence to shape priorities for responses. For example, migratory shorebird populations in decline in the Africa-Eurasia region included a preponderance of those breeding in the arid and semi-arid zones of western and central Asia and the Mediterranean; those breeding in temperate wet grasslands in Europe; and certain long-distance, non-stop migrants using the coastal East Atlantic Flyway (Stroud et al., 2004).

466. Declines in the first of these groups have been linked, as for many other farmland birds in the region, to agricultural intensification and wetland drainage. For the second group, the most likely driver of change is also agricultural intensification, including drainage and water abstraction, coupled with increasingly severe and prolonged droughts. For the long-distance migrants in the East Atlantic Flyway, deterioration of critically important spring staging areas, (notably the Wadden Sea, resulting from direct and indirect impacts of commercial shellfisheries) is strongly implicated (Davidson and Stroud, 2006).

467. Further insights may be gained by looking at this in terms of where in the Africa-Western Eurasia region different populations spend their non-breeding season; as shown for example in Figure 22. Of populations which spend their non-breeding season wholly within Europe, 78% are in favourable status,

compared with only 47% of those which depend on Africa and just 29% depending on West Asia and the Middle East. As might also be expected, those populations which are more widespread than others (occurring in more than one of these sub-regions) have a relatively better status (56% of populations in favourable status). This pattern holds for several different groups of waterbirds.

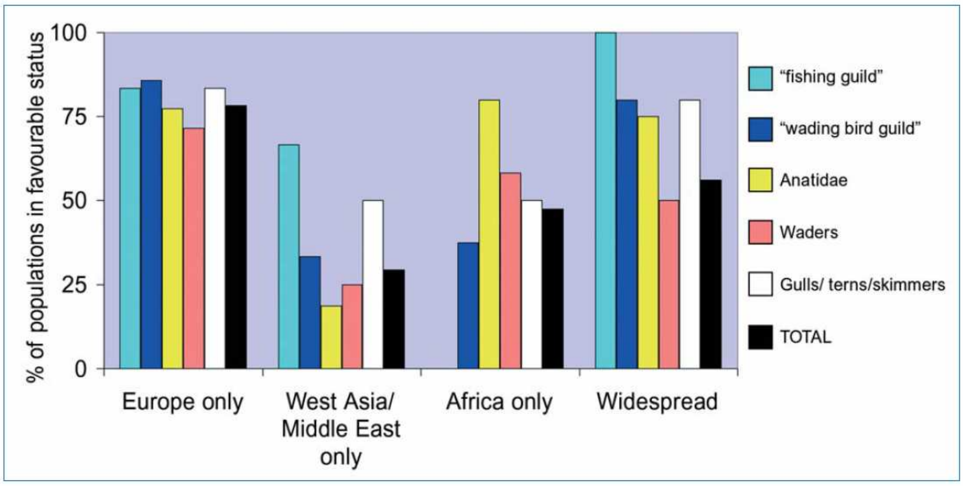


Figure 22: The percentages of different waterbird "guilds" in favourable status (stable or increasing populations) dependent on different African-Western Eurasian sub-regions during the non-breeding season. The category "widespread" represents populations occurring in more than one sub-region. "Fishing guild" includes divers, grebes, pelicans and cormorants; "wading bird guild" refers to herons, storks, ibises, spoonbills and cranes. No status data are available for "fishing guild" populations in Africa. (From Davidson and Stroud (2006), using data in Wetlands International (2002)).

468. The publication of the 4th edition of Waterbird Population Estimates (WPE4) in 2006 has allowed further assessments to be made. BirdLife International has assembled selected case study assessments of bird status and trends information, and has made these available on-line via its "State of the World's Birds" website (http://www.biodiversityinfo.org/sowb/default.php?r=sowbhome). One such assessment relates to waterbird population trends, based on analyses at the global, regional, country, taxonomic group and species level, with data derived from WPE4 (Figure 23).

469. BirdLife's analyses indicate that for the 1,200 (52%) of the world's waterbird populations for which reliable trend data are available, overall 40% of these are in decline, with 17% increasing and 43% stable. The picture however varies regionally and is worst in Asia, where the proportion of all waterbird populations in decline is 59%. (Note that BirdLife's delineation of the Asian region does not exactly coincide with that used by the Ramsar Convention). Some long-term country-level studies that are cited in the same assessment paint an even more dramatic picture, for example a recent review of long-term trends of shorebird populations in eastern Australia reports that migratory populations have dropped by 79% over a 24-year period (Nebel et al., 2008).

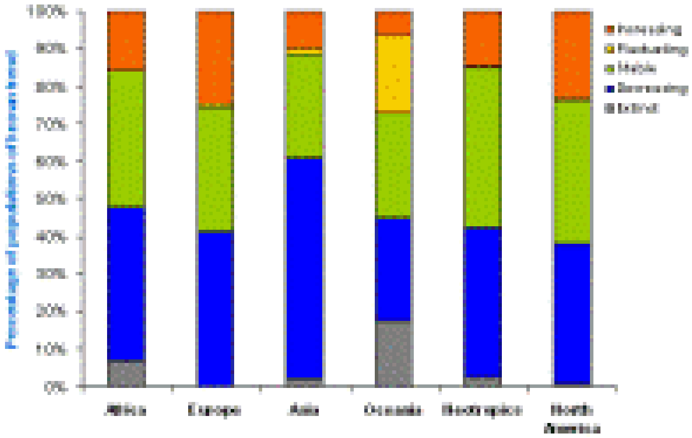


Figure 23: Waterbird population trends, in different regions. (From BirdLife International, on-line).

470. Some perspective of changes over time can be gained by comparing the overall proportions of waterbird populations for which favourable and unfavourable trend assessments are given in each of the four WPE publications issued since 1994 (see Figure 24 and Figure 25).

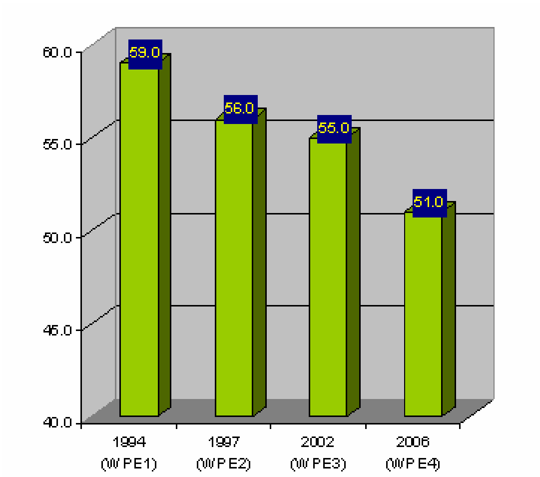


Figure 24: Proportion of global waterbird populations in "favourable" status (stable or increasing). (Based on the 4 successive Wetlands International WPE publications).

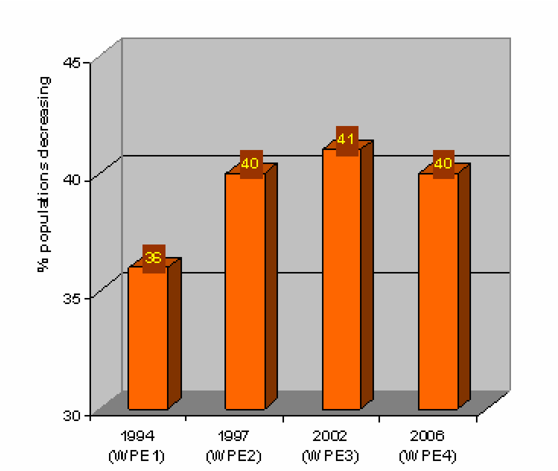


Figure 25: Proportion of global waterbird populations in decreasing status. (Based on the 4 successive Wetlands International WPE publications).

471. This appears to give a clear picture of overall deterioration over the period concerned. Given however that, as mentioned above, only some of the populations have trend assessments, and that others are known to be being affected in recent times by significant problems, the true situation may be still worse than that portrayed above.

472. As also mentioned above, even where trends are given in WPE, some of them are based on population estimates which have been carried forward from the previous period, without being empirically re-assessed or updated by field data from the intervening years. The citing of these trends in association with particular publication dates, alongside other trends which represent genuinely substantiated changes, may therefore give a spurious impression of stability in the populations concerned.

473. The assessments which follow below, undertaken within the Ramsar Secretariat (N. Davidson) and due to be published at a later date, address these issues in two ways. First, these analyses include only those populations for which a WPE trend assessment exists for the period/s referred to. Second, instead of using the published WPE figures, the underlying raw source data has been used, so that estimates/trends can be assigned to the actual time-period to which the corresponding field-counts relate, rather than to dates of compilation. These analyses concentrate just on the sub-set of waterbirds belonging to the Charadrii (waders/shorebirds).

474. In the context of the 2010 biodiversity target, which expects a change in the rate of change, a first analysis has examined those shorebird populations for which two or more “genuine” (i.e. empirically re-derived) trend assessments can be compared. Each trend is classified as “increasing”, “stable” or “decreasing”; so an improvement in trend (as opposed to an improvement in gross population) would be where, for example, “decreasing” for one time-period is followed by “stable “ or “increasing” for a subsequent period. “Decreasing” followed by “decreasing” represents no change in trend, even though the population it refers to will have been becoming progressively smaller.

475. For shorebirds, the proportion of populations in decline has, overall, grown progressively since the early 1980s. This can be examined further in relation to given bands of years, allocating trends to bands according to the time-period to which they refer. Doing this reveals for example that in the early

1980s a majority (62.5%) of assessed populations were in “favourable” status (increasing or stable trends), but by the mid 2000s a majority (51.7%) were in “unfavourable” status (declining trend).

476. To give an illustration of a 2010-relevant calculation, shorebird trends were allocated to the three periods “early-mid 1980s”, “early-mid 1990s” and “early-mid 2000s”, which then allows results to be plotted as two points on a graph representing (i) the rate of change from the first period to the second, and (ii) the rate of change from the second period to the third. The two points can then be compared to see whether there has been an improvement in the rate of change. (NB “rate” in this sense refers to proportions per time-period, rather than rapidity).

477. For shorebird population declines, each of the two points was calculated as the percentage rate of change per year, observed at that time, in the [number? proportion?] of assessed populations showing a decreasing trend. This is shown in Figure 26, which also includes a comparison with the result that would be expected if the 2010 target were being met. (The target expects a “significant” reduction in the rate of loss, and since “significance” in this context has not been defined, several “expected” result-lines are shown, representing a selection of different percentage reductions in loss-rate).

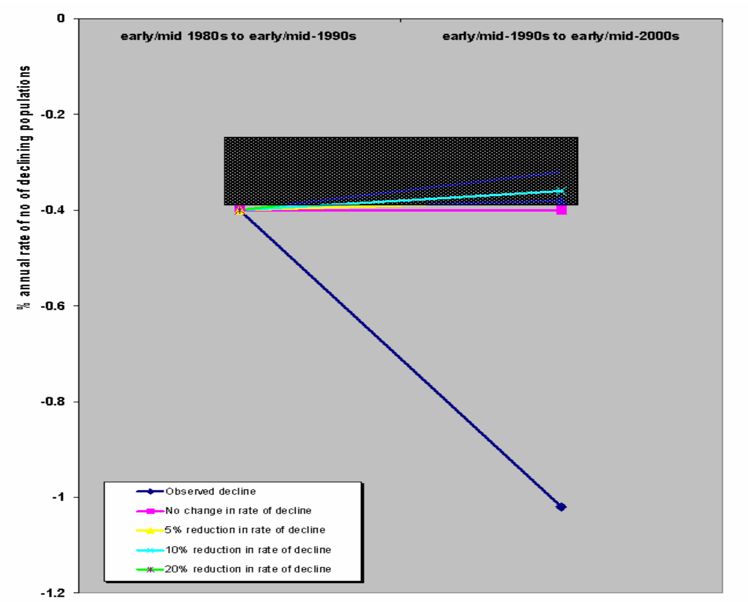


Figure 26: Change in rates of decline of shorebirds (expressed as annual percentage rates of change in the populations in decline) compared to the result that would be expected if the 2010 target were being met. (Source: N Davidson, Ramsar Convention Secretariat).

478. The story these data tell is that the observed annual percentage rate of change in the shorebird populations in decline has more than doubled in recent years - from an additional 0.40% of populations per year to an additional 1.02% of populations per year. In other words, at the population level, shorebird status is now (early-mid 1990s to early-mid 2000s) deteriorating at a rate 2.55 times greater than the earlier rate of deterioration (between the early 1980s and the mid-1990s). Put yet another way, shorebird populations have been losing their “favourable status” (stable or increasing population trend) at an annual percentage rate over 2.5 times greater in recent years than before. In respect of the 2010 target, this indicates that not only is the rate of loss of biodiversity in the case of shorebirds not reducing, but on the contrary it has more than doubled over the last 10 years.

479. As discussed above, conversion of results to index scores allows enhanced comparability between time-periods, geographical areas or other data classes. To apply this to the shorebird trend data, index scores were assigned to the trend categories such that a score of 0 represented a decreasing trend, 1 represented a stable trend and 2 represented an increasing trend. Then in a similar way to that described for Indicator A(ii) the index for a given set of populations in a given time-period was calculated as the ratio of the actual average score per population to the theoretical maximum possible average score per population (which is 1.0, i.e. the average if all populations were increasing over the time-period concerned).

480. The picture obtained from this will obviously depend on which populations are included in the analysis, and it may also vary according to the selection of time-periods for comparisons. One portrayal of it is given in Figure 27 which uses all shorebird populations globally for which at least one trend assessment has been made at some point between the mid-1980s and the present.

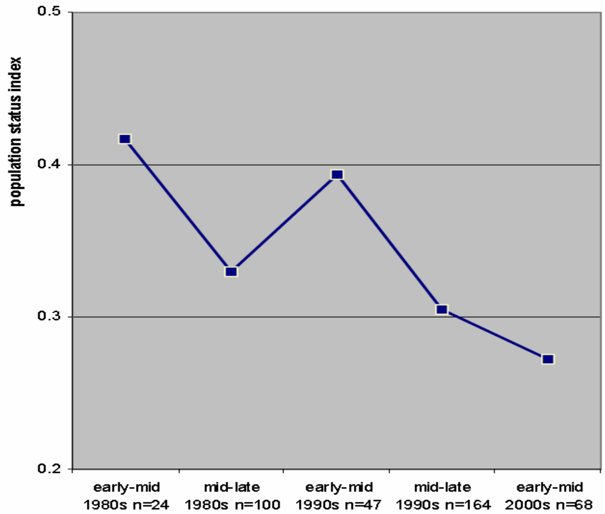


Figure 27: Change in overall shorebird population trend index scores since the mid-1980s.

481. The story these data tell is that the global overall population trend status of shorebirds was already poor (index of 0.42) in the early-mid 1980s (the first period for which IWC-based trend assessments are available); and that the overall situation has deteriorated further since then, with the global index dropping to 0.27 by the mid-2000s.

482. The apparent improvement between the mid-late 1980s and the early-mid 1990s appears at first sight to be at odds with the picture of progressive continuous overall decline throughout the period that was presented earlier above (from the non-index-based analysis). In each time-period, however, the number of populations for which trend assessments are available varies widely (from 24 to 164), and the taxonomic and geographical composition of the lists of these populations is not the same in each time-period either; so there is not complete comparability.

483. In the early-mid 1990s, the majority of the available trend figures relate to just two categories of populations, namely endemics, mostly in sub-Saharan Africa (accounting for 20 out of the 47 available trend figures), and populations in the Americas (19 of the 47 trends). Since the populations in both of these categories at the time had on average better status than the average for other groups/areas elsewhere

in the world (see separate analysis further below), they have skewed the results to make the situation in the mid-1990s period appear better than it should.

484. Similarly, the number of trends assessed for the early-mid 1980s period is small, and most of them (18 of the 24 assessments) relate to the East Atlantic Flyway, with the rest relating to the Black Sea/Mediterranean flyway. In both of these flyways too, shorebird populations on average had better status than elsewhere. This may make the picture appear better than it should in terms of shorebird status in the early part of the period, while at the same time making it appear worse than it should in terms of the steepness of the overall trend-line. (Removing both of the potentially anomalous data-sets from the index analysis however actually has little effect on the pattern as a whole, as can be seen from Figure 28 and Figure 29.

485. Notwithstanding this, if it were felt necessary to generate a potentially more robust result, one way of doing so would be to look only at those specific populations which have featured repeatedly in trend assessments, i.e., in two or more time-periods (so that comparisons between the time-periods would be of “like with like”). Only in the East Atlantic flyway are there sufficient data of this kind to look at trends since the 1980s for a consistent set of the same populations: this has no been done here, but could be explored separately.

486. The results above are based on one method of calculating a trend index. Alternative approaches are possible. For example it could be done as a "global favourable status index", reflecting the proportion of the total assessed population trends that are classed as either “stable” or “increasing” (or conversely a “global index of concern”, based on the proportion of trends classed as “decreasing”). A third approach could be to calculate the ratios of increasing trends to decreasing trends (i.e., excluding the stable trends). Figure 28 illustrates the overall trend lines produced by each of these methods, alongside the line produced by the global population status index already discussed above. (The time-axis has been simplified by condensing the five assessment periods into three decadal evaluation points).

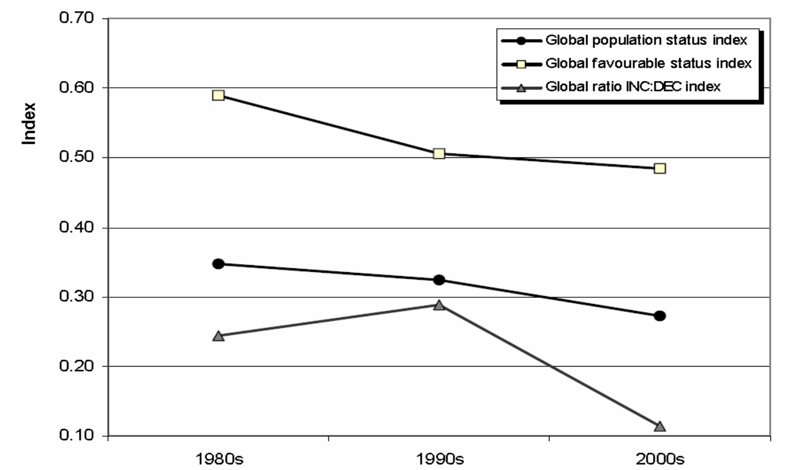


Figure 28: Global trends in shorebird populations, shown according to three alternative index methods. (The differences in index scores within each decade should be ignored, since each index is derived differently and the purpose here is to see the trend-lines that each one produces over the three-decade period)

487. This can also be presented with the exclusion of the potentially anomalous assessment periods discussed above (early-mid 1980s and early-mid 1990s); and the resulting alternative outcome is shown in Figure 29.

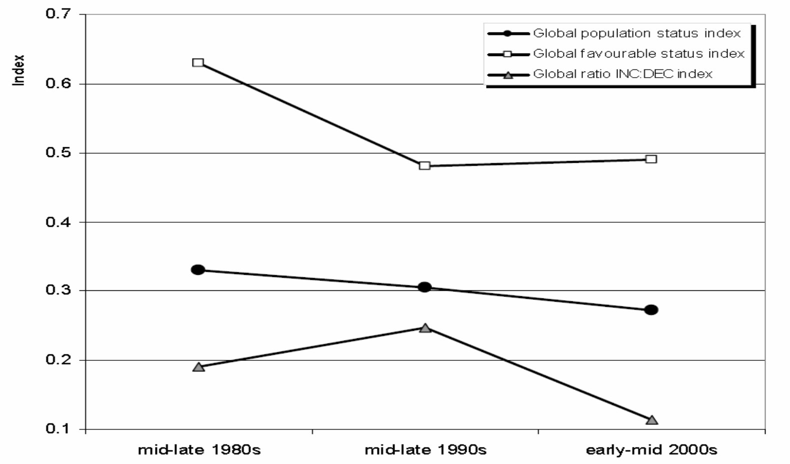


Figure 29: Global trends in shorebird populations shown according to three alternative index methods, with assessments for early-mid 1980s and early-mid 1990s excluded from the analysis.

488. The two additional indices presented in these Figures show that (i) less than half of the assessed shorebird populations are now in favourable status compared with over 60% in the mid-late 1980s, the steepest status decline having occurred between the mid-late 1980s and the mid-late 1990s; and (ii) the overall ratio of increasing population trends to decreasing trends dropped sharply after the mid-1990s.

489. The differing pictures brought out by these various methods of calculation and presentation reinforce the value of examining trends in several ways, rather than relying on a single choice of analysis method; even when a single headline indicator has been agreed as the best way of framing the question.

490. It seems clear nonetheless that the basic story told by all the approaches presented above is in principle the same: that the overall status of shorebird populations shows a considerable and progressive decline since the 1980s, when they were already in generally poor status. Nearly all of the calculation methods used show worse rates of trend status deterioration in more recent times compared to earlier times.

491. Trend comparisons based on index scores can be related to the 2010 target expectations in the same way as was shown above with the non-index-based data - see Figure 30.

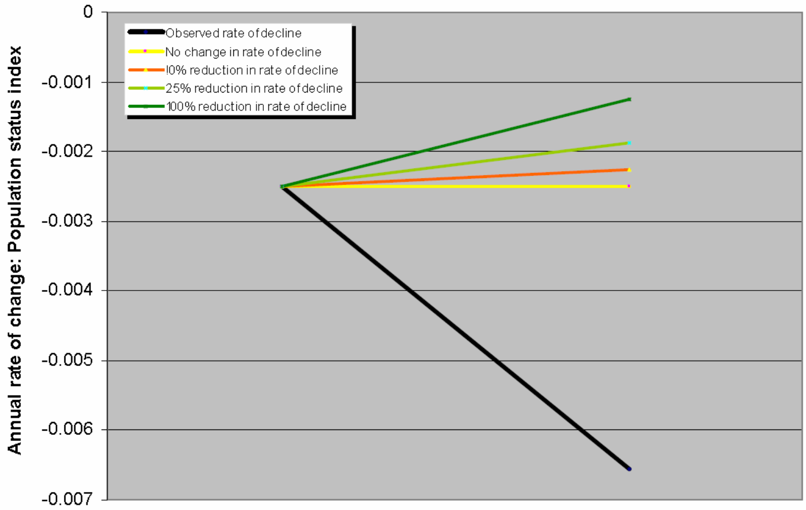


Figure 30: Overall shorebird population status index results for trend differences between early-mid 1980s and early-mid 1990s (data-point on left) and between early-mid 1990s and early-mid 2000s (data-point on right), compared to the result that would be expected if the 2010 target were being met. (As in the earlier example, several "expected" result-lines are shown, representing a selection of different percentage reductions in loss-rate).

492. The story these data tell is that the global population status index for shorebirds has declined since the mid-late 1980s; and the latest rate of decline is 2.64 times greater than the previous rate (the decline index has increased by 0.0066 per year for the period from the early-mid 1990s to the early-mid 2000s, compared with an increase of 0.0025 per year for the period from the early-mid 1980s to the early-mid 1990s). This is similar to the findings from the non-index-based assessment method described earlier, where the trend was found to be worsening over the same period by a factor of 2.55. Again, in respect of the 2010 target, this indicates that not only is the rate of loss of biodiversity in the case of shorebirds not reducing, but on the contrary it has more than doubled over the last 10 years.

493. Further insights may be gained by disaggregating the global dataset to compare particular groupings of populations, such as those relating to specific flyways, as already referred to above. The global average and index results given above present net trends, which may be composed of a range of contrasting individual trends. Strong positive and negative underlying stories could in theory balance out to produce a net indicator finding of stability, when in fact none of the constituent populations is in a stable status. Hence it is important to look at smaller subdivisions too, where possible.

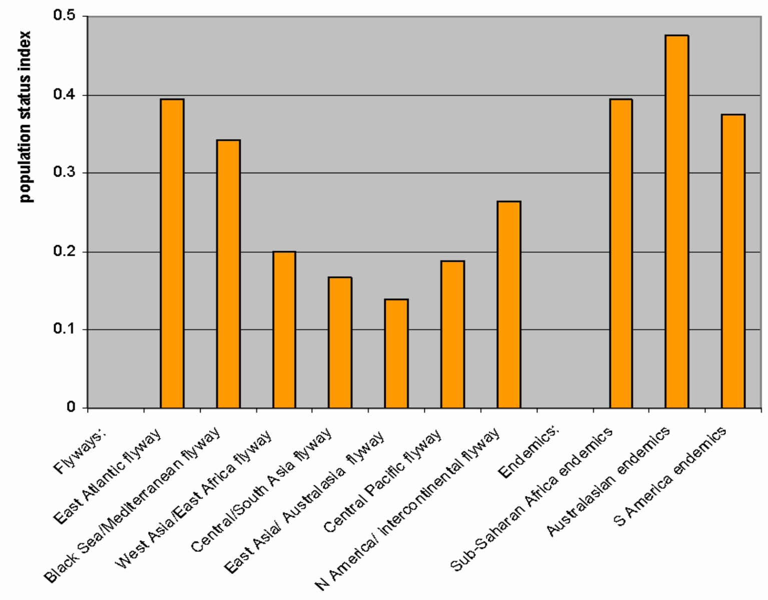


Figure 31: Shorebird population status index scores (for trends from the mid-1990s to mid 2000s), disaggregated by flyway and endemic groupings.

494. As with the WPE3-based picture presented earlier above, these data confirm that appreciable differences in indexed trends exist between shorebird populations in different geographical areas (Figure 31). In relation to flyways, trend status is particularly poor on flyways across Asia/Australasia and especially on the Central/South Asia and East Asia/Australasia Flyways. Status is best on the East Atlantic and Black Sea/Mediterranean Flyways, although even here it is not high, with index scores still below 0.4. The status of endemic shorebirds is more favourable than the status of migratory flyway populations.

495. Although the number of trend assessments available for earlier time-periods in some cases is relatively small, it is nonetheless possible to compare changes in trend status over time for these same disaggregated population-groups, as in Figure 32.

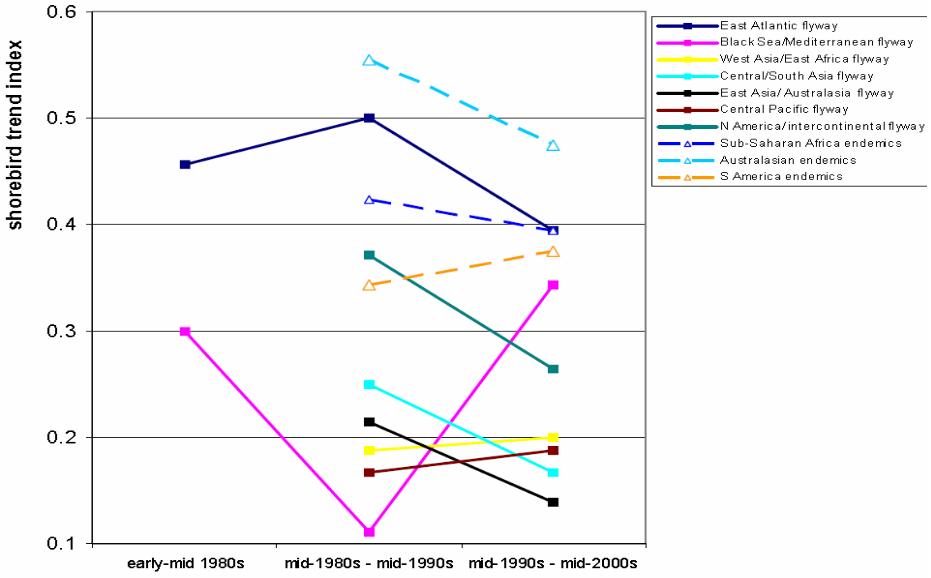


Figure 32: Change over time in shorebird population status index scores, disaggregated by flyway and endemic groupings.

496. The story these data tell is that deterioration in shorebird trend status has been occurring within each of a number of different flyways and regions of the world. The situation in the Black Sea/Mediterranean Flyway has switched over the last 20 years from a deterioration to an improvement, with the reverse happening in the East Atlantic flyway. It appears that slight improvements have occurred in recent times also in respect of the Central Pacific and West-Asia/East Africa and South American endemics. Given the small sample sizes in some cases, care is needed in interpreting these results; but the main patterns seem reasonably clear.

497. In due course it will be desirable to examine disaggregations of other kinds, for example to compare trends in common/widespread species with those in geographically or ecologically more restricted species. The scope of analyses for Indicator F will also widen further when it becomes possible in future to generate equivalent trend data for other waterbird taxa beyond shorebirds, and for other biodiversity beyond waterbirds.

498. In the European region, waterbird population trend indicators are included in the SEBI2010 indicator initiative, which aims to coordinate indicator work in Europe related to the 2010 biodiversity target (and has been referred to above).

499. As part of this, the Pan-European Common Bird Monitoring Scheme (PECBMS) has published breeding population trends and indices for 135 species of common birds in 20 countries, on the website of the European Bird Census Council (www.ebcc.info). The trends and indices published in the most recent (4th) update (2008) cover the years 1980-2006, although data going back to the 1960s are available from some of the countries.

500. Individual national species indices are produced by annually operated national breeding bird census schemes, moderated by a software package which allows for missing counts in the time series and expresses standard errors. The national indices are weighted by estimates of national population sizes when they are combined into supranational indices, to allow for the different proportions they each hold of the European total.

501. In line with adopted continental biodiversity indicators, aggregated indices have been produced for groups of species (each one weighted equally) associated with farmland and with forests, but as yet there is no programme for doing this in respect of wetland/inland waters species. In the meantime however the trends for individual waterbird species can be examined. Two examples are shown below, for common snipe and grey heron (Figure 33 and Figure 34). In the case of the declining example, numbers of snipe went down by 36% from 1980-2006 and by 16% from 1990-2006: so in relation to that particular baseline year there has been a reduction in the rate of decline, although there is of course still a significantly reducing trend overall.

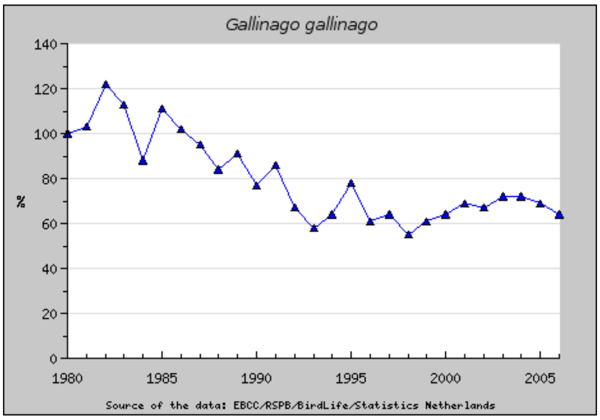


Figure 33: Trends in populations of breeding common snipe (*Gallinago gallinago*) in Europe, relative to 100% baseline of 1980. (From Pan-European Common Bird Monitoring Scheme, on-line).

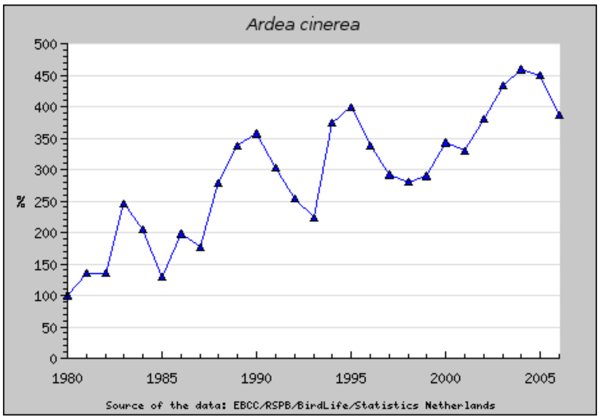


Figure 34: Trends in populations of breeding grey heron (*Ardea cinerea*) in Europe, relative to 100% baseline of 1980. (From Pan-European Common Bird Monitoring Scheme, on-line).

3. Ramsar Indicator results: water quality

502. Water quality indicates both major direct threats to the sustainability of inland waters and the effects of unsustainable activities from beyond these ecosystems. It is another facet of the fact that the functioning and integrity of inland waters is an excellent indicator of the status of terrestrial ecosystems more broadly. In addition, as mentioned further below, water quality in general is directly correlated to inland waters biological diversity.

503. After a review of numerous options by the STRP, Ramsar indicator C was defined as two sub-indicators addressing selected aspects of the issue, viz: (i) "trends in dissolved nitrate (or nitrogen) concentration", and (ii) "trends in Biological Oxygen Demand (BOD)". The first of these aims to reflect changes over time (once differences between water body type and seasons have been taken into account) in both pollution and trophic attributes of inland water ecosystems. Measurements from individual sites reflect influences from their wider area (e.g. pollution in the catchment from fertiliser run-off). BOD indicates levels of organic matter inputs, for example from effluent.

504. As defined, these sub-indicators can be operated at national level or below, in the many cases where relevant parameters are part of existing water quality monitoring programmes. At global level, the CBD has provisionally defined an indicator area concerning "biological oxygen demand (BOD), nitrates and sediments/turbidity" (COP Decision VIII/15). The Biodiversity Indicators Partnership (BIP) includes "water quality" in its list of indicators, and has identified the UNEP-GEMS/Water Programme as the principal data provider for this.

505. The Ramsar Secretariat/STRP Indicators Working Group, in the context of the Convention's participation in the BIP (as an end-user, as well as a co-designer), has worked on the basis that data collated as part of the BIP programme would populate Ramsar indicator C. While UNEP-GEMS/Water has collated data on dissolved nitrogen and oxygen, it has also gone further and developed specifically for the BIP process a "Water Quality Index for Biodiversity" (WQIB), which incorporates additional parameters that have relevance for the status of biodiversity.

506. Consequently, notwithstanding the original restriction of the Ramsar indicator definition to BOD and nitrogen/nitrates, the approach to be taken now is likely to feature this broader index in addition, or instead. The information below is therefore largely based on the principal report provided to date for BIP by UNEP-GEMS/Water (Carr and Rickwood, 2008).

507. The UNEP-GEMS/Water Programme maintains the only global database of water quality for inland waters, based on sampling from over 3,200 surface and ground-water monitoring stations around the world and made available online through GEMStat at http://www.gemstat.org/ . The results do not relate the location of monitoring stations to the location of wetland systems (although they have been related to freshwater ecoregions - see below), and for application of the data to questions of Ramsar Convention effectiveness this would be a desirable future development. Nonetheless, water quality in general is directly correlated to inland waters biological diversity (a degradation of water quality can be expected to result in a loss of biodiversity), hence its inclusion in 2010 indicators. Carr and Rickwood discuss this correlation further in their report, as the basis for their development of the WQIB.

508. The index is composed from data on the following parameters:

- Dissolved Oxygen
- Electrical Conductivity
- pH
- Temperature
- Nitrogen
- Phosphorus

509. In addition to being well correlated with biodiversity, these parameters were chosen because they are good indicators of specific issues of global relevance (eutrophication, nutrient pollution, acidification, salinisation and climate change). Biological Oxygen Demand (BOD, also referred to as Biochemical Oxygen Demand), which was identified as an intended component of Ramsar indicator C, is not included in the index (absolute Dissolved Oxygen levels are used instead), since many countries no longer monitor BOD and in some regions there is no good basis for assessing trends after 2000. Earlier BOD trend information is however referred to in the present section below, following discussion of the WQIB.

510. The Water Quality Index for Biodiversity is a proximity-to-target index, computed on a monitoring station by monitoring station basis using measurements of the parameters listed above. The reference target for each of the parameters is shown in Table 6.

Table 6: Summary of targets defined by UNEP GEMS/Water for parameters included in the Water Quality Index for Biodiversity. (From Carr and Rickwood, 2008).

Parameter	Target	Details
Dissolved oxygen	6 mg/l	DO must not be less than target when average water temperatures are > 20 ºC
	9.5 mg/l	DO must not be less than target when average water temperatures are ≤ 20 ºC
pH	6.5 – 8.5	pH must fall within target range
Conductivity	500 µS/cm	Conductivity must not exceed target
Total Nitrogen	1 mg/l	Total nitrogen must not exceed target
Total Phosphorus	0.05 mg/l	Total phosphorus must not exceed target
Temperature	(Latitude dependent)	Temperature must not exceed modeled temperature for the given latitude

511. A WQIB score of 100 indicates that targets for all of the parameters measured at a given station in a given year were met. Increasing distance away from a perfect score indicates progressively worse water quality.

512. Results shown by Carr and Rickwood are based on a total of 73,657 records from 88 countries in each of the world's continents (except Antarctica), up to and including 2007. While the average time span and number of years of data for the entire set is 12 years, some stations have as many as 55 years of data, spanning time periods of up to 74 years. The overall average WQIB score was 83.3, and Table 7 shows this broken down for the different parameters.

Table 7: Overall distance-to-target scores making up the WQIB. (From Carr and Rickwood, 2008)

Parameter	Mean WQIB score	% of records failing to meet target	No of records
Conductivity	91.6	13.6	23,995
Nitrogen	76.4	61.3	65,874
Oxygen	85.6	31.1	53,184
pH	92.3	12.2	54,327
Phosphorus	81.1	59.7	64,520
Temperature	85.0	31.2	7,921

513. The Carr and Rickwood report shows trends over time in average WQIB scores for each region - see Figure 35. Statistical analysis is also provided. Scores have generally increased in Asia and Oceania and decreased in the Americas and Europe, while water quality in Africa has been more variable over time, although tending to score generally towards the poor end of the scale.

514. Greater declines in water quality over time imply movement away from the 2010 target of reducing rates of biodiversity loss. Although water quality in Europe and the Americas has declined in recent decades, the rate of decline has slowed compared to that of the late 1960s and 1970s (while still being a decline, so implying the same direction of the biodiversity trend). In Asia and Oceania on the other hand there seems to be some evidence of actual improvement.

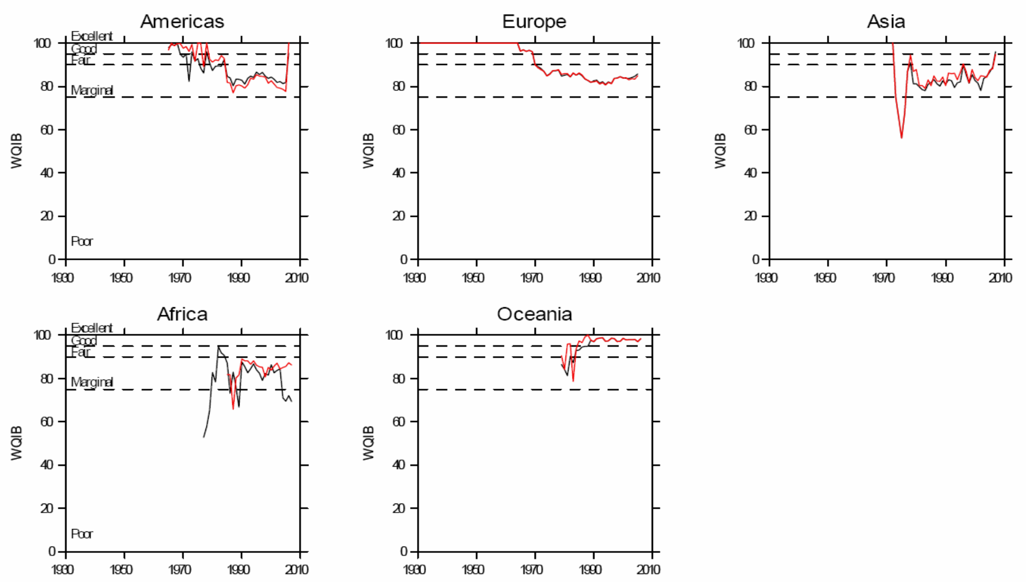


Figure 35: Mean Water Quality Index for Biodiversity (WQIB) scores by geographic region and year. Black lines are trends when all monitoring stations are included. Red lines are trends when only stations that have been monitored recently (since 2002), regularly (at least 5 years of monitoring data), and over a long time period (minimum of 10 year time span between beginning and end of monitoring record) are included. Dashed lines correspond to the water quality classifications described further below. (From Carr and Rickwood, 2008)

515. To aid interpretation, WQIB scores were divided into classes of “excellent” (WQIB = 100), “good” (95 ≤ WQIB < 100), “fair” (90 ≤ WQIB < 95), “marginal” (75 ≤ WQIB < 90) and “poor” (WQIB < 75). Consistent with the findings described above, general declines in the percentage of stations classified as “excellent” or “good” were detectable in the Americas and Europe dating back to the 1970s and 1980s, while the reverse was found in Asia and Oceania. Patterns in Africa have been more variable, but it appears that water quality has been declining there, with fewer river and lake monitoring stations showing results in the “excellent” or “good” categories in recent years (see Figure 36).

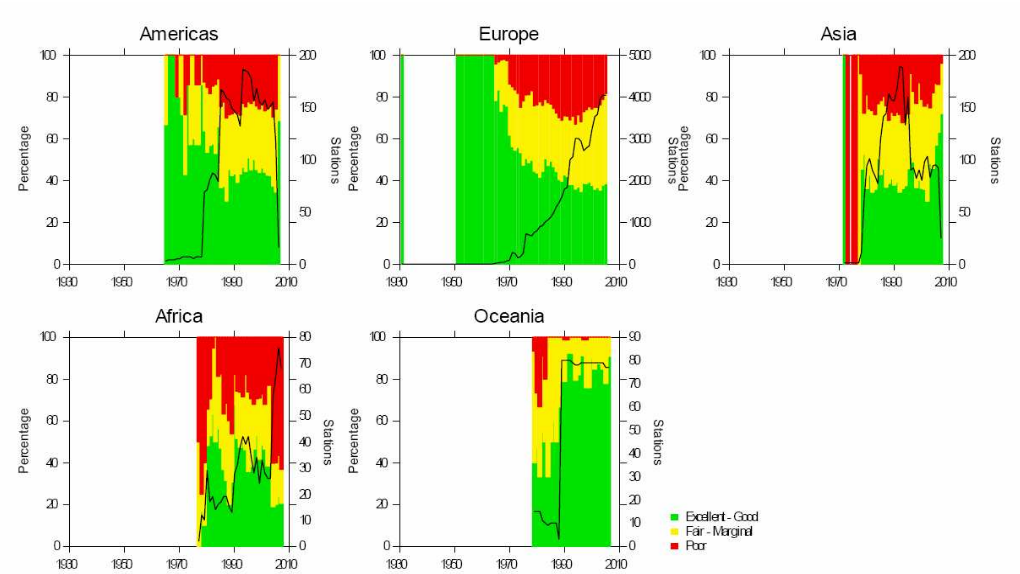


Figure 36: Percentage of “excellent-good”, “fair-marginal” and “poor” WQIB scores by region and year. Black lines represent the number of monitoring stations reporting in each year. (From Carr and Rickwood, 2008)

516. To quantify trends further in relation to the 2010 target, recently monitored stations with long water quality time series were examined for station-by-station trends in WQIB scores over time. With this analysis method, approximately twice as many long-term stations showed improvements (2,152) as those showing deteriorations (1,040).

517. This latter result is strongly driven by results from Europe, where WQIB scores increased at more than twice as many long-term stations as those where they decreased, contrasting with the picture obtained by the first method of calculation described above. In Oceania the number of stations with increasing and decreasing scores is approximately the same, which again contrasts with the results above. Findings for Africa and the Americas (majority of stations declining) and Asia (small majority improving) are more consistent with those presented above.

518. These discrepancies are believed to be due to the wide variability that can occur in the number of stations reporting in a given period in each region - for example in Europe the number rose from under 100 in the mid 1980s to over 4,000 in the mid-2000s (see black lines in Figure 36). In fact average index scores have been found to be significantly affected by the number of stations involved (and even more confusingly, the effect has been positive in Oceania, Asia and Africa but negative in Europe and the Americas).

519. This effect however reduces substantially or disappears at finer geographical scales; hence it may be more meaningful to express results at such scales. One convenient framework for doing so is the system of “Freshwater Ecoregions of the World” (FEOW), which has been delineated on a basis of natural freshwater communities, species (particularly fish) and ecological parameters (Abell et al., 2008).

520. Water quality monitoring stations for which a WQIB was computed fall within 183 of the 426 defined freshwater ecoregions. Results from one example, the Southern Temperate Highveld ecoregion in South Africa, are shown in Figure 37. Overall, the proportion of stations in this ecoregion whose scores fall within the respective water quality classes has been variable since 1990; but over the last five years there has been a steady increase in the number of stations classed as “excellent-good” and, up to 2006, a steady drop in the number stations classed as “poor”. This would suggest that water quality in this ecoregion is improving.

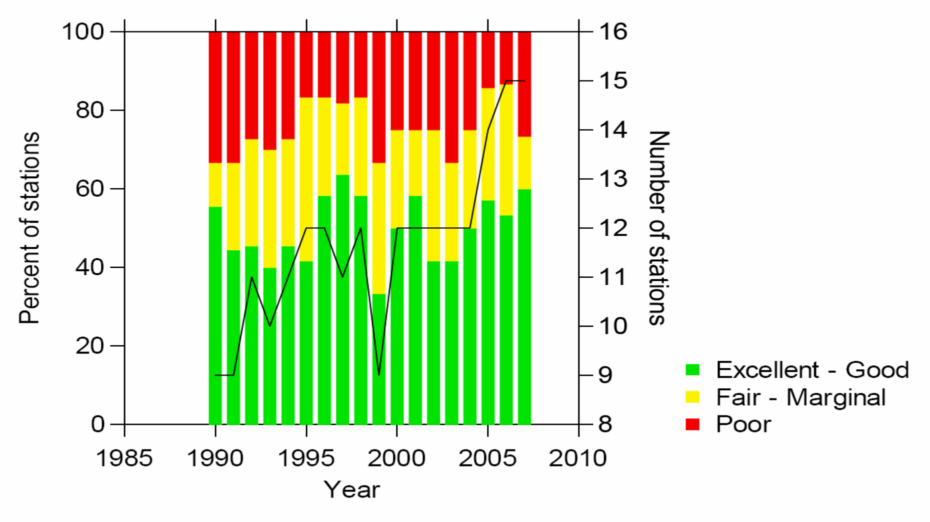


Figure 37: WQIB scores for the South African Southern Temperate Highveld freshwater ecoregion. Bars are the percentage of “excellent-good”, “fair-marginal” and “poor” scores for each year. The black line represents the number of monitoring stations reporting in each year. (From Carr and Rickwood, 2008)

521. Within ecoregions, the index trends can also be shown for individual areas, such as sections of a particular river (see e.g. Figure 38 for the Vaal River); and data for an individual parameter contributing to the index can be can be disaggregated and related to the target for that parameter (see e.g. Figure 39, for nitrogen in the Vaal River).

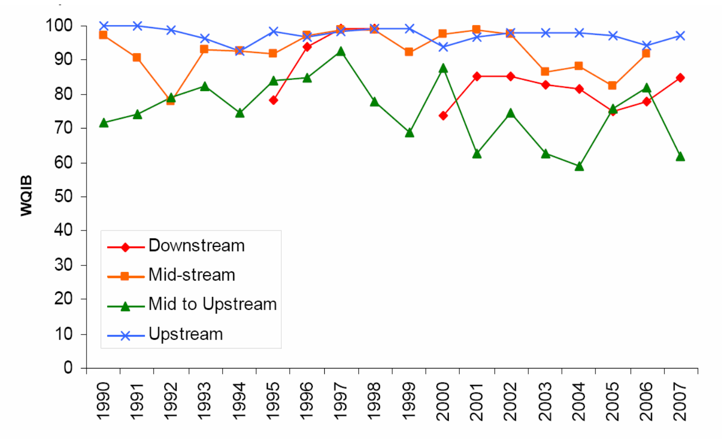


Figure 38: WQIB scores for the Vaal River, South Africa. (From Carr and Rickwood, 2008)

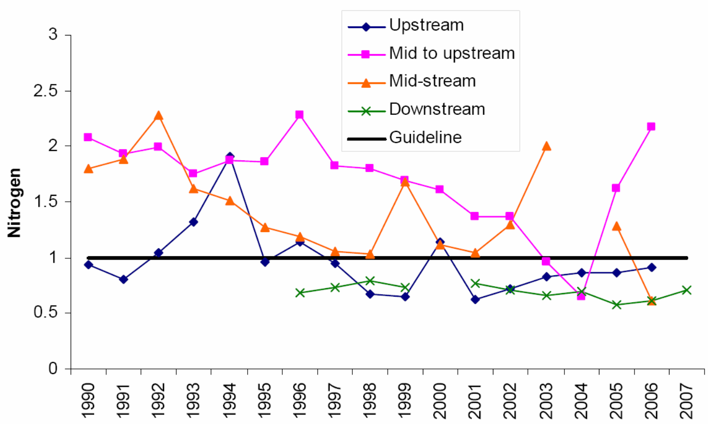


Figure 39: Nitrogen levels in the Vaal River, South Africa (mg/l). The black line indicates the water quality target. (From Carr and Rickwood, 2008)

522. Concerning nitrogen, the Global Biodiversity Outlook 2 (CBD Secretariat, 2006) mentions that "inorganic nitrogen pollution of inland waterways has more than doubled since 1960 and has increased tenfold in many industrial parts of the world". No source is given for this, but it is likely that it comes from UNEP-GEMS/Water. GBO2 gives no further information on nitrogen, and nothing is included on nitrate water pollution.

523. The GBO presents some data on Biological Oxygen Demand (BOD), derived from 528 UNEP-GEMS/Water stations in 51 countries over three decades up to 2005. As mentioned above however, many countries no longer monitor this indicator, and in some regions there is no good basis for assessing trends after 2000.

524. Nonetheless, on the basis of the data available, the GBO reported that while water quality as measured by BOD has improved since the 1980s in Europe, North America, Latin America and the Caribbean, it has deteriorated over the same period in Africa and in the Asia-Pacific region (Figure 40. In Europe and Africa in the 1980s and 1990s, mean BOD concentrations typical of moderately polluted waters (~ 5-7 mg/l) were documented, and then European rivers appear to have improved to levels typical of light pollution (~ 3-4 mg/l) after 2000. BOD concentrations typical of unpolluted waters (~ 2 mg/l)

were documented in North America and in the Asia-Pacific region in the 1990s and in Latin America and the Caribbean after 2000. Very high mean BOD concentrations in Latin America and the Caribbean in the 1990s reflect values observed at several stations that were near pollution point sources, and which were not monitored after 2000.

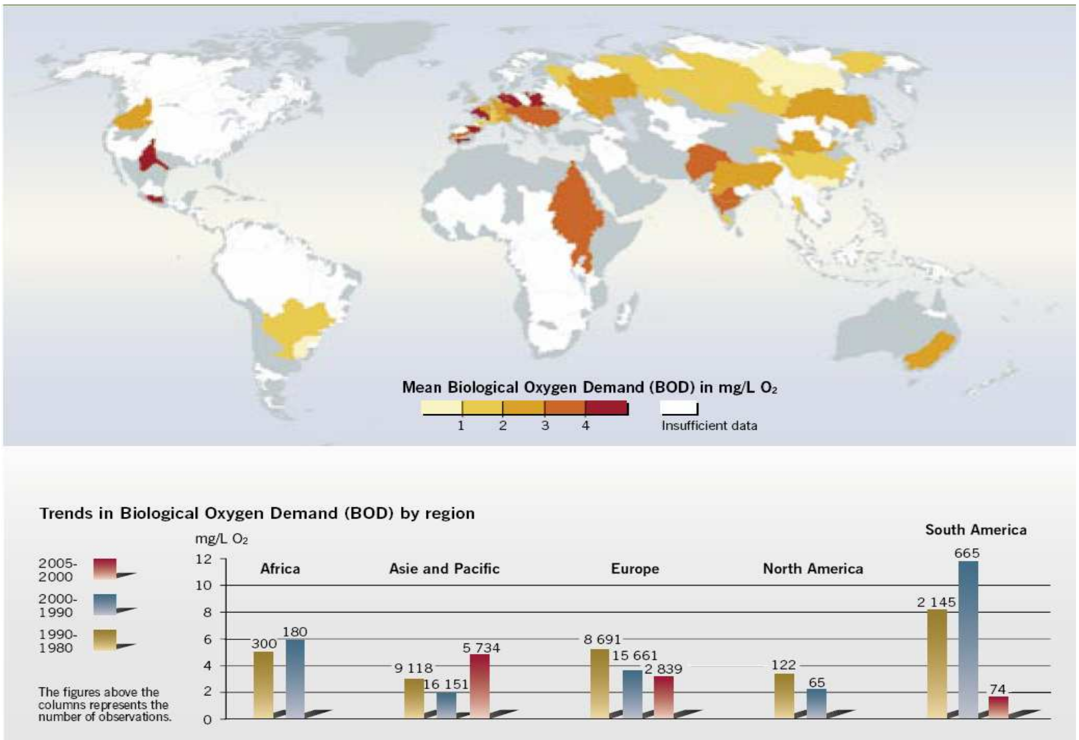


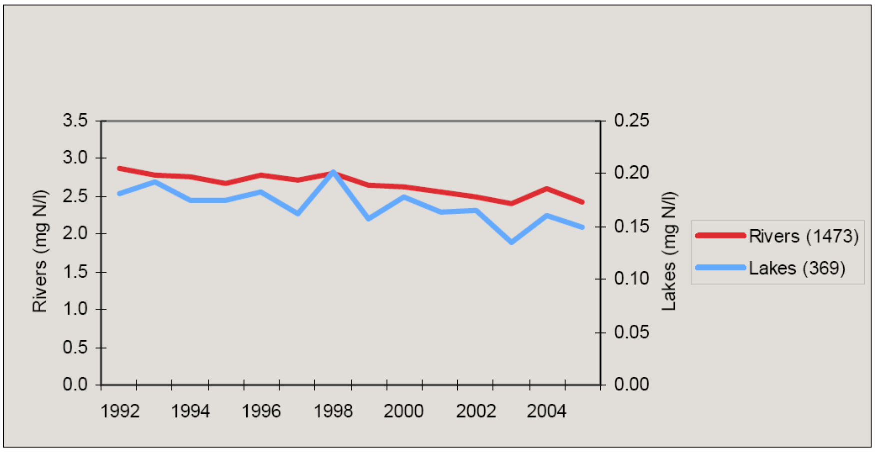
Figure 40: Status and trends in Biological Oxygen Demand (BOD) of major rivers in five regions, 1980–2005. (From CBD Secretariat, 2006, using data from UNEP-GEMS/Water).

525. The European Environment Agency monitors annual average water quality conditions in the European region, based on data submitted by EU Member States from monitoring stations covering over 5,000 rivers, lakes and groundwater sites, and with records dating from as far back as the 1930s through to the present.

526. The EEA's core set of indicators, referred to above, includes CSI 020, "Nutrients in freshwater", which tracks levels of nitrate, orthophosphate and total phosphorus in different inland waters. Assessments have been published in European Commission (2008) and most recently (January 2009) on-line at http://themes.eea.europa.eu/IMS/CSI (Figure 41).

527. These assessments show that average nitrate concentration in European rivers has decreased by approximately 10% since 1998, from 2.8 to 2.5 mg N/l. Around 35% of monitoring stations on rivers showed a statistically significant decreasing trend between 1992 and 2005 (3% showed an increase). The overall trend reflects the effect of measures to reduce agricultural inputs of nitrate.

528. Nitrate levels in lakes are in general much lower than in rivers, but here too there has been a 15% reduction in the average concentration, and a statistically significant decrease at 38% of lake monitoring stations (4% showed an increase). The overall trend is thought to be partly due to lower nitrogen oxides emissions to air.



Source: Waterbase Version 6

Note

Concentrations are expressed as annual mean concentrations for groundwater, and station weighted mean of annual mean concentrations for rivers and lakes. Only stations with time series consisting of minimum seven years are included. The number of stations included per country is given in parenthesis.[5]

Figure 41: Concentrations of nitrate in European rivers and lakes, 1992-2005. (From European Commission, 2008).

529. Nitrate concentrations in inland surface waters vary between sub-regional groupings of countries, particularly in the case of rivers. Countries with the greatest agricultural land use and highest population densities (such as Belgium, Denmark and the United Kingdom) generally had higher nitrate concentrations in rivers and lakes than those with the lowest proportion of agricultural area and population density (such as Estonia, Norway, Finland, and Sweden). The average concentrations in western European rivers as a whole were double those in eastern Europe, with rivers in the north of the region having the lowest levels. Since the mid-1990s, river nitrate concentrations have reduced by 11 %, 8 % and 6 % in the western, northern and eastern countries respectively (Figure 42).

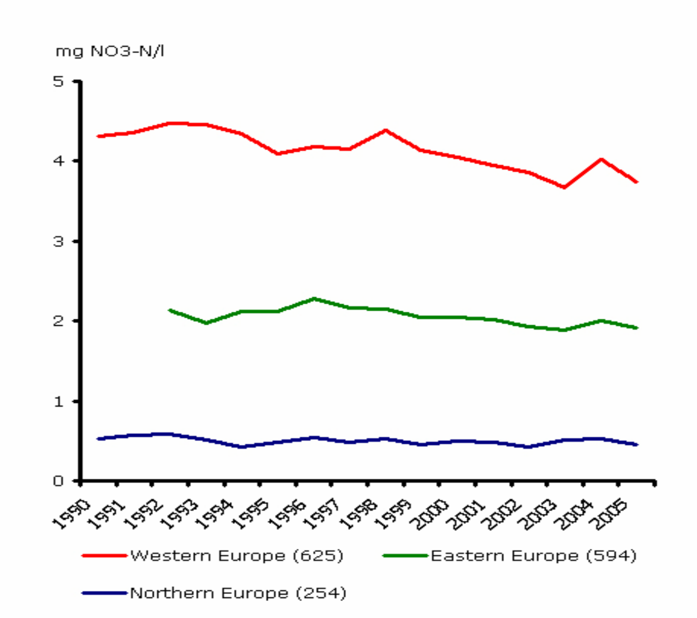


Figure 42: Nitrate concentrations in rivers between 1990 and 2005 in different regions of Europe. Only stations with a minimum data time series of seven years are included. Data are from: Eastern Europe = the countries BG, CZ, EE; HU; LV, LT, PL, SI, SK; Northern Europe = the countries FI, SE, NO; Western Europe = the countries AT, BE, DE, DK, FR, GB, LU, NL (From EEA website).

530. Nitrate concentrations in Europe's groundwaters increased in the first half of 1990s and have then remained relatively constant, as a whole (Figure 43. This overall picture is however made up of where there was a statistically significant decreasing trend situations (32 % of groundwater sites for which there were available data), and others where there was an increase (11%).

531. Again the results vary between sub-regional groupings of countries. Concentrations of nitrate in groundwater in the different European countries generally reflect the relative importance and intensity of agricultural activities above the groundwater bodies. Western and eastern European countries had relatively high nitrate concentration in groundwater compared to northern countries. 19 of the 31 countries with available information for 2005 had groundwater sites exceeding the parametric value (EU Drinking Water Directive 98/83/EC) of 50 mg/l NO3.

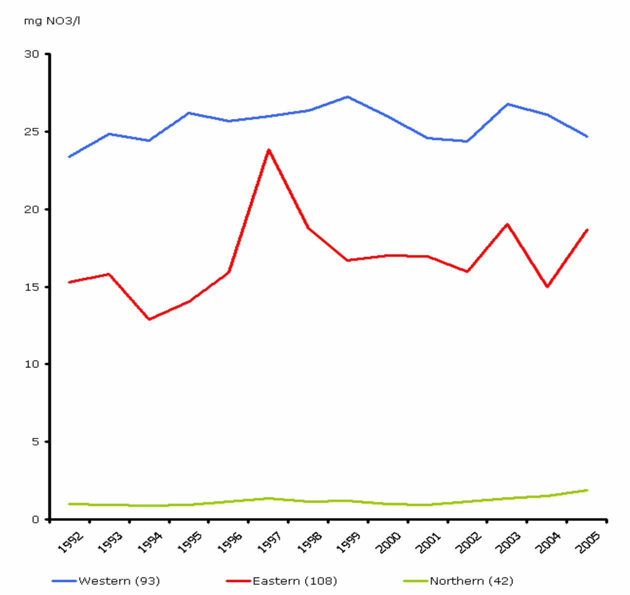


Figure 43: Nitrate concentrations in groundwater between 1992 and 2005 in different regions of Europe. Only stations with a minimum data time series of seven years are included. Data are from: Eastern Europe: BG, EE, HU, LT, LV, PL, SK; Northern Europe: FI, NO, SE; Western Europe: AT, BE, DE, DK, GB, IE, LI, NL(From EEA website).

532. Phosphorus concentrations in European rivers and lakes have generally decreased during the last 14 years, reflecting the general improvement in wastewater treatment and reduced phosphate content of detergents over this period (Figure 44). The average concentrations of orthophosphate in European rivers halved over the past 14 years. In many rivers the reduction started in the 1980s.

533. During the past few decades there has also been a gradual reduction in phosphorus concentrations in many European lakes (Figure 44). As treatment of urban wastewater has improved and many waste water outlets have been diverted away from lakes, phosphorus pollution from point sources is gradually becoming less important. Agricultural sources of phosphorus are still important and need increased attention. The improvements in some lakes have generally been relatively slow despite the pollution abatement measures taken. This is at least partly because of internal phosphorus loading from phosphorus stored in the lake sediments and because the ecosystems can be resistant to improvement and thereby remains in a poor state. Such problems may call for restoration measures, particularly in shallow lakes. (Source: EEA website).

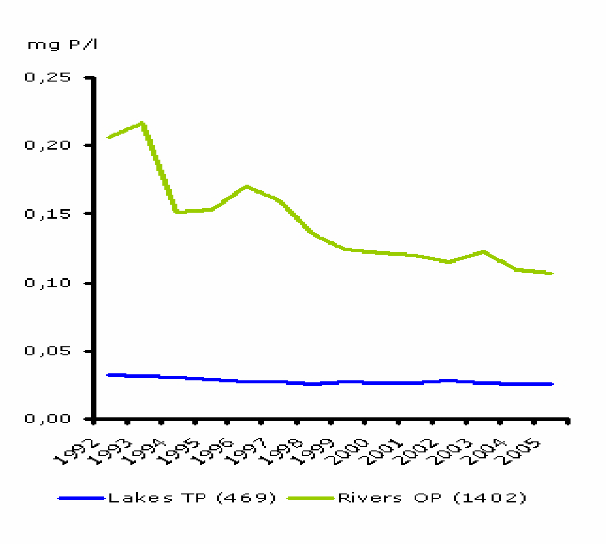
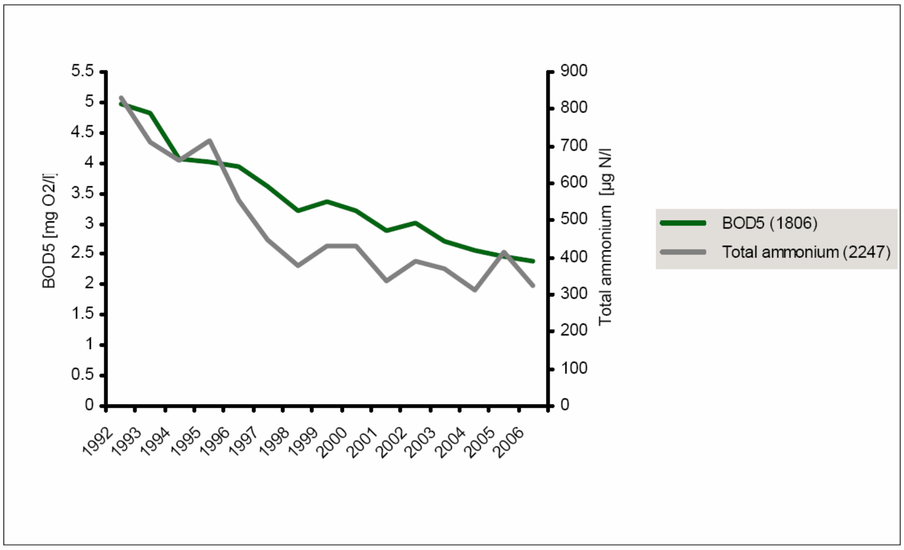


Figure 44: Concentrations of phosphorus (orthophosphate, OP, or total phosphorus, TP) in European freshwater bodies, 1992-2005. Only stations with a minimum data time series of seven years are included. (From EEA website).

534. In the European SEBI2010 indicator system, though not in the EEA Core Set of Indicators system, Biochemical/Biological Oxygen Demand (BOD) and ammonium concentrations are monitored in a similar way to the indicators described above. Both of these measures have shown declines in European rivers in the period 1992 to 2005, corresponding to the general improvement in wastewater treatment (Figure 45). BOD and ammonium concentrations are generally highest in eastern, southern and south-eastern European rivers, with the biggest improvements having occurred in the rivers of the Western and Eastern European countries respectively (European Commission, 2008).



Source: Waterbase Version 7

Figure 45: Biochemical Oxygen Demand (BOD) and total ammonium concentrations in European rivers, 1992-2006. (From European Commission, 2008).

4. Ramsar Indicator results: drivers of change (threats to Ramsar sites)

535. Some of the Ramsar effectiveness indicators address wetlands in general, and some address listed wetlands of international importance (i.e., Ramsar sites) in particular. One of the latter type is Indicator D, entitled "the frequency of threats affecting Ramsar sites - qualitative assessment". (Given the processes now being used for this, it may be more correct to refer to it as "semi-quantitative").

536. This indicator tracks information about a range of types of pressures on wetlands; but from the perspective of their effect (or threatened effect) on specific receiving environments, i.e., on the listed sites. Hence it is an indicator of the status and trends of the wetlands concerned (they are more or less threatened, threatened by different things etc); but is also capable of illuminating the status and trends of the drivers of change themselves. (This demonstrates why it has been unfruitful to try to characterise Ramsar indicators as falling straightforwardly into categories of "state", pressure" and "response").

537. If the Convention is effective in its aim of promoting the conservation of Ramsar sites and maintaining their ecological character (Article 3.1, Resolution VIII.8), then not only will potential unwanted changes in the ecological character of sites be averted by protective policy and decision-making regimes and site management, but risks and proposals which would pose such threats should diminish in frequency over time, as awareness of the status of sites increases and as the conservation objectives for them are more widely shared.

538. Indicator D is designed to show whether or not this trend occurs. In the first instance it may only be able to show the absolute trend, but with future development it should be able to show whether threats are reducing relatively more than the trend for threats generally (e.g. in a country), and relatively more in relation to Ramsar sites than in relation to undesignated wetlands. It is being implemented (initially at

least) through qualitative assessment methods. There is a link to Indicator C on water quality (above), since threat monitoring includes information on water pollution.

539. Many organisations and processes acquire information on threats to Ramsar sites, but Indicator D requires sources which can be sustainable for regular use, and be systematically replicable from place to place and time to time. Several potential sources of information may be able to contribute to this (e.g. national protected area monitoring systems, and other monitoring systems where some intelligence on threats is "incidentally" recorded, and where overlap with Ramsar sites can be established, such as the International Waterbird Census). This will rely to some extent on the development of suitable data coding conversion methods.

540. Some examples are included at the end of this section of status and trends information from initiatives that were not necessarily designed to be more than a single assessment, but which add value to the picture being presented here, and which could potentially be repeated and therefore contribute further in future as well.

541. In the meantime, the initial operation of this indicator to date is drawing on two main sources: (i) data held in the Ramsar Sites Information Service (database) and provided by Ramsar Contracting Parties by means of the Information Sheet they submit for each Ramsar site, and (ii) data from BirdLife International's Important Bird Areas (IBAs) monitoring system, in relation to those IBAs which are also Ramsar sites. Some preliminary examples of results from each of these are introduced in turn below.

542. The structure of the Information Sheet for Ramsar Wetlands (known as the Ramsar Information Sheet, or RIS) was agreed by the Convention's Parties at COP4 in 1990, and has been in use since then as the official description of sites provided (only) by governments when sites are designated.

543. Section 26 of the RIS asks for information on "factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects (a) within the Ramsar site and (b) in the surrounding area. The accompanying guidance (http://www.ramsar.org/ris/key_ris_e.htm) requests quantitative data when it is available, and stresses the need to "specify both the agent for the change and the resulting change and its impact" (see comment at the beginning of the present section above). In the context of this RIS data field, the interpretation of "threat" includes impacts that are already occurring.

544. The Information Sheet and its accompanying guidelines are kept under on-going review and have been amended/supplemented more than once, but not in such a way as to affect the consistency of recording threat information over time.

545. From 1996, under Resolution VI/13, the Parties committed themselves to providing updated RIS information for all of their Ramsar sites at least every six years, or on the occasion (if sooner) of any significant change in the sites' ecological character. In principle therefore this creates a method of recording changes in the Party government's assessment of threats, among other things.

546. Of course absence of a recorded change may not necessarily represent confirmation of a continuance of the threat position that was first recorded, but simply an absence of new information; and where there is a change, the date of the updated RIS does not necessarily correspond to the date of the change. These and other caveats need to be taken into account in analyses: RIS updates are only a very crude method of tracking changes and they were not designed primarily for this purpose.

547. In addition however, the guidance on RIS section 26 asks compilers to record “information on the … trend of the change factor and its impact”; so some picture of trends could in principle be obtained from a single submission (as with Indicator A(ii) discussed above.

548. RIS information is transcribed by Wetlands International into the Convention’s central global sites database (the Ramsar Sites Information Service, or RSIS). Threat types, i.e. the “factors” reported in section 26 of the RIS, are assigned by Wetlands International to one or more of 115 categories, which in turn are grouped for analysis purposes into 17 category clusters. A simple tabulation of the frequency of threat types recorded from RIS information in the database for the full site list as at March 2009 is given in Table 8 and Figure 46. (Note that none of the analyses in this section has yet separated data for inland waters from data for wetlands as a whole)

Table 8: Frequency of types of threat affecting Ramsar sites, recorded by Contracting Party governments via Ramsar Information Sheets. (From Ramsar Sites Information Service, March 2009).

Threat type	Number of sites for which the threat type is recorded (more than one type can be recorded per site)
Aesthetic effects	4
Species effects	513
Habitat effects	1045
Impacts from agriculture	806
Impacts from fishing	341
Impacts from forest exploitation	309
Impacts from human habitation	294
Impacts from hunting	246
Impacts from industry	146
Impacts from mining/energy sector	411
Impacts from recreation/tourism	336
Impacts from transportation	161
Impacts from waste disposal/treatment	243
Impacts from water regulation	1084
Possible/partial natural impacts	307
Pollution	281
Others	21

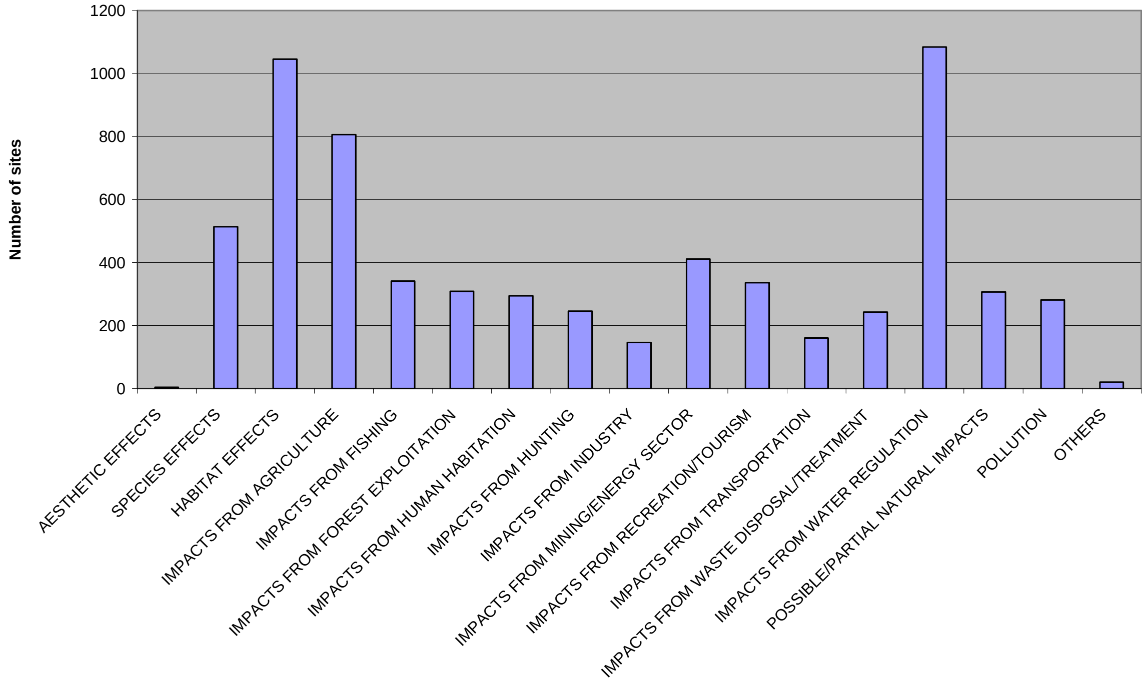


Figure 46: Frequency of types of threat affecting Ramsar sites, recorded by Contracting Party governments via Ramsar Information Sheets. More than one type can be recorded per site). (From Ramsar Sites Information Service, March 2009).

549. The story these data tell, for a particular point in time (March 2009), is that there are notable contrasts in the frequency of different types of threat recorded across the global network of (over 1,800) Ramsar sites. Pressures associated with water resources management, land use change (land claim and habitat loss) and agricultural activities are by far the most dominant issues recorded.

550. This preliminary analysis of the status of threats from the RIS dataset will be built upon further in future, when it becomes possible to compare different points in time and therefore to express trends as well. It may also be possible to extract trend information from individual RISs too, depending on the extent to which responses to section 26 of the Sheet pick up on the prompt to refer to trends, as mentioned above.

551. The background total of Ramsar sites in the List is increasing over time - this will not greatly affect some comparisons (such as the one above, between overall frequency of threat types, although the “numbers” axis may need to be changed to “percentages”), but it may affect others (such as comparison of time-series trends between regions). Analyses by the Ramsar STRP will also investigate the relationship between threat frequency and relevant co-variates, to shed light on Convention effectiveness; but as discussed above this aspect goes beyond the status and trends of the wetlands themselves and so is not covered in the present report.

552. BirdLife International’s Important Bird Area (IBA) programme is a worldwide initiative aimed at identifying, protecting and managing a network of sites that are important for naturally occurring bird populations, across the geographical range of those bird species for which a site-based approach is appropriate. More than 10,000 IBAs have been identified, using standard, internationally recognised criteria. In respect of IBAs with wetland interest, both the criteria and the approach to the system in

general have much in common with the criteria and approach used by the Ramsar Convention for its site network, and in many places there is a close concordance on the ground between the demarcation and the values of Ramsar sites and wetland IBAs.

553. This has offered good scope for synergy across the two networks in relation to activities for site monitoring, and hence it has been agreed to use data on threats from IBA monitoring to feed in to Ramsar Indicator D, in respect of the sub-set of IBAs that either coincide exactly or overlap partly with Ramsar sites. (An initial step is required to cross-relate and filter sites in this regard, making appropriate inclusion/exclusion decisions or other adjustments in relation to respective area overlaps that are only partial).

554. The detailed Global Framework for IBA monitoring (BirdLife International, 2006, and see also Bennun et al., 2005) defines the two-tier (universal basic and selective in-depth) system of routine reporting by locally-based monitors on standard forms at intervals of every one, two or (the minimum) four years. This includes a standardised procedure for central collators to assign scores for the timing (imminence), scope (scale) and severity (impact) of recorded threats to IBAs (linked to the bird species for which the site qualifies as internationally important), which are then indexed on a four-point scale for the site overall, from 0 (low threat) to 3 (very high threat). Data are entered into BirdLife's World Biodiversity Database (WBDB) to allow analyses of trends and comparisons.

555. The BirdLife system is not yet in full global operation, and global time-series data are not yet available (though see later below for one country pilot of the kind of data which should emerge when this occurs). In the meantime, some initial results have been compiled (BirdLife International, 2008b) for a sample of 167 IBAs which are established (from WBDB protection status data) also to be Ramsar sites, relating to the period 1994–2008 and covering 50 countries in four BirdLife regions, namely Africa (89 sites), Asia (23 sites), Europe (30 sites) and Middle East (25 sites). (Note that BirdLife regions are not exactly equivalent to Ramsar regions; and that at present both inland and coastal wetlands are included in these analyses).

556. Somewhat disturbingly, every one of the IBAs/Ramsar sites in the sample was recorded as subject to some level of threat. 59% were recorded as subject to "high" threat levels, 18% to "very high" levels, and just 6% to "low" levels (see Figure 47).

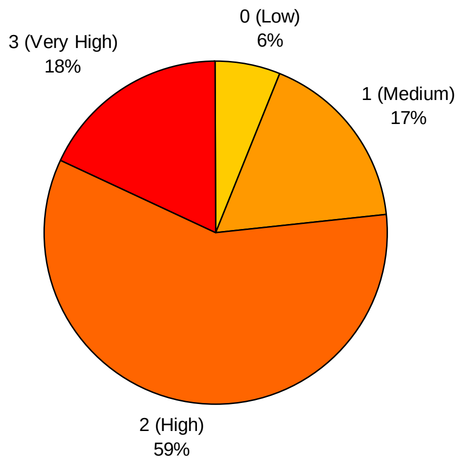


Figure 47: Percentages of a sample of 167 IBAs/Ramsar sites recorded as experiencing respectively "low" (score 0), "medium" (score 1), "high" (score 2) and "very high" (score 3) levels of threat; 1994–2008. (From BirdLife International database).

557. The frequency of threat types in this sample was assessed by reference to 15 main types defined (with slight modifications) on the basis of the internationally adopted 3-tier standard definitions which are used in the IUCN Red List species assessment process, and which are applicable both to species and to sites (Salafsky et al., 2008) (see Figure 48). Comparisons were also made between the four regions referred to above (see Figure 49).

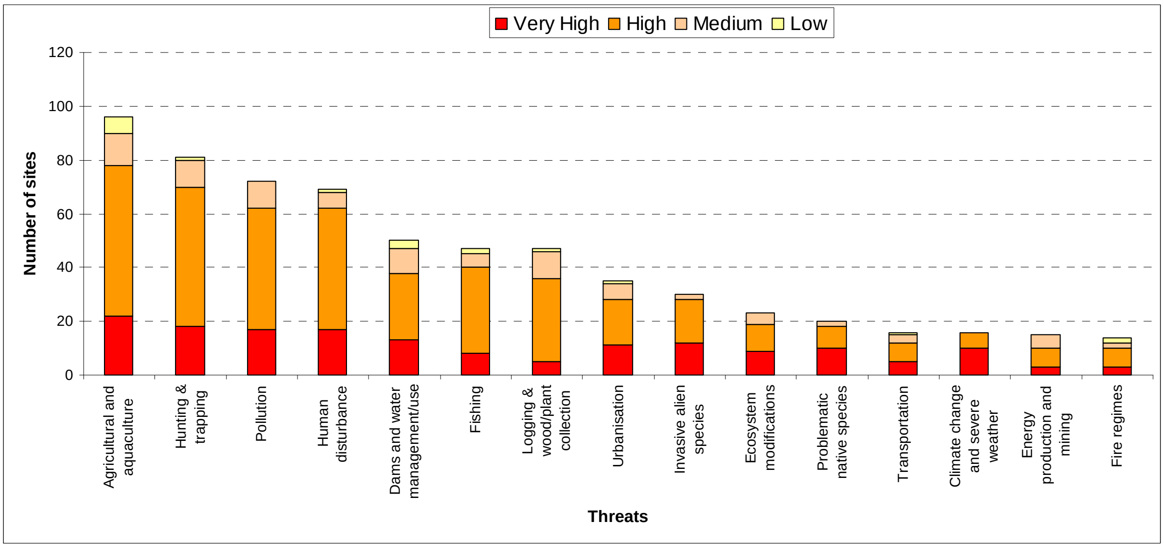


Figure 48: Frequency of different types of threat affecting a sample of 167 IBAs/Ramsar sites; 1994–2008. (From BirdLife International database).

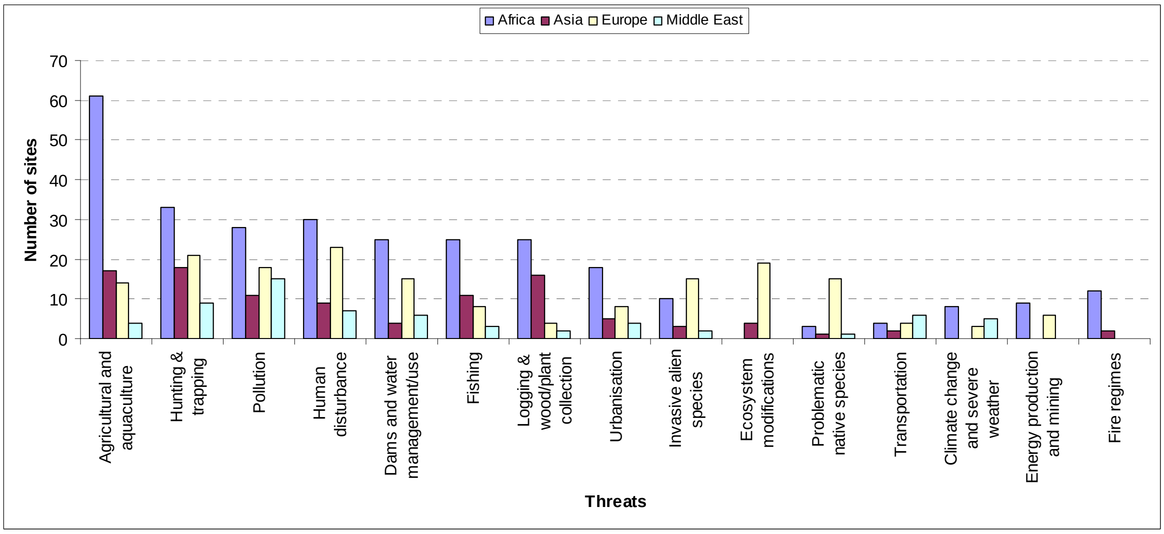


Figure 49: Frequency of different types of threat affecting a sample of 167 IBAs/Ramsar sites, divided according to the 4 BirdLife regions concerned (Africa, Asia, Europe and Middle East); 1994–2008. (From BirdLife International database).

558. The story these data tell is that even the world's most prominently protected wetlands are seemingly all still subject to some kind of threat, with over three-quarters of the sample tested being subject to "high" or "very high" threat levels. In terms of impacts on bird interests, the most frequently recorded problems were associated with agriculture (including plantation forestry), aquaculture, hunting, trapping, pollution (largely caused by agricultural effluents) and human disturbance (mainly recreational impacts).

559. Compared to the RIS-based assessment in Figure 46, hunting and pollution are recorded with higher relative frequency in the assessment by BirdLife in terms of impact on bird populations, than in the assessment by Ramsar Administrative Authorities in terms of impact on the overall ecological character of the sites (although, given that "species effects" were the 4th most frequently recorded category in the RIS assessment, this may not be as much of an inconsistency as it appears). The markedly high frequency of agriculture-related threats is common to both assessments.

560. When the four sampled regions are disaggregated, the dominance of agriculture is seen again in Africa, but in Asia the most frequently recorded issues relate to hunting and trapping, in Europe to human disturbance and in Asia to pollution. (Note that the vertical axis of Figure 49 reflects only numbers of sites and has not yet been corrected, e.g. by conversion to percentages, for the different sample sizes in each region, as described above - hence conclusions should not be drawn from it as it stands about the relative frequency of total threats between regions).

561. In future there will be a range of capabilities for tracking trends over time with these datasets. As with the RIS, as was mentioned above, IBA monitoring report forms ask compilers to include their own expert assessment (or evidence) of the trends in effect at the time of submitting a datasheet; but this may best be viewed as a supporting component, and no systematic analysis of it in its own right has been attempted.

562. More robust will be the derivation of trend information from comparisons of the results of repeated assessments (showing for example differing degrees of improvement, deterioration or stability of

average threat scores, for a given threat type, wetland type, geographical area, time-period or any combination of these). For the time being, one national case study is available for IBAs in Kenya, where trends over a 5-year period were calculated, showing relatively stable or slightly reducing levels of threat affecting the 10 wetland IBAs concerned (Mwangi et al., in press; Figure 50).

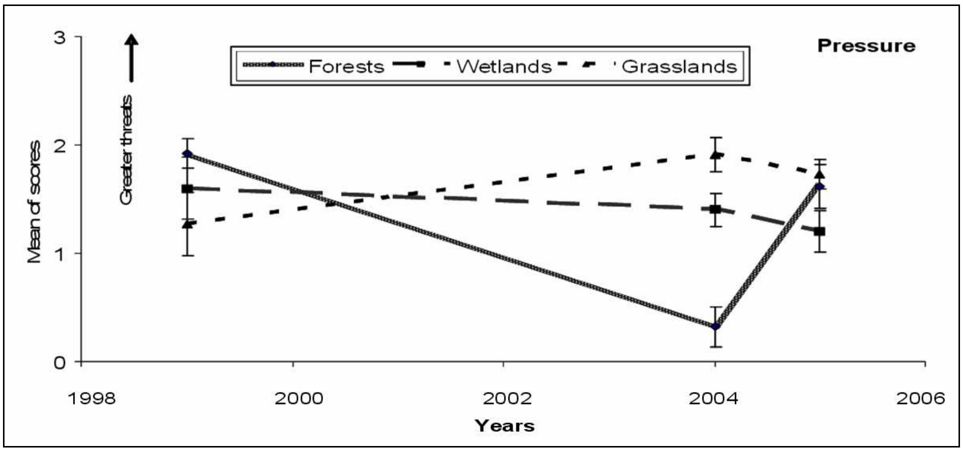


Figure 50: Trends in the index of average threat scores for IBAs in Kenya, 1999-2005 (central dashed line relates to wetland sites, N=10). (From Mwangi et al., in press).

563. The threat categorisation system used in the BirdLife assessments (based, as mentioned, above on Salafsky et al., 2008) is not identical to the one used in the Ramsar Sites Information Service, and so integration or comparison of these datasets needs to have regard to this fact. Ramsar's STRP indicators working group is addressing this during 2009, and in practice the issues are almost entirely presentational rather than concerning significant differences of inclusion /exclusion of particular threat types. Giving similar consideration to the closely related systems used in the assessments conducted for the Mediterranean Wetlands Initiative (see below) and in the Site Assessment Tool used by the Western Hemisphere Shorebird Reserve Network, which itself integrates several systems (WHSRN-SAT: see http://www.manomet.org/WHSRN/site_assessment.php), should further extend the scope of future analyses.

564. In addition to the initial generic findings given from BirdLife's IBA monitoring system described above, some results have also been produced from it relating to one specific cause, namely dams and other water control structures; using information from the World Commission on Dams (published in summary on-line at http://www.biodiversityinfo.org/sowb/default.php?r=sowbhome) (Figure 51). In Africa, the Middle East and Europe (as defined according to BirdLife's regions, which as mentioned above are not exactly coterminous with their Ramsar equivalents), dams and other water control structures are considered to pose a threat to nearly 10% (304) of the 3,701 IBAs in these regions; and 87% of these sites contain areas either already designated or qualifying for designation as Ramsar Sites (the proportion actually designated has not been published).

Figure 51: Wetlands of international importance for birds that are threatened by dams, barrages and embankments in Africa, Europe and the Middle East. (From BirdLife International's World Bird Database, 2004).

565. The sub-global qualitative assessment conducted by the Ramsar Secretariat for the area covered by the MedWet (Mediterranean Wetland) Initiative (noted above) is based on 156 responses (covering site, national and supranational perspectives) to a questionnaire survey of experts closely associated with wetland sites or issues in the region. This included questions on "negative drivers of change", and a summary of the results is given in Stark et al. (2004).

566. Respondents were asked to identify the major drivers of change affecting the wetlands on which they were reporting (from a list of 22 driver categories); and to say whether each driver was intensifying, diminishing or not changing in "intensity". (The results are presented for wetlands in general, rather than only for Ramsar sites, and so the findings below have a different scope from that of Ramsar Indicator D).

567. The most frequently reported negative drivers were urban development/infrastructure (featuring in 57% of responses), urban/industrial pollution (50%), tourism (45%), water abstraction (43%), agricultural intensification (43%), agricultural run-off (40%) and hunting (42%) (see Figure 52). The high prevalence of threats from pollution and hunting matches the findings from the BirdLife data reported above, and the high prevalence of threats from water abstraction and habitat loss to development matches the findings from the Ramsar sites database reported above. Agricultural threats showed a consistently high prevalence in all three datasets.

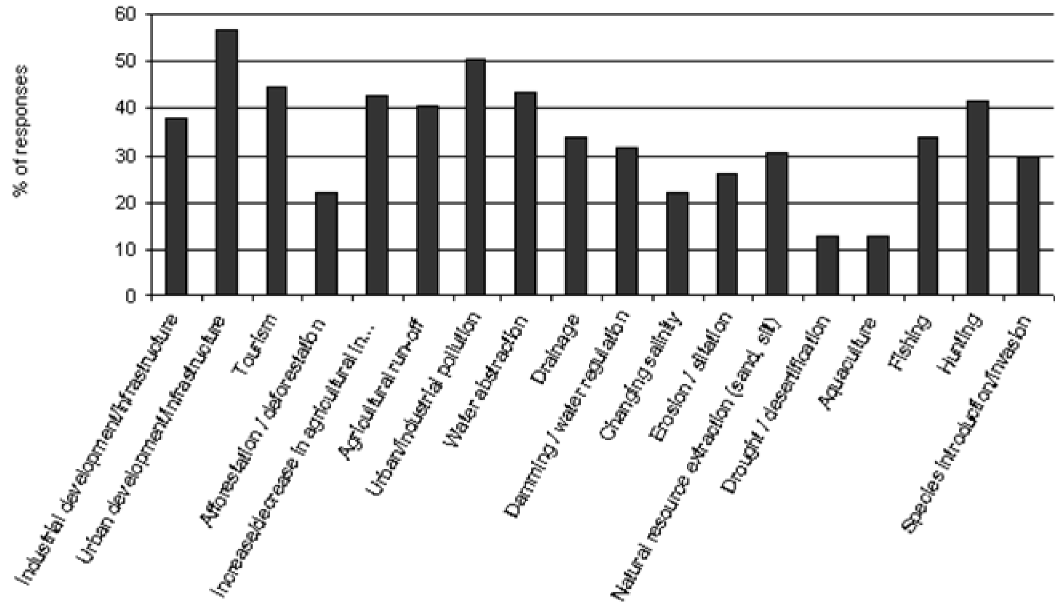


Figure 52: Frequency of occurrences of major negative drivers of change affecting wetlands in the Mediterranean Basin. (From Stark et al., 2004).

568. Differences were observed between inland and coastal wetlands and between northern and southern parts of the Basin. For example, urban and infrastructure development was reported as a more frequent negative driver for coastal (64% of responses) than inland wetlands (48%), whereas water abstraction was more frequent in inland (56%) than coastal wetlands (33%). Agricultural intensification was reported as a more frequent problem for northern Mediterranean wetlands than for wetlands in the south, while industrial development showed the reverse.

569. Concerning trends, negative impacts of infrastructure developments, tourism, pollution and agriculture were reported the most frequently as intensifying overall; although nearly all drivers were reported as intensifying in at least some parts of the area. None was found to be diminishing overall; but a diminishing trend was found for agricultural intensification, urban/industrial pollution, hunting and fishing, in a small number of instances (no more than 20% of responses in each case).

570. Another regional dataset is the one produced from a questionnaire survey conducted in Africa in 2007-08, the results of which are published in Gardner et al., (2009). This does not contain trend information, but provides a useful snapshot at one point in time. Among the “challenges to sites” rated highest by respondents were: effects of land-use practices and activities (on- and off-site), development pressures, changes to the water regime, overexploitation (both legal and illegal), trespassing and poaching. Examples of these results are shown in Figure 53, Figure 54 and Figure 55.

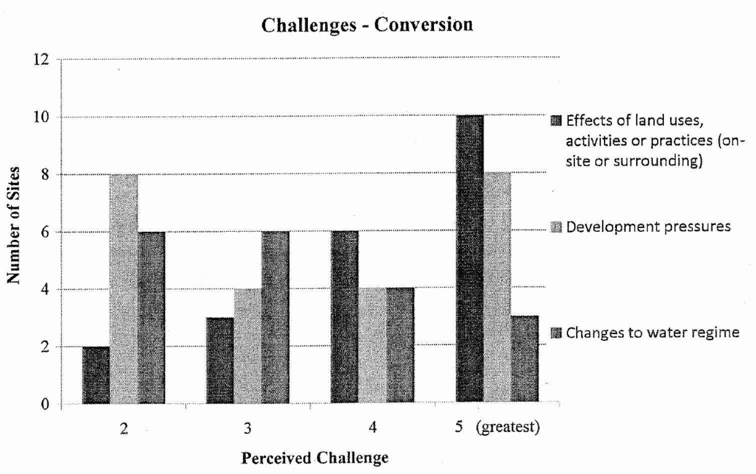


Figure 53: Perceived challenges facing African Ramsar sites from land and water use conversion, 2008: the horizontal scale represents the perceived severity. (From Gardner et al., 2009).

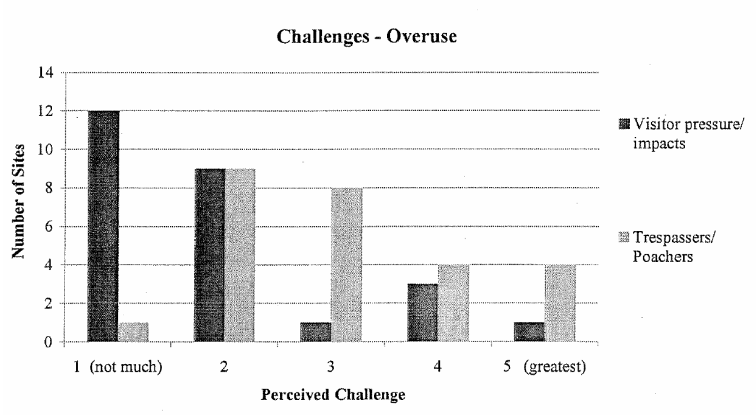


Figure 54: Perceived challenges facing African Ramsar sites from “over-use”, 2008: the horizontal scale represents the perceived severity. (From Gardner et al., 2009).

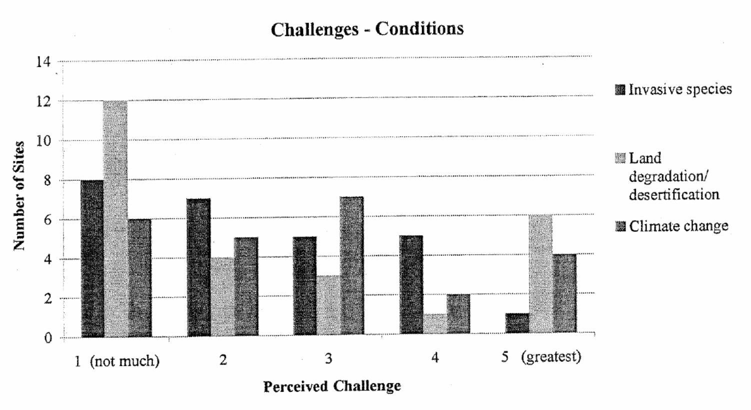


Figure 55: Perceived challenges facing African Ramsar sites from other conditions, 2008: the horizontal scale represents the perceived severity. (From Gardner et al., 2009).

571. Some other information exists at national levels: for example Lynch-Stewart (2008) found that managers of 15 (54%) of Canada's Ramsar sites reported that there had been a change in the ecological character of their wetland since its designation as a Ramsar site, and identified "effects of land uses, activities or practices (on-site or surrounding)" as the top management challenge, with invasive species and visitor pressure as the next most pressing challenges (Figure 56).

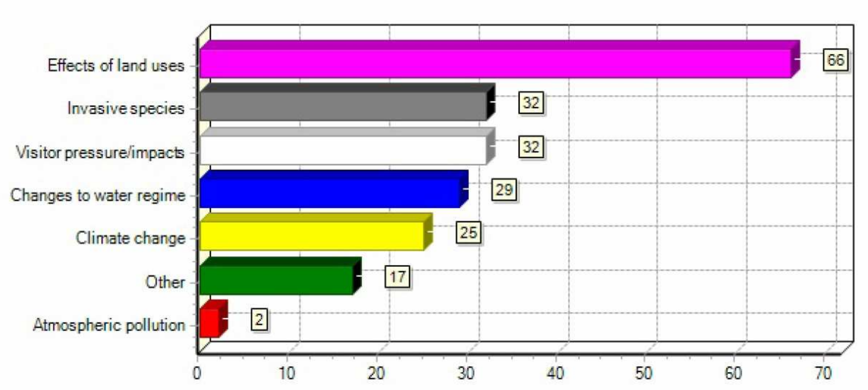


Figure 56: The most important "management challenges" perceived by Ramsar site managers in Canada in 2007. (Figures refer to scores for a weighted index, explained in Lynch-Stewart, 2008).

5. Ramsar Indicator results: effectiveness of responses

572. This report as a whole concentrates on what is currently known about the status and trends of the world's inland water biodiversity itself, without going into a treatment of the drivers of change (except for the examples given above on site threat information, as an attribute of "status"), and without attempting to address response options. Since, however, the Ramsar Convention indicators process is designed to generate status and trends information specifically in a context of judgements about the effectiveness of responses, then it is appropriate to illustrate just one example here of how light may be shed on this dimension.

573. Ramsar indicator reports seek to relate results concerning wetland ecological outcomes to a range of Ramsar inputs, also referred to as "process indicators" or "co-variates"; and effectiveness is then the relationship between the inputs and the outcomes. Propositions are tested concerning which aspects of "effective implementation of the Convention" may have been a cause of or contributor to the observed results.

574. The example given here refers to the proposition that "overall wetland status in a country is associated with the existence of a National Wetland Policy or equivalent". Ramsar Parties have long been encouraged to adopt and implement National Wetland Policies (NWPs) or equivalent instruments; and extensive guidance on this has been agreed by the COP. The NWP concept is distinctively attributable to the Ramsar Convention, and the existence/non-existence of such a policy in a given country is easy to discern.

575. Data on wetland status are derived from Parties' answers to question 1.1.4b in the 2008 (COP10) national reporting form which asked whether their "need to address adverse change in the ecological character of wetlands" was less, the same or greater in 2005-2008 than in 2002-2005. The expectation is that countries following the Ramsar guidance on national wetland Policies should have less need to address adverse change than those which do not have a NWP.

576. Question 1.2.1 in the COP10 national reports asked Parties to say whether a NWP or equivalent is in place, offering response options of "yes", "no", "in preparation" or "planned". Data on this in one form or another in fact goes back to 1987; but for the purposes of relating the existence of a NWP to what is shown by question 1.1.4b for a comparison of 2002-2005 with 2005-2008, only the figures from COP9 (2005) and COP10 need to be used here.

577. At COP11 in 2012, it will be possible to compare the change between COP10 and COP11 in the numbers of Parties having a NWP with the change in overall wetland effectiveness index for the same period; assuming the same questions are asked again.

578. In the meantime the COP10 data can be used to compare the index scores for countries having a NWP with the scores for those without. "Those without" are here assumed to be a combination of those responding "no", "in preparation" or "planned" to question 1.2.1, plus those not responding at all (the inclusion of the latter group is a pragmatic working assumption and may hide a small inaccuracy if any NWPs exist in non-respondent countries). This comparison is shown in Table 9 and Figure 57. (More fine-tuned analysis may be possible in future, for example to relate index scores to the length of time that a NWP has been in place for each country, rather than simply its presence or absence).

Table 9: Comparison of wetland status effectiveness index scores for Ramsar Parties respectively with and without a National Wetland Policy or equivalent in 2008. (Based on data in Party national reports to COP10).

	Parties **with** a NWP/equivalent in 2008	Parties **without**[1] a NWP/equivalent in 2008
Of those submitting reports (141)	61 = 43%	80 = 57%
Of the total Parties existing at the time of COP10 (158)	61[2] = 37%[2]	97[2] = 61%[2]
Of those answering 1.1.4b[3] and 1.2.1 (91)	45 = 49%	46 = 51%

Parties (from the 91 referred to above) with greater need to address adverse change, COP10 *cf* COP9	18	28
“” “” same “” “”	25	17
“” “” less “” “”	2	1
Wetland status effectiveness index for each category[4]	0.32	0.21

[1] = those Parties either (i) answering COP10 national report question 1.2.1 on NWPs with “no”, “in preparation” or “planned”, or (ii) not responding to the question/not submitting a report (Parties in category (ii) are assumed not to have a NWP, though this may be incorrect in a few cases).

[2] = based on the assumption made for category (ii) in footnote (1) above.

[3] = those Parties submitting national Reports for COP10 who answered “yes” or “for some sites” to question 1.1.3 and then gave some answer to question 1.1.4b, concerning trends in the need to address adverse change in ecological character of wetlands.

[4] = this refers to the index of overall global effectiveness in the conservation of wetland status, COP10 cf COP9, for the Parties concerned; taken only from the pool of 91 who answered question 1.1.4b. It is expressed here as the proportion which the total for each category (= column in this table) comprises of the possible maximum total for that category (ie in the same way that each individual Party’s index scores were calculated, allowing a range from 0-1), and not the average of the scores for the category (which would allow a less intuitively interpretable range of 0-2).

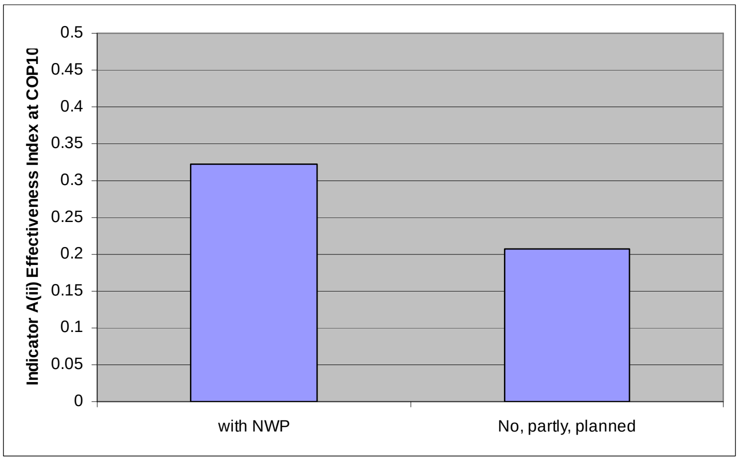


Figure 57: Comparison of wetland status effectiveness index scores for Ramsar Parties respectively with and without a National Wetland Policy or equivalent (from among only the 91 Parties answering both of the relevant questions in national reports to COP10, 2008). (“With” N = 45 countries, “No, partly, planned” N = 46 countries)

579. The story these data tells is that better overall wetland status in a country is associated with the existence of a National Wetland Policy/equivalent. In terms of a finding about responses, this appears to confirm that the advice to Ramsar Party governments to implement NWPs (as a means of achieving

conservation and wise use of wetlands) holds good; and it would be a basis for action recommendations urging those countries still without a NWP/equivalent to adopt one.

580. Some caution however is required in interpreting findings of this kind. What the data show, as in the first statement in the paragraph above, is that an association is apparent between the wetland status outcome and a given process/input. This in itself does not resolve two further questions, described below.

581. The first is the degree of significance of the association concerned, i.e. whether the extent of it stands out by comparison to all the other ranges of theoretical variation in the two variables concerned, and the probability of its arising by chance is so small as to be safely discounted. Statistical analyses to establish this will feature more fully in later stages of implementation of the Ramsar indicators, and different approaches are still in testing at the time of writing. Provisional indications however (not reproduced here) are that the association shown above does indeed have statistical strength.

582. The second question is whether or not the association represents a relationship of cause and effect between the two variables. It could be that both results are effects of a cause lying with a third variable which has not been monitored. Or it could be that the variable assumed to be the effect is actually the cause, and *vice-versa* (for example, good wetland status may motivate a country to consolidate its favourable position by adopting a National Wetland Policy). National report data shed little light on these issues.

6. Further analyses to be produced under Ramsar

583. The purpose of this section is simply to signpost some directions for further analyses that are either already intended, or have been identified as potentially valuable, and which would further illuminate the picture of the status and trends of inland waters biological diversity. As with the present report, this overall picture is in turn designed to provide a key part of the platform for deliberations concerning future programming, target-setting, action and monitoring in the post-2010 period.

584. Although other efforts will also be relevant, the focus here is mainly on work driven by processes under the Ramsar Convention in the context of the Ramsar-CBD Joint Work Plan, relating partly to Ramsar sites but equally (if not more so) to wetlands as a whole.

585. This includes inland waters, although in many cases a specific step would be required in order to calculate and present findings separately for wetlands considered to be "inland waters" and wetlands considered to be "marine/coastal". This aspect may need to be factored in as an addition to currently-envisaged Ramsar work plans, and to be resourced accordingly. The benefit of enabling both CBD and Ramsar needs to be met by one process should however be worth some investment; and indeed would enhance overall cost-effectiveness. Not all base data-sets will however allow inland wetlands to be distinguished from other wetlands, and in the first instance some examination of this question may be required to establish what might be possible.

586. The present report has shown some early results from Ramsar effectiveness indicators A(ii), C, D and F. In the current wok plan of the Convention's Scientific & Technical Review Panel (STRP) for 2009-2012, a range of activity (dependent on funding) is foreseen to make fully operational both these and the remainder (A(i), B, E, G and H) of the "first tranche" indicators; and to develop further, test and put forward for use by Parties and others as appropriate the "second tranche" (I, J, K, L and M). (For the issues covered by each indicator). Individual analysis and results reports are expected to be presented for at least the first tranche indicators over the next three years.

587. As with some of the indicators described in the present report, relevant existing topic-specific programmes operated by others have been identified as data-providers for some of the others in the list, such as the Red List Index for Indicator G (some results now available, but awaiting STRP consideration) and a global tracking tool for site management effectiveness for Indicator E. Specific partnership arrangements with Ramsar are also in continuing development with providers of remote sensing earth observation data, such as the European Space Agency and the Japanese Space Agency, which will be tailored to support indicator purposes.

588. A key part of the process for all of the Ramsar indicators is the relating of wetland outcomes to various correlates ("Ramsar inputs", "co-variates" or "process indicators") which may help to shed light on the effectiveness of implementation of the Convention. This aspect has not been covered in the present report (apart from the example demonstrated in the previous section), since the focus here is instead on what can be said at present about the status and trends of the inland waters biodiversity itself. Nonetheless this effectiveness correlation aspect, and its illumination of the "responses" dimension, should be mentioned as a major part of the future analyses to be conducted under Ramsar. It will have utility in other parts of the CBD's consideration of the inland waters Programme of Work which lie beyond the present status and trends assessment.

589. A further dimension to be explored, as part of this, is the relationship between the issues represented by the individual outcome indicators. So for example Indicator A(ii) on overall wetland conservation status could be examined in relation to Indicator B on the status of Ramsar sites, to produce statements of the degree of difference between protected wetlands and wetland ecosystems at large, or to test whether countries producing the most positive results for special sites also do the same for the landscape as a whole. (Indicator B in this sense thus performs both as an outcome indicator in its own right and as a co-variate for others).

590. Although some of the Ramsar indicators comprise measures that in themselves contain trend information, given that they have been coming on stream only in recent times, key additional value will accrue in future when the first year's baseline results can be compared with iterations providing a time-series. An important first milestone in this respect will be Ramsar's COP11 in 2012, when Party national report data can be analysed again to compare with the COP10 data that has featured in the present report. This will enable a picture to be formed both of trends in overall "headline" indices for key variables, and of any changes in the comparisons between countries, regions, wetland types etc, and any changes in the correlations between inputs and outcomes. Such a capability of course depends on consistency of methods, including consistency in the framing of questions in national report pro-formas and other data-gathering processes.

591. A further issue being investigated by the STRP is that of suitable approaches to the testing of the statistical significance of findings, across the whole of Ramsar's indicators agenda. This is still a developing dimension, and will require more work.

592. In addition to the indicators referred to in the present section above, further work is also in train or envisaged on the others which have been presented in this report, and some comments on this have been made in the corresponding sections above. For example, in respect of Indicator C on water quality, improved targeting of UNEP-GEMS/Water datasets to Convention needs would require some filtering of data to relate the location of monitoring stations to the location of wetland systems of interest, and some adaptation of region-based findings to the geographical regions defined by Ramsar.

593. A range of desirable enhancements to the analysis of threat data for Indicator D has been mentioned above, principally to consolidate a capability to produce trend findings from assessments repeated over time, and then to go beyond absolute trends and be able to show whether threats are

reducing relatively more than the trend for threats generally (e.g., in a country), and relatively more in relation to Ramsar sites than in relation to undesignated wetlands. There is some work in hand also to reconcile differing threat type classification systems in use by different international programmes of relevance. Ways of supplementing the overall picture made up from BirdLife IBA data and Ramsar Information Sheet updates with information that comes from other Ramsar-specific processes (such as Article 3.2 reports and free text fields in Party national reports) will also be investigated.

594. Potential may also exist to link threat types to land-use data on the Ramsar sites database, and then to use Earth Observation methods for monitoring land-uses as a surrogate for the threats. It is hoped that this may be among the issues to be addressed in 2009-2010 by the second phase of "Globwetland" project activities being coordinated by the European Space Agency, focused on the Mediterranean Basin.

595. There are a number of angles identified for further analysis of the rich data existing on waterbird population trends (and in due course other taxa) under Indicator F. This includes additional comparisons between sub-sets of the data, disaggregated according to particular species groups, time-periods or geographical areas (including a country breakdown, which has not yet been possible); and more in-depth treatment of the populations for which there are the longest and most complete runs of data. In addition, since International Waterbird Census data are collected from defined sites, there could be ways of filtering the data by site and (i) correlating Indicator F findings with findings from the separate site-based indicators, and (ii) correlating results with earth-observation-scale data for example on land-cover, to work towards the potential use of waterbird counts as a validated proxy for wetland ecosystem condition.

596. The Ramsar COP has in addition asked the STRP to support evaluations of performance of the Convention through the Key Result Areas defined in the Ramsar Convention Strategic Plan 2009-2015, and assessments of information in national reports to COPs, "in ways which are complementary and supplementary to the work on effectiveness indicators". Methods for doing this are still to be determined, but this task is now in the STRP's work programme. It is likely to result in some kind of Strategic Plan monitoring report, focused (given that it is an STRP activity) on scientific and technical aspects rather than administrative ones, and hence may provide additional perspectives on wetland status and trends in a target-driven strategic context.

597. Another current STRP activity of relevance is the further development of the Convention's "data and information needs framework", adopted in "work in progress" form by COP10 as Resolution X.14. This consolidated route-map to all measurement, monitoring, assessment and information management needs for the Convention is central to refining definitions of purposes and end-uses for all status and trends information handled through the Convention, and is organised in accordance with the structure and priorities of the Ramsar Strategic Plan. Continuing gap analysis and harmonisation aspects of this work will also strongly support the more effective use of such information for shared interests on inland waters with the CBD.

598. The 21 targets and 66 "activities for Parties" in the CBD inland waters Programme of Work have been cross-mapped to the 62 questions in the latest Ramsar national report format (for COP10) in Table 1and Table 2 above. There would be scope for identifying some of the most useful and closely-matched of these correspondences that go beyond the selected few topics covered by the Ramsar indicators, and extracting relevant data for them from Ramsar's national reports database, to shed light on actual implementation of particular elements of the Programme of Work in those countries (the majority) that are Parties to both Ramsar and the CBD. In addition, any issues that are not well covered by either this or the indicators could be considered for enhanced attention in the updated format being devised (already in 2009) for Ramsar reports to COP11 in 2012.

599. Other specific activities undertaken by Ramsar Parties in response to relevant Ramsar COP Resolutions or Recommendations may also be relatable in some cases to particular items in the CBD Programme of Work, and there may be ways of compiling further data from additional sources to track wetland outcomes relating to these, or for example to track issues concerning capacity-building and constraints to implementation. There are currently no plans to pursue this beyond the indicator and national report etc. processes already discussed above; and capacity/resources would need to be found if it were felt useful to undertake some analyses of this kind.

600. Some specific lines of enquiry might add further intelligence on the extent to which implementation activities under the Ramsar Convention and the CBD are acting in synergistic or harmonised ways in respect of inland waters biodiversity. As one example, the analysis of wetland status against adoption of national policies, which is summarised in the previous section of the present report in relation to National Wetland Policies or equivalents as espoused under Ramsar, could be re-run in relation to information which has already been collated by the CBD about the existence of National Biodiversity Strategies and Action Plans (NBSAPs). Since, however, all but 15% of CBD Parties have adopted an NBSAP, this might not be a very sensitive or revealing comparison; but it is probably worth doing if only to see whether or not the 15% concerned have a markedly different average wetland status index score than the rest. A more refined approach to this subject could investigate the extent to which inland waters/wetlands are incorporated into CBD NBSAPs and cross-check this against NWPs and trends in status, but this would be time consuming.

601. The Ramsar national report format for COP10 in fact asked some questions that bear directly on the issue of synergy between the two Conventions; and a summary analysis of the responses to these (which are stored in a database) could be worth doing in its own right. The questions concerned were as follows:

- 2G. How can national implementation of the Ramsar Convention be better linked with implementation of other multilateral environmental agreements (MEAs), especially those in the “Biodiversity cluster” (Ramsar, Convention on Biological Diversity (CBD), Convention on Migratory Species (CMS), CITES, and World Heritage Convention), and UNCCD and UNFCCC?
- 2H. How can Ramsar Convention implementation be better linked with the implementation of water policy/strategy and other strategies in the country (eg sustainable development, energy, extractive industry, poverty reduction, sanitation, food security, biodiversity)?
- 1.6.2 Have such [invasives] policies, strategies and management responses been carried out in cooperation with the focal points of other conventions and international organisations/processes?
- 3.1.1 Are mechanisms in place at the national level for collaboration between the Ramsar Administrative Authority and the focal points of other multilateral environmental agreements (MEAs)?

602. Logically the same kind of attention should be given to the national reports provided by the Parties to the CBD. These however are not analogous to the Ramsar reports, in that they are compiled less frequently and each one has a different thematic emphasis. Nonetheless it could be worth researching the information provided in the 3rd round of reports (and the 4th, once an appreciable number of them have accumulated during 2009), to uncover relevant information and perhaps make comparisons with the responses given by Ramsar Parties to wetland status questions (such as question 1.1.4b as discussed above in the present report) in their reports.

603. Tabulations like those above which map targets, goals, activities and indicators from the inland waters work programme on to the indicators and other monitoring and reporting processes operated by the Ramsar Convention, could be constructed also for the equivalent targets etc. in the CBD's other thematic programmes. This would help to fill out the picture of potential inputs which might be provided by relevant Ramsar activities across the themes. This in turn will have great utility in relation to continuing activities towards harmonised approaches to reporting, in the biodiversity-related Conventions more generally.

604. This report has referred to a range of activity by others beyond the two Conventions, which should continue to be linked to wetland status and trends assessment wherever possible. A key example is the Biodiversity Indicators Partnership (BIP). Various sections of the present report have referred to BIP indicators which are designed explicitly to coincide with or link to Ramsar's effectiveness indicators, some of them in turn linking with other programmes tracking eg site management effectiveness and Red List species. There are however others (e.g., those addressing genetic diversity, sustainable use, invasive alien species, human well-being, development assistance) for which a wetlands/inland waters "cut" of the analyses might be possible, to provide additional insights for the Ramsar Convention and the CBD inland waters work programme. The BIP indicator on river fragmentation is also obviously relevant.

605. Another example is the Living Planet Index, results from which have already been presented in here. As noted, following the specific additional LPI report which was tailored to the interests of the Convention on Migratory Species (Latham et al., 2008), a similar effort by the LPI team could in principle be envisaged in future to cover the scope of the Ramsar Convention or the CBD inland waters programme of work, to give more targeted attention to wetland and inland waters species groups respectively.

606. It has not been within the scope of the present report to address the drawing-out of implementation lessons learned and the identification of action steps to take, which are otherwise integral components of the indicators and assessment process. A number of lines of new analysis and synthesis will arise in relation to these dimensions too, and they will be addressed in separate forward-looking parts of the inland waters programme review at a later stage.

D. Summary of what the results in this section say about achievement of CBD targets

607. A picture of what existing knowledge tells us about the status and trends of selected aspects of inland waters biological diversity has been presented in the successive sections of this report, and will not be repeated here. The purpose of this picture however is to relate it to CBD objectives and targets, and to see whether it gives a true insight into the extent of progress in achieving them. Part of this question lies with testing hypotheses about the causes of the observed results - that aspect is included in the Ramsar Convention's effectiveness indicators process, but is beyond the scope of the present report and is being documented elsewhere. This section therefore simply draws together some connections between the adopted conservation aim and the "story so far" about the state of the biodiversity concerned.

608. The targets, goals and activities defined for the CBD's Programme of Work on inland waters biodiversity are set out in Table 1and Table 2 of the present report above, mapped against Ramsar indicators and other potential measures. A small number of them correspond particularly to the main selection of issues that are presented in this report, and an indication of the "storylines" which have emerged on each of these is given in Table 10.

Table 10: Summary of findings in the present report, related to the most closely corresponding goals, targets and activities in the CBD inland waters Programme of Work. (Note that not all datasets distinguish inland waters interests from other wetland interests; so some of the statements here relate to wetlands as a whole).

Activity 3.2.2 Identify the most cost-effective approaches and methods to describe the status, trends and threats of inland waters and indicate their condition in functional as well as species terms.

(All of the results sections of the report are relevant to this activity)

Target 2.1 Reduce the decline of, maintain or restore populations of species of selected taxonomic groups dependent upon inland water ecosystems.

Activity 1.3.3 Identify nationally and then act, as appropriate, to improve the conservation status of threatened species, including migratory species, reliant on inland water ecosystems, (see activities 1.2.3 and 1.2.4), taking into account the programme of work on restoration and rehabilitation of degraded ecosystems being developed by the Conference of the Parties as part of its multi-year programme of work up to 2010.

- Populations of inland waters/freshwater species covered in the Living Planet Index declined by an average of 35% from 1970-2005.
- Of the 1,138 waterbird populations whose trends are known, 41% are in decline.
- 43% of all amphibian species are in decline.
- 21% of wetland birds, 37% of freshwater mammals, 20% of freshwater fish, 32% of amphibians, 50% of freshwater turtles and 43% of crocodilians are globally threatened or extinct.
- The rates of decline in status of wetland-dependent species (inland waters species in particular) are worse than those dependent on other ecosystems.
- In a study of 25 European countries, wetland butterflies declined by 37% from the early 1970s to the late 1990s, and this trend was worse than that shown by all of the study's other indicators for birds and butterflies in other habitats.
- Throughout the world, more waterbird populations are decreasing (40%) than increasing (17%).
- Globally, 71% of darter populations with known trends are decreasing, 67% of diver populations, 60% of skimmers, 59% of storks, 50% of jacanas, 50% of rails, 48% of shorebirds, 48% of ibises and spoonbills and 47% of cranes. Only gulls (18%), flamingos (18%) and cormorants (20%) have relatively low proportions in decline; with other groups having intermediate positions.
- In 2002 in Oceania 3.8 times as many waterbird populations were decreasing as increasing; in Asia 3.7 times as many; in Africa 2.8 times; in the Neotropics 2.2 times; and in North America 1.1 times as many.
- The rates of shorebird population decline have themselves worsened, the overall ratio of increasing population trends to decreasing trends dropping sharply after the mid-1990s, and the rate of decline from the early-mid 1990s to early-mid 2000s being around 2.6 times greater than the rate of decline from the early 1980s to the mid-1990s.
- Fewer than half (48.3%) of assessed shorebird populations are now in favourable status (increasing or stable trends) compared with over 60% in the mid-late 1980s.

(In all the above, there are differences between species and between geographical areas, and these are discussed above).
Overall, these findings indicate that target 2.1 is not being achieved and in fact the rate of loss is increasing by most measures.

Target 7.2 Substantially reduce pollution and its impacts on inland water ecosystem biodiversity.

Activity 1.1.3 Identify and remove the sources, or reduce the impacts, of water pollution (chemical, thermal, microbiological or physical) on the biological diversity of inland waters.

- "Water Quality Index for Biodiversity" scores, and the percentages of monitoring stations with water classified as "excellent" or "good", have both generally increased in Asia and Oceania and decreased in Europe and the Americas, while water quality in Africa has been more variable over time, although tending to score generally towards the poor end of the scale.
- Although the decline in Europe and the Americas continues, the rate of decline has slowed compared to that in the late 1960s and 1970s. In Asia and Oceania there seems to be some evidence of water quality improvements.
- Globally, approximately twice as many water quality monitoring stations with long-term runs of data show improvements (2,152) as those showing deteriorations (1,040).
- Inorganic nitrogen pollution of inland waters has more than doubled between 1960 and 2005, and has increased tenfold in many industrial parts of the world.
- Water quality in rivers as measured by Biological Oxygen Demand shows a contrasting regional picture to that for water quality overall; having improved since the 1980s in Europe and the Americas, and deteriorated over the same period in Africa and in the Asia-Pacific region.

(See also findings on "threats" covered under goal 3.2 below).
Overall, these findings indicate partial progress towards target 7.2 in the case of some regions and some pollutants, and a trend away from it in the case of others.

Target 5.1 Rate of loss and degradation of inland water ecosystem biological diversity, especially through unsustainable water use, are decreased.

(Note that the element of target 5.1 concerning "loss" is addressed by Ramsar Indicator A(ii), and this has not been covered in the present report).

- More than 50% of specific types of wetlands in parts of North America, Europe, Australia, and New Zealand have been destroyed during the twentieth century, and many others in many parts of the world have been degraded. There is also ample evidence of the dramatic loss and degradation of many individual significant wetlands and wetland types, such as tropical and sub-tropical swamp forests. On a global scale however there is insufficient information on the extent of specific inland water habitats to quantify the full extent of habitat losses.
- Nonetheless, it is clear that rates of degradation and loss are worse for wetlands than for other ecosystems.
- The construction of dams and other structures has resulted in fragmentation and change to flow-patterns of almost 60% of the large river systems in the world.
- From among a range of wetland and other habitat types assessed in 25 European countries for the period 1990-2000, mires, bogs and fens showed the largest proportional losses of area (-5%); while the area of "inland surface water" increased over the same period. 70% of the remaining bogs and freshwater habitats were classed as being in unfavourable conservation status.
- The "overall need to address adverse change in the ecological character of wetlands" was perceived in the years 2005-2008 by Ramsar Convention Party Governments nearly everywhere as at least the same, and in a majority of cases greater, than in the years 2002-2005; i.e. a net deterioration in wetland conservation status.
- In three out of six Ramsar regions in 2005-2008 (Africa, Neotropics, North America) a majority of Parties perceived that the need to address adverse change in the ecological character of wetlands in general had increased compared with the previous triennium. In Europe a majority of countries perceived the need as unchanged (though this need still

reflects on-going declines), and in Asia and Oceania the picture was more equivocal.

- Index scores for overall effectiveness in the conservation of wetland status are above the global average in Europe and Asia, while the Neotropics and North America score least.
- In the Mediterranean region, 65% of expert respondents to a survey categorised the overall status of Mediterranean wetlands in 2004 as "good" and 35% as "poor". Inland wetlands were regarded as having better status than coastal wetlands.
- The assessment of trends was worse than for status, dividing equally between perceptions that trends were deteriorating and that they were stable or improving. More deteriorating trends were noted for coastal wetlands than for inland wetlands, mainly in the countries in the south of the region.
- Roughly equal proportions of responses recorded perceived improvements and deteriorations for wetlands in the Mediterranean basin as a whole in relation to the longer time-period of 1991-2004. 20% of responses assessed the trend over this period as "stable".
- The proportion of respondents assessing trends as "deteriorating" in 2004 was higher than for the same respondents' assessments of the trend over the preceding 13 years; suggesting a worsening of the status of Mediterranean wetlands as a whole.

(See also findings on "water quality", covered under target 7.2/activity 1.1.3 above; and findings on "threats", covered under goal 3.2 below).
Overall, these findings suggest that target 5.1 may not be being achieved; although most datasets/assessment methods are not specifically geared to addressing <u>change in rates</u> of loss/degradation.

Goal 3.2 To develop, based on inventories, rapid and other assessments applied at the regional, national and local levels, an improved understanding of threats to inland water ecosystems and responses of different types of inland water ecosystems to these threats.

- The degradation and loss of inland wetlands and species has been driven by infrastructure development (such as dams, dikes, and levees), land conversion, excessive water withdrawals, pollution, salinisation, eutrophication, overharvesting and overexploitation, and the introduction of invasive alien species. Increased human use of fresh water has reduced the amount available to maintain the ecological character of many inland water systems.
- Conversion (clearing or transformation) or drainage for agricultural development has been the biggest single cause of inland wetland loss worldwide.
- Over the past four decades, excessive nutrient loading has also emerged as one of the most important direct drivers of ecosystem change in inland (and coastal) wetlands.
- The construction of dams and other structures along rivers has resulted in fragmentation and flow regulation of almost 60% of the large river systems in the world.
- Modifications to water regimes have drastically affected the migration patterns of birds and fish and the composition of riparian zones, opened up access to invasive alien species and contributed to an overall loss of freshwater biodiversity and inland fishery resources.
- While habitat loss is the primary cause of extinction of freshwater species, the introduction of non-native invasive species is the second most important cause of decline.
- Global climate change and nutrient loading are projected to become increasingly important drivers in the next fifty years. Climate change is expected to be additive to the impacts of other drivers, and to exacerbate the wetland loss and degradation that is already occurring as a result of other causes,
- Overall, there is evidence that growing pressures from multiple drivers are increasing the likelihood of nonlinear and potentially abrupt changes in ecosystems.
- Pressures associated with water resources management, land use change (land claim and habitat loss) and agricultural activities are by far the most dominant issues recorded at Ramsar sites worldwide.
- In a sample of 167 Ramsar sites that are also Important Bird Areas (IBAs), every one was recorded as subject to some level of threat, with 77% being subject to "high" or "very high" threat levels. In terms of impacts on bird interests, the most frequently recorded problems were associated with agriculture (including plantation forestry), aquaculture, hunting,

trapping, pollution (largely caused by agricultural effluents) and human disturbance (mainly recreation).

- Comparing regions in the same study, agricultural threats dominated in Africa, but in Asia the most frequently recorded issues related to hunting and trapping, in Europe to human disturbance and in Asia to pollution.
- In Africa, the Middle East and Europe, dams and other water control structures are considered to pose a threat to nearly 10% of the 3,701 IBAs in these regions; and 87% of these sites contain wetlands of international importance.
- In the Mediterranean region the most frequently reported negative drivers of change in wetlands are urban development/infrastructure (featuring in 57% of survey responses), urban/industrial pollution (50%), tourism (45%), water abstraction (43%), agricultural intensification (43%), agricultural run-off (40%) and hunting (42%). Urban and infrastructure development was reported as a more frequent negative driver for coastal (64% of responses) than inland wetlands (48%), whereas water abstraction was more frequent in inland (56%) than coastal wetlands (33%).
- The most frequently intensifying threats overall In the Mediterranean region are reported to be infrastructure developments, tourism, pollution and agriculture, although nearly all threats are intensifying in at least some parts of the area, and none is diminishing overall.
- Agricultural threats show a consistently high prevalence in all the datasets referred to above.

Overall, these findings contribute to the "improved understanding" sought by goal 3.2, but (although not specified as part of the goal) more work is needed to understand trends over time.

609. The summary sentences at the foot of each section in Table 10 present a picture of inland waters programme performance outcomes that could be characterised as a combination of "not being achieved", "mixed picture" and "not very easy to say". No indicators are showing outcomes that could be characterised at global level as "clearly being achieved". Where more robust and accurate data are available they suggest that rates of decline/loss are accelerating (e.g., waterbird population data).

610. The global "2010 target", of significantly reducing the rate of loss of biodiversity by 2010, is regarded as incorporated into the inland waters Programme of Work targets by being the basis from which they are all derived. The statement in the preceding paragraph is therefore a statement of conclusions on progress towards this global target too, as far as inland waters biodiversity is concerned.

611. The key feature of the way in which the global 2010 target is expressed is that its monitoring requires measures and findings which are capable of speaking about a change in the rate of change, and this requires some care in interpretation. The above analysis of waterbirds, and particularly the analysis presented there of data on shorebirds, is the one which probably approaches most closely to the kind of metrics required. With datasets on trends, where each point is itself an expression of a rate of change, at least two data-points are required to make the requisite comparison. With datasets on status, a time-series of at least three data-points is required, so that two rates of change (from point 1 to point 2, and from point 2 to point 3) can be compared.

612. It is also critical in interpreting 2010 target results to be clear that a "success" in terms of reducing the rate of decline (which, depending on the mode of presentation, may appear as an "improving trend") will still relate to a continuing absolute loss of biodiversity, unless the trend has improved to the extent of passing the threshold point where it switches from negative to positive. Summary "storylines" need to be very clear about what constitutes "good news" or "bad news" in this context.

613. This report has looked at a selection of inland waters biodiversity outcomes, but has not (apart from the one illustrative example and a few other incidental observations) looked at whether these

outcomes result from actions by governments in response to the 2010 target or to the targets, goals and actions in the Programme of Work. This aspect is beyond the scope of the present portrayal of status and trends; but it is being addressed elsewhere in the context of work on the Ramsar Convention's indicators of effectiveness. This separate work will show that a constant or worsening rate of biodiversity decline is occurring even in some cases where diligent implementation of agreed actions is being undertaken by relevant governments. Again, care in interpretation will be required: this does not necessarily mean that the action was misguided or a waste of effort, since the question may be how much worse the situation would have been without it. In general though, baselines, control situations and hypotheses are all relatively weak areas of indicators in this field. In most cases, all that it is possible to do is to compare "with action" and "without action" outcomes in different places as a surrogate for changes over time; or to compare "before action" and "after action" outcomes in the same place but without being able to keep other variables constant. These are important challenges for future analyses.

E. Comments on links to other CBD programme areas

614. Inland water ecosystems and biodiversity exist within a physical landscape matrix and a socio-political matrix, and while they have scientifically definable distinctiveness, they are also connected to a continuum of other interests, meaning that their treatment in a separate programme is a necessary but (ecologically speaking) somewhat artificial expedient.

615. As mentioned at the beginning of this report, wetlands occur in all biomes and are potentially influenced by all sectoral activities, and the CBD's ecosystem approach provides an appropriate paradigm for the cross-cutting approach to land and water that is required to meet both the CBD's aims and the Ramsar Convention's aims. CBD COP Decision VII/4 refers to the presence of inland water ecosystems within ecosystems addressed by the Convention's other programmes of work, and encourages cross-referencing and coherence among the programmes in this respect; while it has also been observed that "the health and integrity of inland waters is an excellent indicator of the health of terrestrial ecosystems" (CBD Secretariat, 2006). Cooperation between the two Conventions has a corresponding breadth of scope, and so is far from being confined only to the inland waters agenda.

616. In particular perhaps, most of the same considerations would apply to the Programme of Work on marine and coastal biodiversity, given that Ramsar's definition of "wetland" includes all intertidal systems and near-shore marine areas to a depth of 6m. In eco-hydrological terms, inland and coastal/near-shore marine areas are linked by functional influences from the one to the other, and by the topography of watersheds, catchments and basins. It has been noted in the present report that many of the datasets underpinning indicators and other measures (e.g. trends in certain waterbird populations) are not able to separate an inland component and a marine/coastal component, and so the findings they generate constitute an integrated story about both of these environments.

617. Wetland storylines are also germane to the CBD's thematic programmes on biological diversity of forests (some forests are also wetlands), islands, agricultural lands, and mountains. Given the centrality of water to the picture too, there is also relevance in some respects to the programme on dry and sub-humid lands.

618. Clearly also there are close correspondences (and examples already of harmonised or joint approaches) between the two Conventions in relation to the CBD's cross-cutting issues, and Ramsar indicator information (especially the analyses of effectiveness correlates) will be of relevance to the issues concerning environmental impact assessment, climate change, invasives, communication and incentives, among others. In particular, those indicator analyses which are focused on various aspects relating to Ramsar sites are of importance for the Programme of Work on protected areas.

619. Further Ramsar monitoring, indicators and reporting work is likely to able to explore a number of finer disaggregations of datasets, in ways which may enable findings to be derived specifically in relation to individual wetland types, threat types or other categories which would be particular to one or other of the CBD themes or issues.

620. Tabulations of the kind which map targets, goals, activities and indicators from the inland waters work programme on to the indicators and other monitoring and reporting processes operated by the Ramsar Convention, could be constructed also for the equivalent targets etc in the other CBD programmes. This would help to fill out the picture of potential inputs which might be provided by relevant Ramsar activities across the themes. This in turn will have great utility in relation to continuing activities towards harmonised approaches to reporting, in the biodiversity-related Conventions more generally.

621. The previous and present sections have together provided some closing comments on this review of the status and trends of inland waters biological diversity in the context of the 2010 biodiversity target. They may perhaps at the same time constitute an opening comment for the dialogue that lies ahead, concerning appropriate responses and action objectives for the Parties of both Conventions to consider in relation to the post-2010 period.

III. DRIVERS OF CHANGE – WATER RESOURCES USE

622. The following sub-sections are derived largely from the Third World Water Development Report (WWDR3) published in 2008 by UNESCO (WWDR3, 2008) [5]. The Secretariat of the CBD provided information, editorial assistance and oversight to WWDR3.

623. WWDR3 includes an assessment not only of the status and trends with water itself, but also those of the uses to which water is put, their impacts on water availability and the environment and the direct drivers of changes in water (both quantity/availability and quality). Climate change is considered throughout as a cross-cutting issue. WWDR3 also places particular emphasis on the indirect drivers of change (for example: population pressures, changing consumption patterns, economic forces, trade etc.). It notes pertinently that it is these indirect drivers that exert the key influences on water and its environment. As such these indirect drivers must be considered and addressed if water (and hence inland waters biodiversity) is to be managed sustainably. Other sources of information are quoted where relevant.

624. Sustainable development depends on the management of water resources. Managed water resources are an essential component of growth, social and economic development, poverty reduction and equity. They will be essential to the achievement of most (if not all) the Millennium Development Goals.

A. Global Crises and the Role of Water

1. Water Is Food

625. Water is essential for the production of food and agriculture is by far the greatest consumer of water, estimated at about 70% of all water consumption. During a U.N. Summit on June 3-5, 2008 in Rome, Italy, the participants of the High-Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy stated their concern and provided insight into the crisis and its resolution. The summit adapted by acclamation a declaration that states “There is an urgent need to help developing countries and countries in transition expand agriculture and food production, and to increase investment in agriculture, agribusiness and rural development, from both public and private sources,” and calls on donors and international financial institutions to provide “balance of payments support and/or budget support to food-importing, low-income countries.” This summit showed how various processes involving food security, climate change, markets, development assistance and energy were interlinked and could aggravate the situation in one sector while contributing to the solution in another. Another observation from the summit was the **lack of water as an explicit agenda item** even though it has strong links with all these issues and many more.

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[5] The World Water Development Report series is the flagship report of the World Water Assessment Programme and the reporting process includes both contributions and oversight from UN-Water. It therefore represents a synthesis of information, analysis and views of all the 26 United Nations agencies or programmes dealing with water – plus a number of partners beyond the UN-system (including IUCN, WWF, World Water Council, Ramsar Convention, IWMI, Stockholm International Water Institute, UNSGAB, International Water Association, International Association of Hydrogeologists, Aquafed, The Global Compact, Global Water Partnership, International Association of Hydrological Sciences, International Commission on Irrigation & Drainage, Public Services International, Water Supply & Sanitation Collaborative Council, World Business Council for Sustainable Development,

2. Climate Change and Water

626. Scarcity as measured by available water per capita is forecast to get worse where the population is still growing significantly – in Sub-Saharan Africa, South Asia and some countries in South America and the Middle East. Worse, climate models show that extremes of rainfall are probably going to get worse resulting in heavier floods and more frequent droughts in regions already affected by these. These are often the very same regions with low income levels per capita, widespread absolute poverty, strong population growth and rapid urbanisation. These regional and local crises concern the world.

627. Adaptation to climate change adds a critical challenge for all countries, particularly for cities in coastal zones and for developing countries that will be hit hardest and earliest, with low capacity to adapt and for almost all business sectors. Even if GHG concentrations are stabilized in the coming years, some impacts from climate change are unavoidable. These include increasing water stress, more extreme weather events, the potential for high levels of migration and the disruption of international markets. If climate change brings even more significant shifts in the availability of water resources, there could be an influence on patterns of human migration. These challenges cannot be separated from the challenges of sustainable development. The issue is one of development in a more difficult climate. In fact, the incremental costs of adapting to climate change for some developing countries will soon be close to the current flow of aid to them. The leaders of the G-8 meeting in Hokkaido Japan committed to accelerating enhanced action on technology development, transfer, financing, and capacity building to support mitigation and adaptation efforts (Box 1). Again, such statements fail to grasp explicitly the importance of water. Such adaptation measures are related to water resources which will be most affected by climate change, as evidenced, for example, in a recent UNFCCC document (2007)[6]: "…sector-specific adaptation planning and practices were discussed in the areas of agriculture and food security, water resources, coastal zones and health. Those sectors were selected based on their importance to Parties and organizations as highlighted in their submissions...".

628. It is of concern that the interlinkages to water resources and water management are not recognized more explicitly in dealing with climate change and its impacts on other sectors.

Box 1: Extracts from Declaration of G-8 Leaders Toyako, Hokkaido, Japan, 9 July, 2008

> Climate change is one of the great global challenges of our time. Conscious of our leadership role in meeting such challenges, we, the leaders of the world's major economies, both developed and developing, commit to combat climate change in accordance with our common but differentiated responsibilities and respective capabilities and confront the interlinked challenges of sustainable development, including energy and food security, and human health.
>
> We will work together in accordance with our Convention commitments to strengthen the ability of developing countries, particularly the most vulnerable ones, to adapt to climate change. This includes the development and dissemination of tools and methodologies to improve vulnerability and adaptation assessments, the integration of climate change adaptation into overall development strategies, increased implementation of adaptation strategies, increased emphasis on adaptation technologies, strengthening resilience and reducing vulnerability, and consideration of means to stimulate investment and increased availability of financial and technical assistance.

629. A strong element within the case for action on climate change lies with the vulnerability of poor communities. Projections from climate scientists and modellers warn that changes in water availability

[6] United Nations Framework Convention on Climate Change, Report on the workshop on adaptation planning and practices, FCCC/SBSTA/2007/15, 25 October 2007

and quality may have disastrous consequences. Because water is the principal medium through which changes in climate will impact upon economic, social and environmental conditions, changing water availability translates into economy-wide impacts. Thus, the prevailing water situation is invoked as a primary justification for action on climate. It is very high on the agenda of water managers to take actions to resolve current problems before the main impacts of climate change start to kick-in. However even without climate change development is threatened in many regions by factors we fail to address time and again, and which pose the most urgent threats to development.

630. What advocacy on climate change has done is to bring to the fore a dire projection of a worsening water situation – a different cause, but the same end result. It is an unfathomable paradox that the world is motivated to respond to the impacts of climate change of the future, yet has remained disinterested in taking the actions needed to meet the rising water crisis that is upon us today.

3. Water in Environmental, Social and Economic Security

631. Climate change and especially its implication on scarce water resources becomes a security issue with a new dimension – not only a matter of narrow national security, but about a collective security in a fragile and increasingly interdependent world.

632. In Africa alone, by 2020 between 75 and 250 million people may be exposed to an increase of water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems (IPCC 2007).

<u>Box 2: U.N. Secretary General Ban Ki-moon warns that water shortages are increasingly driving conflicts</u>

Increasingly, fights are erupting over such basic human needs as water or arable land. I find this trend deeply worrying, especially because such shortages are only projected to grow in coming years," he said, adding that water also underpins many of the world's key development challenges – food, the environment, health and economic well-being.

Until only recently, we generally assumed that water trends do not pose much risk to our businesses. While many countries have engaged in waste-water treatment and some conservation efforts, the notion of water sustainability in a broad sense has not been seriously examined. Our experiences tell us that environmental stress due to lack of water may lead to conflict and would be greater in poor nations.

Ten years ago -- even five years ago -- few people paid much attention to the arid regions of western Sudan. Not many noticed when fighting broke out between farmers and herders, after the rains failed and water became scarce. Today everyone knows Darfur. More than 200,000 people have died. Several million have fled their homes.

There are many factors at work in this conflict, of course. But almost forgotten is the event that touched it off –- drought. A shortage of life's vital resource.

We can change the names in this sad story. Somalia. Chad. Israel. The occupied Palestinian territories. Nigeria. Sri Lanka. Haiti. Colombia. Kazakhstan. All are places where shortages of water contribute to poverty. They cause social hardship and impede development. They create tensions in conflict-prone regions. Too often, where we need water we find guns.

Speech of Secretary General Ban Ki-moon at the Davos World Economic Forum, 2008

633. Management of the crises is made even more difficult by the fact that in most countries the knowledge and information and understanding of its importance that is required for decision-making and

long-term planning is simply not available. Very few countries, if any, have a good knowledge of how much water is used and for which purposes, of the quantity and quality of water that is available and can be withdrawn without serious environmental consequences and of how much is invested in water management and infrastructure. Underfunding of observation, monitoring and information systems leads directly to weaknesses in infrastructure, research and development and training in addition to reduced efficiencies. This applies too at the global scale where such information is essential to the construction of global models of the hydrological cycle and for making decisions on where interventions, such as external aid, are most required.

634. It is generally accepted that growth is a necessary, if not sufficient, condition for broader development. WWDR3 placed more emphasis on development than its predecessors. But growth requires access to and the use of natural resources. The Growth Report[7] says that we may be entering a period in which natural resources, broadly defined, impose new limits on growth. Interestingly the Report makes no major reference to the essential role of water resources. While the Report points out that "Each country has specific characteristics and historical experiences that must be reflected in its growth strategy", WWDR3 makes the case that the availability of water resources and their management is one of the key characteristics that determine the growth strategy of a country.

635. In Africa this was recognised by the heads of state gathered in Sharm El Sheikh, Egypt when they adopted the declaration in Box 3.

Box 3: Commitment of African Heads of State

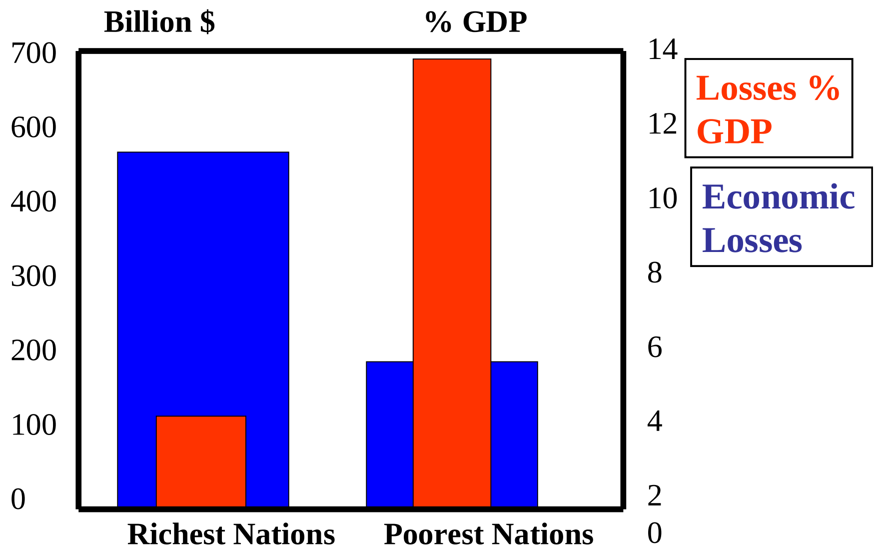
WE, the Heads of State and Government of the African Union, meeting at the 11th Ordinary
Session of our Assembly in Sharm El-Sheikh, Arab Republic of Egypt, from 30 June to 1 July 2008,
Recognizing the importance of water and sanitation for social, economic and environmental development of our countries and Continent;
Reaffirming our commitment to the principles and objectives, stipulated in the Constitutive Act of the African Union aimed at promoting cooperation and integration between our countries in all fields with a view to raising the living standards of our peoples and the wellbeing of future generations;
Recognizing that water is and must remain a key to sustainable development in Africa, and that water supply and sanitation are prerequisites for Africa's human capital development;
Concerned that there is an underutilization and uneven sharing of water resources in Africa, and that remains a growing challenge in the achievement of food and energy securities; …………
WE COMMIT OURSELVES TO:
(a) Increase our efforts to implement our past declarations related to water and sanitation.
(b) Raise the profile of sanitation by addressing the gaps in the context of the 2008 Thekwini Ministerial Declaration on sanitation in Africa adopted by AMCOW.
(c) Address issues pertaining to agricultural water use for food security as provided for in the Ministerial Declaration and outcomes of the first African Water Week.
And particularly;
(d) Develop and/or update national water management policies, regulatory frameworks, and programmes, and prepare national strategies and action plans for achieving the MDG targets for water and sanitation over the next seven (7) years;
(e) Create conducive environment to enhance the effective engagement of local authorities and the private sector;

[7] Commission on Growth and Development, 2008. *The Growth Report: Strategies for Sustained Growth and Inclusive Development.* …………………………

(f) Ensure the equitable and sustainable use, as well as promote integrated management and development, of national and shared water resources in Africa;
(g) Build institutional and human resources capacity at all levels including the decentralized local government level for programme implementation, enhance information and knowledge management as well as strengthen monitoring and evaluation;
(h) Put in place adaptation measures to improve the resilience of our countries to the increasing threat of climate change and variability to our water resources and our capacity to meet the water and sanitation targets;
(i) Significantly increase domestic financial resources allocated for implementing national and regional water and sanitation development activities and Call upon Ministers of water and finance to develop appropriate investment plans;
(j) Develop local financial instruments and markets for investments in the water and sanitation sectors;
(k) Mobilize increased donor and other financing for the water and sanitation initiatives including national projects and Rural Water and Sanitation Initiatives, the African Water Facility; Water for African Cities programme and the NEPAD Infrastructure Project Preparation Facility, as committed in the G8 Initiatives on water and sanitation…

636. This represents a significant global development challenge as highlighted by the Asian Water Development Outlook (2007), which emphasises a "multidisciplinary and multi-sector perspective (on water) around the Asia and Pacific region" in facing the challenging of sustaining growth. Particularly highlighted by that recent report are "important topics that have been neglected or are being inadequately considered in most countries of the region. Among these is the urgent need to address the inherent interrelationships between water and other important development-related sectors, like energy, food, and the environment". Economic growth has yet to receive much prominence in Poverty Reduction Strategies, or PRS. So, there is currently little in the way of a detailed roadmap for water resources development.

637. Interest is growing in the evidence of the macro-economic returns of investments in water. Disasters such as floods (from typhoons or hurricanes and tsunamis as well as from rainfall exceeding the carrying capacity of channels) and droughts are clearly linked to water. An illustration of the costs of disasters, highlights the impact on poor economies as compared with those wealthy enough to cope is provided in Figure 58.



***Disasters Losses, Total and as Share of GDP, In the Richest and Poorest Nations, 1985 – 99** (world watch 2001)*

Figure 58: The costs of disasters – total and as share of GDP, in the richest and poorest nations

638. In the past, concerns about the sustainability of these activities have tended to be put off until countries were sufficiently wealthy to invest in repairing the damage already done and preventing further damage. To-day it is recognised that our planet cannot support this way of managing water and that investment in environmental sustainability must accompany investment for growth. It is similarly recognized that delaying equity issues until an economic development threshold is reached is not justifiable as it aggravates the problems of social justice and poverty while contributing little to economic benefits.

639. The economic benefits of addressing water and sanitation are huge. Increased access would save millions of working days. The overall economic loss in Africa alone due to lack of access to safe water and basic sanitation is estimated to be some US$28.4 billion per year or around 5% of GDP (WHO, 2006).

640. Excessive environmental degradation caused by water pollution and withdrawals also is a source of negative economic impacts. For example, the damage cost of environmental degradation in Middle East and North Africa (MENA) has been estimated to be of the order of US$9 billion per year, or 2.1 - 7.4 per cent of GDP, with a mean estimate of 5.7 per cent of GDP (Hussein, 2008). Industrialized countries are learning the enormous costs associated with some degree of restoration of essential ecosystems. In the USA such costs have been currently estimated at $60 billion and will continue to rise as more is known (Box 4).

Box 4: Examples of the costs of restoring inland water ecosystems

Everglades Restoration: $10.9 billion. GROUNDWORK LAID FOR EVERGLADES RESTORATION, BUT PROJECTS EXPERIENCING DELAYS http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=11754

Restoration of the Upper Mississippi River: $5.3 billion, 50-year CRS Report for Congress: Upper Mississippi River - Illinois Waterway Navigation Expansion: An Agricultural Transportation and Environmental Context, July 15, 2004 Restoration of Coastal Louisiana: $14 billion Coat 2050 Towards a Sustainable Coastal Louisiana. http://www.coast2050.gov/2050reports.htm Restoration of Chesapeake Bay: $19 billion. Chesapeake Bay Program http://www.chesapeakebay.net/fundingandfinancing.aspx?menuitem=14907 Restoration of Great Lakes: $8 billion Great Lakes Restoration and Protection Priorities: An Overview of Programs, Funding Streams and Critical Gaps Prepared for the Council of Great Lakes Governors. Policy Solutions Ltd.111 West Washington Street, Suite 1415 Chicago, Illinois 60602 Restoration of California Bay Delta: $8.5 billion (first 7 years) Large Scale Ecosystem Restoration Initiatives. http://www.nemw.org/calfed.htm Restoration of Missouri River – to be determined

641. That the reduction of poverty is the single overriding policy is evidenced by the primacy of PRSs and national development plans (NDPs) as the governing mechanisms for partnerships and finance from the international community. As of mid-2008, 59 countries have prepared full PRSs and an additional 11 countries have completed preliminary, or “interim”, PRSs. The focus in those countries has moved to implementing those strategies. This represents a significant change. For many years previously, action on water that could deliver benefits to the poor had lacked the vital accompaniment of government frameworks that prioritised the reduction of poverty and the mobilisation of finance. Yet, even though PRSs offered prospects of aligning action on water with poverty reduction, few current PRSs pay action on water anything other than scant recognition.

642. New information has also begun to emerge on the significance of scaling to the potential benefits of water management opportunities. While there are many opportunities for development, those opportunities are not unlimited. For example, evidence from the Zambezi Basin (World Bank, 2006) shows that even full development of the basin’s irrigation potential could benefit, as a maximum, no more than 18% of the basin’s rural poor, even including off-farm multipliers. Concentrating services risks the heightening of regional disparities where water is scarce may need to be matched by policies that promote specific action in economically disadvantaged areas alongside stimulating the advantaged.

643. Unless the growth and poverty reducing contributions of water resources are made more explicit and specific at country-levels, the development-oriented finances are unlikely to follow. The specifics of those developments will bear influence upon sources, costs, viability, sustainability and instruments of finance. But only national and local level action plans can secure the necessary alignments between water resources, economic growth and poverty reduction. Forging those alignments within proper frameworks such as a subsequent round of Poverty Reduction Strategies, PERs or NDPs that are more growth-orientated will help make essential connections.

4. Reaching the Millennium Development Goals

644. Water is the key mechanism linking the various MDGs (Figure 59).

645. Achieving the goal of reducing the number of those afflicted by hunger and malnutrition depends on the performance of the agriculture sector, the sector that uses more than 70% of the water withdrawn.

In a context of abundant supply of water, and with little understanding of environmental implication, irrigated agriculture has increased practically unconstrained in the second part of the 20th Century. As a result, the environmental limits of hydraulic systems are being reached in an increasing number of places. Increasing water scarcity and concern for environmental sustainability now constrain further development of water for agriculture, and in places, competition from other sectors leads to a reduction of volumes allocated to agriculture. The key to ensuring continuous supply of food and other agricultural commodities therefore lies in increased productivity of water. Indeed, without further improvements in agricultural water productivity or major shifts in agricultural production patterns, the global amount of agricultural water demand in agriculture would increase by 70%–90% by 2050 (CA 2007), an unsustainable situation.

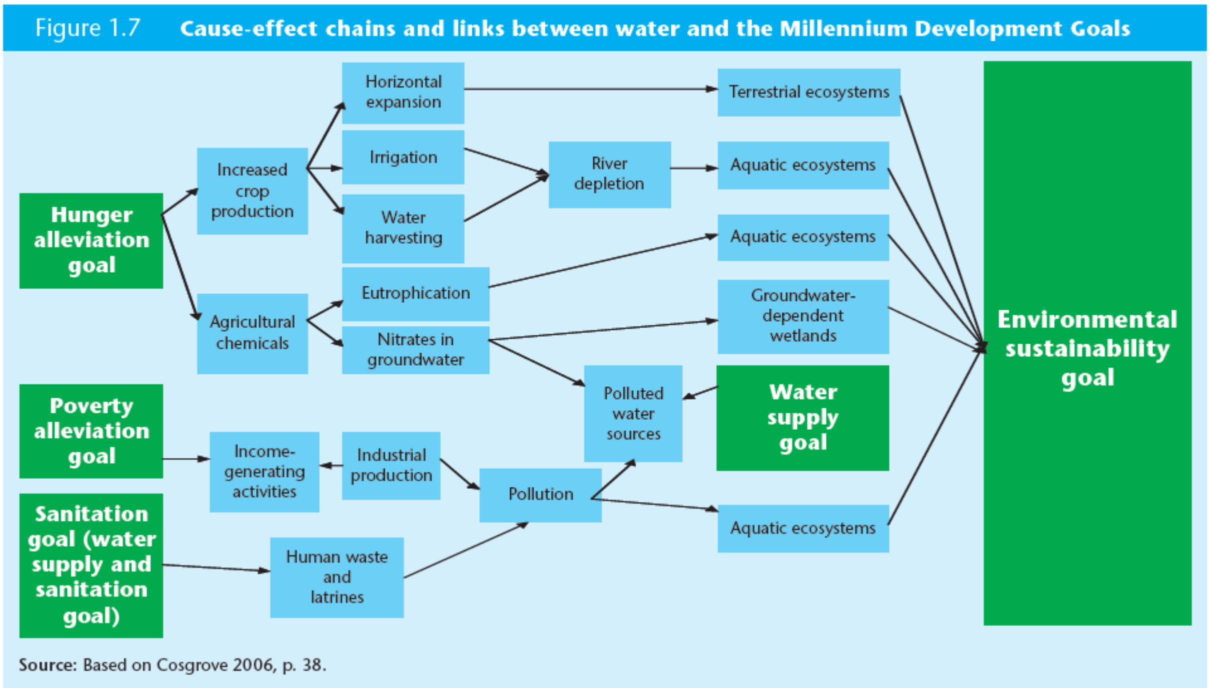


Figure 59: Cause-effect chains and links between water and the MDGs (Source: W.J. Cosgrove Water for growth and security in Water Crisis: Myth or Reality. Fundacion Marcelino Botin. Taylor and Francis London 2006; from WWDR3 2008).

646. The impact of climate change on environmental sustainability is increasingly recognized. At the High Level Event on the Millennium Development Goals at the UN on September 25, 2008 discussion focused on the need for national development plans to be climate resilient, especially for the LDCs, and for new adaptation strategies to be developed and implemented.

5. *Environmental Sustainability*

647. Humans and other species on the planet are dependent on water for life. Yet, man has not always demonstrated good stewardship of the water environment. Today, water management crises exist locally or are developing throughout most of the world. UN-Water (2007) has reported that in just one week in mid-November 2006, national media sources reported local but high-profile shortages in parts of Australia, Botswana, Canada, China, Fiji, Kuwait, Liberia, Malawi, Pakistan, Philippines, South Africa, Uganda, the United Arab Emirates and the United States of America.

648. Generally regional phenomena, water crises can emerge as water shortages and droughts, floods or both, now aggravated by the consequences of climate change. They may be natural or caused by increasing demands that exceed supply, lack of infrastructure or poor water management. They may be the result of waste or abuse resulting in pollution. Each shortage imparts local impacts. In accumulation, they risk threatening the lives and livelihoods of billions of people and irrevocably changing the ecosystems the planet.

649. Many place the sustainability focus firmly onto the environment, and its ability to continue to support progressive social and economic development. International Conventions such as the United Nations Convention to Combat Desertification (UNCCD) and the United Nations Convention on Biodiversity (UNCBD) have made water a global issue. There have been successes - 90% of pollution is handled in developed countries. Other multi-stakeholder processes, such as the World Commission on Dams have seen environmental sustainability rise in prominence as a factor influencing the manner in which water development takes place.

650. It has long been recognized that the environment in which people live – from the household to the community to the global level – significantly affects their health (Box 5) .

Box 5: Malnutrition Attributable to Environmental Risk Factors (Based on: Environmental Health and child survival: Epidemiology, economics, Experiences (Box 4.1). The World Bank. 2008. ISBN- 13:978-0-8213-7236-4)

In Preventing Disease through Healthy Environments[8], expert opinion was cited as indicating that poor water, sanitation, and hygiene and inadequate water resources management contributed to 50% of the consequences of childhood and maternal underweight. This expert opinion builds on evidence that emerged toward the end of the 1950s on the impact of environmental infections on a child's growth.

A technical review by the World Bank of 38 recent cohort studies corroborates this 50 per cent (confidence interval of 39 to 61 per cent) figure used to estimate the consequences of malnutrition attributable to environmental risk factors. Evidence from several of the studies demonstrates how exposure to environmental health risks in early childhood leads to permanent growth faltering. Lowered immunity, and increased mortality. The results from these studies were scrutinised to evaluate whether infections cause growth faltering and, if so, to what extent.

For example, a relatively recent large study from Bangladesh reveals that dysentery and watery diarrhoea together could retard weight gain by 20 to 25 per cent compared with those periods where no infections occurred9. This weight gain reduction is likely to be significantly higher when compared with international standards, and simulations that reveal 35 per cent weight gain retardation result in approximately the same environmentally attributable health burden as the estimate in Prüss-Üstün and Corvalán. 2006.

651. It is also well recognised that the poor rely disproportionately upon natural resources for their livelihoods – forestry products, wetland products, fisheries and rain-fed farming systems. Rates of destruction and degradation are high because poor people face few options available to them, and are often posed with short-term decisions on survival that jeopardise longer-term sustainability. More and more, the tackling of environmental degradation is embracing solutions among poor communities.

[8] Prüss-Üstün and Corvalán. 2006. *Preventing Disease through Healthy Environments: Towards an Estimate of the Environmental Burden of Disease.* Geneva: World Health Organisation

[9] Alam et al. *Association between Clinical Type of Diarrhoea and Growth of Children under 5 Years in Rural Bangladesh.* International Journal of Epidemiology 29 (5) 916-21

652. While water has a productive value limiting decisions to this greatly underestimates the value of the resource per se (Box 6). Citizens who realise this are calling for action to protect water. Businesses, recognizing the importance of protecting the sources of their water are joining them.

Box 6: Water as capital

Fifty years ago sustainability was simply not a part of the vocabulary, and water was not a particular consideration for economists. Classical economists recognized land (meaning all natural resources), labour, and produced capital as the basic sources of wealth. Neoclassical economists focused only on labour and capital, with “land” treated as just another interchangeable form of capital. The general view was that natural resources were abundant relative to demand and therefore not an important focus for the economist, whose task it was to allocate scarce resources—those whose use constrained alternative economic opportunities. There was little appreciation of the fact that the environment is used not only as a “source” of valuable inputs but also as a “sink” for the waste and pollution of the economy. Neither was there much thought about the possibility that the world might reach a scale of resource exploitation at which the capacity of both the “source” and “sink” functions of the environment could become a binding constraint on well-being and economic growth.

The focus on produced rather than natural capital is particularly stark when it comes to water. Prices are typically related to the capital outlays required to deliver water (that is, the infrastructure and the operations and maintenance charges) without any component of value attributed to the resource itself. Not only does an undervalued water resource tend to be overused, it also induces distorted prices that provide poor information about whether investments make sense. It provides no insight into whether economic activities are actually creating value or whether the resource is running out and needs to be conserved. It must be said, though, that water delivery is highly capital-intensive, and produced capital will therefore remain a crucial focus for financial and economic analyses of water investments. The point to recognize is that the value of water resources also matters, and that water’s availability, quality, and timing cannot simply be “assumed.”

Source: Bergkamp and Sadoff, in 2008 State of the World, the Worldwatch Institute. Norton. New York.

B. Broadening the issues – indirect influences

653. The interaction between sectors of the economy that availability of water resources should be a factor to be taken into consideration by those attempting to find ways to avoid these crises. However this is far from the way water is managed to-day.

654. Historically until about the 1990s (and in some countries still to-day) the various sub sectors within the water sector worked quite independently, with specialists in water supply and sanitation, hydropower, irrigation, flood control (management) etc. interacting very little with one another. As more and more basins approached closure[10] as a result of population growth and other drivers, the need for water management across sub-sectors at the basin level became evident. This concept was expanded in the 1990’s to one in which water was to be managed to ensure efficient water use, equitable sharing of the benefits and environmental sustainability. The title ‘Integrated Water Resources Management (IWRM)’ was coined to describe this approach. At the Johannesburg Summit in 2002 an objective was set that all countries should develop IWRM plans by 2005. (It should be noted that the approach had been in use before then although not described in these words. A notable example was the development of the

[10] Demand for water use within the basin resulting in the withdrawal of all of the water in the basin.

Tennessee River in the USA. Many countries continue to adopt the approach using different terminology to describe it).

655. The approach is now well understood by most of those working in the water sector, and is beginning to be taught in universities as an interdisciplinary approach. However it still is largely an approach managed within the water sector, where it is well understood that water is essential to all life on the planet (human and the other species) and to human livelihoods. IWRM is still seen by many as a technocratic process. There is a beginning of recognition within the sector that it is the decisions by others outside the water sector that determine how water will be used. Still the approach from within the sector has been to invite those working in other socio-economic sectors to join in IWRM, i.e. the other sectors are seen as cross-cutting in water management.

656. The technological aspects of IWRM need to be linked with the societal and political questions that determine the real allocation and management of water resources.

1. The sphere of decision making & the water box

657. It has become increasingly clear that factors outside of the direct control of decision-makers and managers working in the water sector have more important impacts on water resource management than those that they can manage. So, approaches that have targeted governance and capacity within the water sector have had too narrow a focus in the past. A large number of countries have now adopted water resource management laws, policies or strategies that reflect links between water and the social and economic sectors.

2. Actors in water management & decisions

658. Making trade-offs and searching for synergies requires cooperation between those responsible for different sectors of the economy. An example of this would be a decision to make judicious use importing goods with virtual water content to offset water shortages. The role of water managers is to ensure that these decision makers are informed of constraints and opportunities presented by water resource management and the development of water infrastructure. Thereafter it is their role to carry out their activities in line with the national development strategy.

659. Learning how to create institutions to facilitate this process is work in progress. Controlling corruption must be part of institutional development. Transparency International[11] reports that corruption in the water sector is widespread. It is not unusual that the investments required in water supply and sanitation and irrigation infrastructure are 25-30% higher than they should be because of corrupt practices.

660. Within government there are a number of actors taking decisions that control what will happen in the water sector, or be constrained by the water sector. These decisions are generally motivated by finance (budget) or politics (keeping power)[12]. Governments by their actions facilitate, encourage or discourage such investments, acting nationally, locally and regionally. Much investment leading to development is in the private sector. Where there has been sustained development, the role of government generally has been to facilitate action by others (The Growth Commission, 2008) and to regulate the process.

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[11] Transparency International, 2008. *Global Corruption Report 2008.* TI Berlin.

[12] Nick Manning. Strategic Decision-making in Cabinet Government: Institutional Underpinnings and Obstacles. The World Bank. Washington D.C. 1999. ISBN: 0-8213-4627-X ISBN-13: 978-0-8213-4627-3 SKU: 14627.

3. Demographic, Economic and Social Drivers

661. Human activities and processes of all types – demographic, economic and social – can exert pressures on water resources which need to be managed. These pressures are affected by a range of factors such as technological innovation, institutional and financial conditions, and climate change.

662. An increasing standard of living is typically accompanied by increased consumption and production of goods. These patterns translate into increasing demands for water-related household services, and water resources to facilitate increased economic growth and related activities. Increased demand for meat and fish in emerging and urbanized economies, for example, has increased fishery activities and livestock production, which is generally a very water intensive activity (1 kg of beef requires roughly 15,000 litres of water). The result is a continuously increasing demand for finite water resources for which there are no substitutes. When these resources can no longer be provided in sustainable quantities and of necessary quality, there is new or increased competition between different water use sectors and user groups. This outcome can be overexploitation of aquatic ecosystems, as each sector or user group tries to satisfy its own water needs at the expense of others. The ultimate loser is the sustainability of the exploited aquatic ecosystems, as well as the organisms (including humans) dependent on them for their survival and well-being.

663. Consumer choices have a direct impact on domestic water consumption and water pollution. Collectively, individual approaches can change a culture. It is for this reason that many governments, civil society and interest groups, in addition to imposing controls, use awareness raising and social marketing to introduce change.

4. Demographic Drivers

664. Population dynamics (growth, gender and age distribution, migration) create pressures on freshwater resources through increased water demands and pollution. Changes in the natural landscape associated with population dynamics (e.g., migration, urbanization) also can create additional pressures on local freshwater resources and the need for increased water-related services.

665. The impacts of demographic processes on our water resource will continue to be significant as the 21st century unfolds. The world's population, currently estimated at 6.6 billion, is growing by about 80 million people each year. This number implies an increased demand for freshwater of about 64 billion cubic meters a year[13] (Hinrichsen et. al., 1997). It is estimated that 90% of the 3 billion people who are expected to be added to the population by 2050 will be in developing countries, many in regions where the current population does not have adequate access to clean water and sanitation. Nor do national governments in these countries necessarily have the financial resources, institutional capacities or manpower required to provide these needs for human well-being. Further, even in those areas that have experienced gains in the number of people with access to water supply and sanitation since 1990, these gains can be eroded by population growth.

666. While the world's urban population grew very rapidly (from 220 million to 2.8 billion) over the 20th century, the next few decades will see an unprecedented scale of urban growth in the developing world. This will be particularly notable in Africa and Asia where the urban population will double between 2000 and 2030: That is, the accumulated urban growth of these two regions during the whole

[13] Hinrichsen, D., Robey, B., and Upadhyay, U.D. *Solutions for a Water-Short World. Population Reports*, Series M, No. 14. Baltimore, Johns Hopkins School of Public Health, Population Information Program, December 1997.

span of history will be duplicated in a single generation. By 2030, the towns and cities of the developing world will make up 81% of urban humanity.

667. The net implication of all of these demographic processes is clear: the world will have significantly more people in vulnerable urban and coastal areas in the next twenty years. In fact, the rate of slum formation is nearly the same as the rate of urban growth. The implication in areas with already-scarce water resources will be significant, and water managers will be forced to have to look beyond the water sector for solutions. They will need to work closely with other sectors, such as education, health, social services and agriculture, to enable effective response strategies to meet this challenge.

5. Population growth

668. While the 20th Century was the century of population growth (with the world population increasing from 1.6 to 6.1 billion), the 21st Century will be that of population aging, with the proportion above age 60 years increasing from currently 10% in 2000 to 25-45% by 2100 (see Figure 2.1). The world population projections of the International Institute for Applied Systems Analysis (IIASA) show, that with a high probability of 85-90 percent, world population will reach a peak and start to decline over the course of the 21st Century: this has given rise to the notion of the "end of world population growth" (Figure 60).

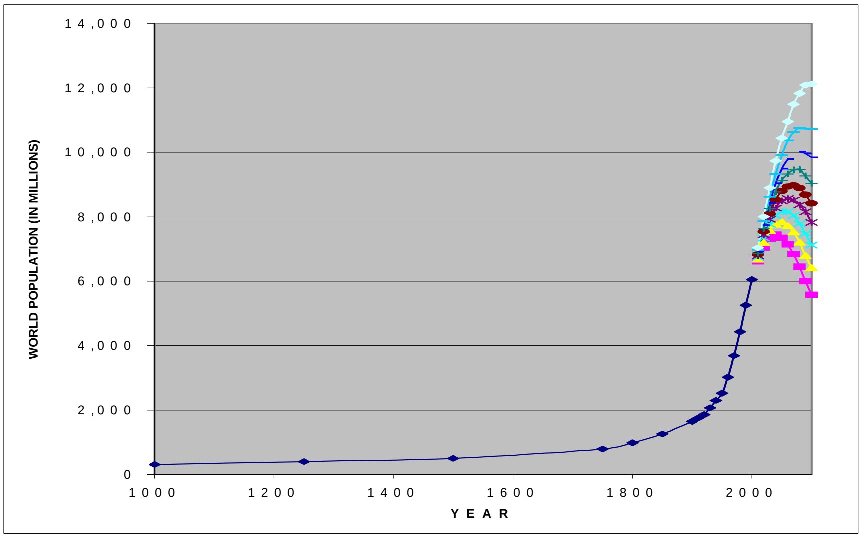

Figure 60: World population from the year 1000 to 2100(Different lines for 21st century show 0.1 fractiles of uncertainty distribution, i.e., 80 percent of the simulated cases lie between the top and bottom lines). Sources: UN (1973, 2005) for historical trends; Lutz et al. (2007a) for IIASA's probabilistic projections).

669. Most of the population growth will occur in developing countries and many in regions that are already in a situation of water stress, in areas with already limited access to clean water and sanitation facilities. More than 60% of the world's population growth that will occur between 2008 and 2100 will be in two regions: Sub-Saharan Africa (32%) and South-Asia (30%) which, together, should account for 50% of the world population in 2100. Such levels of population growth will have major impacts in these regions, given the relatively poor economic conditions in many of the affected countries, and the attendant impacts on other sectors, including education, health care, poverty alleviation, and economic development.

670. The distribution of age and gender also can have considerable implications for consumption and production patterns. The trend of increasing consumerism around the world is evidenced with the 25 members of the Organization for Economic Cooperation and Development (OECD), namely Australia, Canada, Europe, Japan, Mexico, New Zealand and the USA, which collectively consume about half of the world's energy (with is related to water use).

671. The year 2008 marked the transition from a rural dominated world to an urban dominated world, as the world population was estimated to be equally split between urban and rural. By 2030, the number of urban dwellers is expected to increase by approximately 1.8 billion people (from 2005), representing about 60% of the world's population while the number of rural inhabitants is expected to decline slightly from 3.3 billion to 3.2 billion. Nearly 95% of the increase in urban populations is expected to occur in developing countries.

672. This trend has two major features. First, in spite of the great deal of attention that is given to megacities, most of the world's urban populations actually live in cities with less than 500,000 inhabitants. This is not to take attention away from the various challenges of megacities, which require natural resources and create waste in quantities unsurpassed in human history and thus create significant pressures on the environment. Nevertheless, the growth of small and mid-size cities will still have significant impacts on the water resource. Second, the great majority of urbanization will take place in developing countries, especially in Africa and Asia, where the urban population is expected to double between 2000 and 2030 (UNFPA 2007). The rates of urbanization rates are much lower in developed countries, where some are actually decreasing.

673. In addition to the obviously increased density of people in urban settlements, which has its own sociological and health implications, the urbanization process also has its own unique environmental impacts. Urbanization is accompanied by an increasing cover of impervious surface, as previously 'natural' land surfaces become transformed into streets, roofs, parking lots and other types of structures that block the percolation of rainwater into soil. Such construction increases the flow velocity of water over the land surface, carrying all sorts of materials into receiving water systems, degrading water quality and causing local pollution problems. In many cases, this 'urban drainage affect' has led to ever-increasing flash floods, causing casualties and infrastructure damage.

674. Estimates of potential environmentally-displaced people range from 24 million to almost 700 million people that could be displaced by water-related factors, including development projects designed to relieve some water availability stresses in the future.[14] Part of the complexity of unravelling the connection between migration and environmental factors, such as water resources, is that people rely indirectly or directly on their environment for their livelihoods. It is difficult to estimate the magnitude of potential migration to be expected as a result of environmental factors. What is known is that climate change, which is predicted to lead to increase in frequency and intensity of extreme weather events, is likely to result in an overall increase in the displacement of people in the future.

[14] UNEP former head, Klaus Töpfer, talks of 22-24 million environmental migrants (Biermann, 2001), whereas Norman Myers (2005) reports 'at least' 25 millions in 1995 (latest date for a comprehensive assessment), especially in the African Southern Sahara, China, Central America and South Asia. Norman Myers even expects the number to reach around 50 million by the year 2010. The Office of the United Nations High Commissioner for Refugees (UNHCR, 2002:12) for example, estimated there were then approximately 24 million people around the world who have fled because of floods, famine and other environmental factors. Christian Aid released a report in 2007 estimating up to 685 million people forced to move due to environmental factors, including development projects like dams that inundate large areas of inhabited land.

675. One positive development of migration is the lessening of the pressures on the vacated lands, which may be an opportunity for the recovery of some ecosystems. In certain areas of North America and Europe, the rural exodus, combined with public interests for large recreational areas, has resulted in the growth of new parklands.

6. Economic Drivers

676. Growth and changes in the global economy are having far-reaching impacts on water resources and their use. Growing international trade in goods and services can aggravate water stress in some countries, but can relieve it in other countries through the flows of "virtual water," particularly in the form of imported agricultural commodities.

677. Expansion in the global economy has a major impact on water – through the growth in the number of consumers, changes in their consumption habits, changes in the way goods and services are produced, and shifts in the location of activity, which affects international trade.

678. The economy-water nexus has permeated thinking at the highest policy-making levels. Delegates at the 2008 meeting of the World Economic Forum in Davos (Switzerland) voiced their anxieties over the impacts of global economic processes on the worldwide availability of food, energy and water. One leading businessman referred to water as "...the oil of the 21st century"[15], echoing similar remarks of a former UN Secretary-General[16]. A graphic illustration of the interrelationship between food, energy supply, global warming and water is the impact on water supplies of growing crops for biofuel – a measure aimed at reducing dependence on fossil fuels. The production of biofuel requires considerable amounts of water though this depends heavily on the type of crop and the conditions under which it is produced. It takes between 1,000 and 4,000 liters of water to produce a liter of biofuel. Thus, measures taken to tackle energy self sufficiency and climate change can inadvertently add to the gravity of a country's water problem.

679. The dynamic between the economy and water runs in both directions. Water is massively affected by economic forces – but in turn, the state of water resources has a strong feedback to the economy. Companies are becoming aware of the risks of operating in water-stressed areas. In periods of water shortages, public authorities are likely to close down factories, and divert water from farmers, in order to release water supplies for households. Water diverted to public supplies may also prejudice hydropower generation, leading to brown-outs or black-outs, which would have repercussions on agriculture and industry. Water contamination from industrial effluents is causing factory closures and relocation in many areas, while the depletion and contamination of groundwater may cause industries and their workers to relocate to areas with better water potential. Lack of water storage infrastructure can cause heavy economic losses from flooding and drought. Polluted water has high costs for human health, that can subsequently result in poor education of youth affected the pollution, etc. In short, adequate investments in water management, infrastructure and services can yield a high economic return by avoiding such related costs.[17]

680. Globalisation may make the situation worse, but can also provide solutions. In the realm of trade, producing and exporting goods and services with a high water footprint could aggravate the problems of a water-scarce economy. But equally, such an economy could gain from importing goods with a high water content (importing virtual water). Through the medium of direct investment, companies can offload their

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[15] Reported by Gideon Rachman, *Financial Times*, Jan 2008.

[16] "Water will be more important than oil this century" (Boutros-Boutros Ghali).

[17] SIWI: *Making water a part of economic development: the economic benefits of improved water management and services.* 2006

local water problems onto other countries by relocation. However, a growing corporate awareness of a firm's water footprint is leading to greater transparency surrounding the impact of a firm's whole supply chain on its water environment.

7. The global food crises and the rising cost of fuel and energy

681. Reversing decades of low prices, the two-year period between 2006-2008 has been marked by sharp, and largely unanticipated, increases in the price of food. According to the Commission on Growth and Development, there are many potential causes for the steep price increase, the relative importance of which is not yet clear. The contributing factors include rising demand; shifting diets; droughts; possibly financial speculation and a monopolistic marketplace; increased costs of agricultural inputs such as fertilizers; and policies that encourage the use of agricultural land and output for biofuels. Although there is no consensus yet on the relative importance of these factors, many believe that policies that favour biofuels over food need to be reviewed and if necessary reversed.[18] This position was further supported in the Declaration of the High Level Conference on World Food Security: The Challenges of Climate Change and Bioenergy (Rome 2008), stating "It is essential to address the challenges and opportunities posed by biofuels, in view of the world's food security, energy and sustainable development needs. We are convinced that in-depth studies are necessary to ensure that production and use of biofuels is sustainable in accordance with the three pillars of sustainable development and takes into account the need to achieve and maintain global food security."

682. If a drive toward food self-sufficiency were to materialize, it would have considerable implications for national water security, especially in the case of countries located in arid regions. Although they can be highly beneficial for rural development as a whole, by adopting policies for food self-sufficiency, countries also increase their national water footprints as well as forfeit growth in higher income, less water-intensive sectors.

683. Like food security, energy security represents a necessary pathway towards GDP growth. The world will need almost 60% more energy (International Energy Agency) in 2030 than in 2002 with economic growth in the developing world driving most of that increase. Development of hydropower capacity is one energy strategy that would reduce economic dependence on fossil fuels and limit greenhouse gas emissions and developing countries possesses significant, untapped, hydropower potential. Reticulated on-line energy in support of growth within urban centers will invoke WRM responses to centralized power production. Growth in small towns will likely rely more upon off-grid renewable energy sources. Industrial development will introduce intensive demand for water in concentrated locations. For example, it takes 230,000 liters to produce one ton of steel in the US. High technology industries, increasingly important for many economies, are highly consumptive. Producing one 300 mm silicon wafer consumes 8,600 liters[19].

8. Water and Trade: Virtual water and growing awareness of water footprints

684. Water footprints are a means of measuring how much water is used in the overall production/consumption of goods and services, whereas virtual water can serve as a tool to determine the

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[18] The Growth Report: Strategies for Sustained Growth and Inclusive Development, COMMISSION ON GROWTH AND DEVELOPMENT (Conference Edition), 2008 The International Bank for Reconstruction and Development / The World Bank

[19] The World's Water 2006-2007:The Biennial Report on Freshwater ResourcesGary Wolff, Heather Cooley, Meena Palaniappan, Andrea Samulon, Emily Lee, Jason Morrison, David Katz, Peter Gleick. Island Press.

movement of water through international trade. Thus, the concept of virtual water is discussed in terms of trade, whereas that of water footprints is described in terms of environmental awareness and as a tool for assessing the potential for adverse impacts on water resources.

685. Because water is heavy, relative to its value, it is not feasible to transport it in bulk over long distances with the exception of limited schemes for drinking water. In this perspective, water is predominantly a local concern, although it becomes a regional issue where rivers or lakes cross national boundaries. What transforms water into a global issue is the trade in goods and services that have a water content (often referred to as "virtual water"). Providing water and wastewater services to households, industries and farmers is another internationally mobile function.[20]

686. Countries with water shortages can alleviate their situation by importing water-intensive goods and services. In turn, water-abundant countries can take advantage of their bountiful water supplies through exports. While this broadly happens at a regional level many countries have trade patterns that are not so logical. What often happens is that countries, through their patterns of consumption and imports, can aggravate water shortages and pollution of their water supplies. Trade distortions, coupled with a widespread failure to properly price water resources, may worsen the water-related problems of trading partners. Global water saving as a result of international trade of agricultural products has been estimated at about 350 Gm3/yr (Chapagain et al., 2006). This volume is equivalent to 6% of the global volume of water used for agricultural production. An estimated 16% of the existing problems of water depletion and pollution in the world relate to production for export. The prices of the traded commodities seldom reflect the costs of water use.

687. The motivation of companies to assess their water footprints is partly due to their desire to preserve the goodwill of the people among which they operate and on whom they depend, but is also a very practical matter of cost control and risk management, including, for example, safeguarding access to the water essential for their operations. Recent initiatives in the business community to support sustainable water management include the CEO Water Mandate launched at the 2007 UN Global Leadership Forum; the World Economic Forum's call for a "coalition" of businesses to engage in water management partnerships, and development by the World Business Council for Sustainable Development of a water diagnostic tool and water scenario planning supports.[21]

688. Water in all its aspects is being increasingly viewed as a potential threat and constraint to economic growth. As an example, China's remarkable economic growth is translating into serious environmental problems, notably water shortages in the North, and pollution from wastewater effluent across the country. Massive projects begun to divert major water resources from the southern part of China to its populated northern part will doubtless result in major environmental and social problems as these projects are substantially implemented.

689. The question "how much water do people drink?" (on average, between two and five litres per day each in developed countries) is much less relevant than the question "how much water do people eat?" (according to one estimate, 3,000 litres per day in rich countries). It is estimated that the production of a kilogram of wheat takes 800-4,000 litres of water, a kilo of beef 2000-16000 litres, and a kilo of cotton 2000-8700 litres.[22] A growing amount of evidence is available about the "water footprint" of

[20] Import and export of *invisibles*

[21] *Business in the world of water: WBCSD water scenarios to 2025, 2006*

[22] IWMI: *Water for food, Water for life: A Comprehensive Assessment of Water Management in Agriculture*, 2007

different products and sectors.[23] Such calculations raise many methodological issues, but the orders of magnitude they produce should give policy-makers in water-scarce economies much food for thought.

9. Challenges

690. The fist challenge is to shift this balance so that the less fortunate, and the ‘bottom-billion’ in particular, can have access to basic products and services, including access to fresh water and sanitation.

691. The second major challenge is to ensure the cumulative action of economic activities, and all the other noted drivers, does not overwhelm nature’s ability to respond to human needs. The expansion and growth of the global economy, and the resulting increases in human consumption, drives human needs for increasing quantities of natural resources, including freshwater. However, goods and services provided by ecosystems (e.g., water, fibre, food, feed, climate, etc.) are finite and vulnerable. As such, the need to reach a balance between economic development – environment linkages, and all the drivers influencing these linkages, remains a core requirement for sustainable development.

10. Social Drivers

692. Social drivers influence human perceptions and attitudes toward the environment, and particularly water resources which, in turn, influence the pressures people exert on water through water demands and uses.

693. Changes in lifestyles are a function of human needs, desires and attitudes, as illustrated in consumption and production patterns, which are influenced by social drivers such as culture and education, as well as economic drivers and technological innovation, and can strongly influence the decisions we make, which will in turn create – or alleviate – the pressures we impose upon water resources.

694. The linkages between poverty and water resources issues lie in the reality that impoverished people have few options for dealing with environmentally-degrading actions. Simply stated, it leaves individuals with little or no choice – they must do whatever is necessary to ensure their survival and that of their families, regardless of the environmental costs or consequences. Such activities can translate directly into unsustainable use of natural resources, including water, in the pursuit of survival needs. The lack of adequate water resources and sanitation facilities associated with poverty translates into such environmental consequences as water pollution and degraded aquatic ecosystems, including their living resources. Lack of such facilities also results in high levels of water-associated disease (schistosomiasis, malaria, trachoma, cholera, typhoid, etc.). Further, many individuals living in poverty engage in various artisan activities for their meagre livelihoods, such as metal working, many of which generate large quantities of related water pollutants.

695. History suggests some initial level of economic development may be necessary before attention is given to environmental sustainability. However, history may not be the best mentor. The problems are, firstly, that some processes are irreversible (aquifer depletion, contamination, etc) and secondly, that the state of water resources – and the environment in general – affects the poor disproportionately. Investment in environmental protection, water management, and water supply and sanitation services, among others, can have a high payoff in economic benefits.

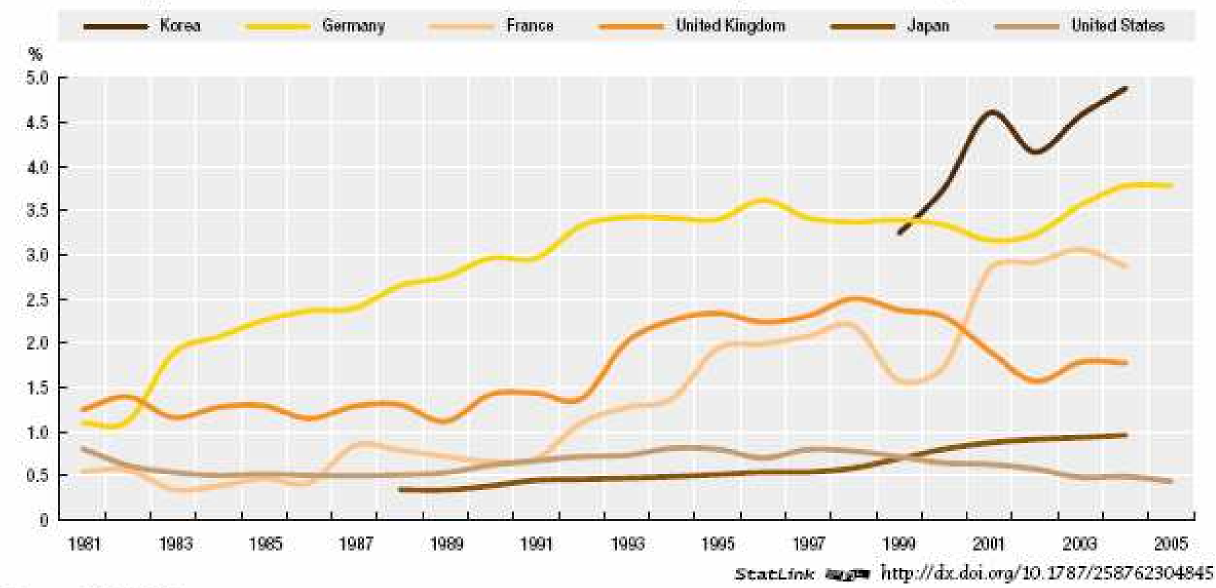
[23] E. g. A.K.Chapagain & A.Y.Hoekstra: *Water footprints of nations*. UNESCO-IHE, Sept 2004.

696. Humanity's overall environmental footprint is increasing dramatically. And despite some laudable efforts to develop cleaner technologies that will decrease this footprint, the sheer magnitude of the growth in living standards poses a considerable threat to the sustainability of our water resources and our environment. The evolution of eating habits or patterns with increasing standards of living may be the most important driver of agricultural water use (along with biofuels). It is estimated, for example, that the Chinese consumer that ate 20 kg of meat in 1985 will eat over 50 kg of meat in 2024. The annual "water footprint" of this change in the diet of the estimated 1.3 billion Chinese people will translate into the need for an additional 390 km3 of water for its production. This is a formidable additional quantity of required water for a country already experiencing serious water shortages in different regions. It should be noted, however, that these levels of beef consumption in China remain well below those of several other countries. For example, in 2002, Sweden consumed 76 kg of meat per capita and the USA consumed 125 kg[25].

C. Technological Innovation

697. Several developed countries have been increasing their investment in environmental R&D in an effort to encourage the development of new technologies that can improve their environmental quality (Figure 3.1). This is not the case in most developing countries, however, because of the many other requirements for their limited financial resources. Thus, the main path of technology transfer typically is from developed countries to developing countries. And not all technology transfers are equally beneficial.

Figure 1.7. Share of environmental R&D in total government R&D, 1981-2005



Source: OECD (2005).

Figure 61: Share of environmental R&D in total government R&D, 1981-2005.

698. Information and communications technology (ICT) can affect the cost and quality of monitoring environmental health and quality in many different ways. Unfortunately, however, this trend does not counterbalance the fundamental problems stemming from an overall lack of original field data required for 'ground-proofing', monitoring and forecasting data, and for informed decision-making.

[24] *Financial Times Magazine, Jan 26/27, 2008*

[25] http://earthtrends.wri.org/searchable_db/index.php?theme=8&variable_ID=193&action=select_countries

1. Biotechnology and the 'Green Revolution'

699. Biotechnology is believed to have a valuable role in addressing water scarcity and quality challenges in both developed and developing countries, particularly in regard to agricultural needs. Biotechnology includes tools of varying degrees of sophistication, some being very expensive. It can be used to improve the productivity of crops (increasing their resistance to pests, diseases and weather extremes) and animals (increase their productivity), and also aquaculture production, focusing on improved water use efficiency. An indicator of water use efficiency from applied biotechnological tools is the harvest biomass production per unit input of water. Biotechnology can be used to modify water availability in the root zones of soils (soil moisture), thereby modifying or enhancing plant production. For situations influenced by biological processes, efforts to increase their efficiency can be made via application of conventional plant breeding and/or biotechnology tools.

700. Asia's Green Revolution, for example, doubled cereal production between 1970 and 1995, while increasing the land area devoted to cereals by only 4%. At the same time, the Green Revolution demonstrates that unintended effects can accompany the adoption of new technologies. The excessive use of agrochemicals has polluted waterways, while wasteful irrigation has contributed to water scarcity in some areas. As previously noted, high livestock concentrations have contributed to the spread of disease in some locations. Further, the traditional polyculture techniques employed in some countries were transformed into the monoculture of specific cereal crops with export value, or for use as animal feed, in some cases actually reducing the economic livelihoods of small farmers because of increased production of cereal crops. Increased agricultural production also results in increased water demands, making water scarcity a problem in some arid/semi-arid regions.

2. Biofuels

701. The International Water Management Institute reported that 1,000-4,000 litres of water are required to produce one liter of biofuel. Another estimate is that 2,200 litres of water are required to grow the sugar cane needed to produce one litre of ethanol in Brazil, with the figure for India being 3,500 liters. Only about 90 litres of water are necessary to produce a litre of ethanol in Brazil mainly from rain-fed sugar cane. Another estimate is that 900 litres of water are required on average to grow 1 kg of maize (Hoekstra and Chapagain 2007)[26].

702. The World Bank's 2008 World Development Report (Agriculture for Development), for example, reported that, although about one-fifth of the maize harvest in the United States was used for ethanol production in 2006/2007, it only displaced about 3 percent of the country's gasoline consumption.

3. Nanotechnology

703. The application of nanotechnology shows particular promise in regard to water resources, especially for developing countries; namely desalinization, water purification, wastewater treatment, and monitoring. The first three areas involve nanofiltration technology, nanomaterials, and nanoparticles, all directed to removing or reducing contaminant levels in water, while the latter involves the development of nanosensors. In regard to water treatment or remediation, nanotechnology has the potential to significantly improve water quality and quantity. Advanced filtration materials, such as nanofiltration membrane technology, can facilitate water desalinization, as well as increased water reuse and recycling.

[26] Hoekstra, A.Y. and Chapagain, A.K. 2007. Water footprint of nations: Water use by people as a function of their consumption pattern. Water Resources Management (21:35-48).

Such technology can be used to remove dissolved salts from salty water, thereby improving desalinization efficiency, as well as reducing the associated costs (especially for energy).

D. Institutions and Finance

704. Effective legal and political frameworks are necessary to develop, carry out and/or enforce the agreed rules and regulations that fundamentally control human water uses.

705. Water policy operates within a context of local, domestic, regional and global policy and legal frameworks, all of which must be supportive of sound water management goals.

706. Legitimate, transparent and participatory processes can be effective ways of gathering support for the design and implementation of water resources policy, as well as creating a major deterrent to corruption.

707. Although water is often described as a ‘Gift of God’, harnessing and managing it for the variety of human and ecological needs entails financial costs.

708. The sources of finance are tariffs, taxes and aid/philanthropy.

709. Policy-makers need to make political decisions about the acceptable compromise between different objectives, and who bears the costs of such compromise.

710. Many political or legal decisions made “outside” the water sector, ranging from those regarding human health to others involving inter-regional trade, can have major implications for water resources. In fact, it is nearly impossible to separate water institutions from those involved in the wider governance of a community or a country.

711. There is no one size-fits-all approach to establishing a fair and functioning institutional framework.

1. International (and regional) Water Policy

712. International goals and objectives concerning water resources can be viewed as political benchmarks and potential drivers. The goals and objectives of various water-related major conferences (Table 11) were negotiated by governmental policy makers either at UN meetings, conferences, and summits or in ministerial-level sessions of World Water Fora that have served as a gathering place for various influential decision makers. The outcomes of such activities serve as potential drivers for water management efforts.

Table 11: Water-Related Goals and Objectives of Major Conferences, etc.[27]

International Fora	Agreed Goals and Objectives
UN Conference on the Human Environment, Stockholm, Sweden, 1972	The main issues of the conference were preservation and enhancement of the human environment. As outcome, the Declaration of the UN Conference on the Human Environment quoted; ‘A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences.’

[27] Sources to the table or data are found: www.un.org/esa/sustdev/ or www.worldwatercouncil.org

United Nations Conference on Water, Mar del Plata, Argentina, 1977	The main objective of this firsts global-scale conference on water was to promote a greater sense of awareness, both nationally and internationally, of global problems related to water, and to assess water resources and water use efficiency: • An integrated approach to water resources management; • Leading to declaration of 1980s as Water Supply and Sanitation, with objective of providing drinking water and sanitation for all people by 1990. :
International Drinking Water and Sanitation Decade, 1981-1990	'The goal of the Decade was that, by the end of 1990, all people should possess an adequate water supply and satisfactory means of excrete and sullage disposal. This was indeed an ambitious target as it has been estimated that it would have involved the provision of water and sanitation services to over 650,000 people per day for the entire ten year period. Although major efforts were made by government and international organisations to meet this target, it was not achieved.' (Choguill, C.; Francys, R.; Cotton, A. 1993. Planning for Water and Sanitation.)
Global Consultation on Safe Water and Sanitation for the 1990s, New Delhi, India 1990	The main issues were safe drinking water, environmental sanitation New Delhi Statement was declared. 'Safe water and proper means of waste disposal … must be at the center of integrated water resources management' (Environment and health, New Delhi Statement)
World Summit for Children, New York, USA, 1990	Health and food supply were the main issues of the Summit. 'We will promote the provision of clean water in all communities for all their children, as well as universal access to sanitation.' (18. World Declaration on the Survival, Protection and Development of Children)
The International Decade for Natural Disaster Reduction (1990–2000)	Recognition of the increased general vulnerability of people and property to natural disasters 'to reduce through concerted international action, especially in developing countries, the loss of life, property damage and social and economic disruption caused by natural disasters...' (Resolution 44/236 of the UN General Assembly)
International Conference on Water and Environment (ICWE), Dublin, Ireland, 1992	The most important achievement was development of the Dublin Principles: • Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment; • Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels; • Women play a central part in the provision, management and safeguarding of water; • Water has an economic value in all its competing uses and should be recognised as an economic good.
UN Conference on Environment and Development (UNCED), Rio de Janeiro, Brazil, 1992	Agenda 21, Chapter 18 "Protection of the quality and supply of freshwater resources: Application of integrated approaches to the development, management and use of water resources" dealt with basis for action, objectives and activities concerning: • Integrated water resources development and management; • Water resources assessment; • Protection of water resources, water quality and aquatic ecosystems; • Drinking water supply and sanitation;

	• Water and sustainable urban development; • Water for sustainable food production and rural development; • Impacts of climate change on water resources.
Ministerial Conference on Drinking Water Supply and Environmental Sanitation, Noordwijk, the Netherlands, 1994	Main issues: drinking water supply and sanitation The programme of Action: 'To assign high priority to programmes designed to provide basic sanitation and excreta disposal systems to urban and rural areas.'
UN International Conference on Population and Development, Cairo, Egypt, 1994	The programme of Action: 'To ensure that population, environmental and poverty eradication factors are integrated in sustainable development policies, plans and programmes.' (Chapter III – Interrelationships between population, sustained economic growth and sustainable development)
World Summit for Social Development, Copenhagen, Denmark, 1995	Main issues: poverty, water supply and sanitation The outcome: Copenhagen Declaration on Social Development
UN Fourth World Conference on Women, Beijing, People's Republic of China, 1995	Main issues: gender issues, water supply and sanitation The outcome: Beijing Declaration and Platform for Action
UN Conference on Human Settlements (Habitat II), Istanbul, Turkey, 1996	Main issue: Sustainable human settlements development in an urbanizing world The outcome: The Habitat Agenda
World Food Summit, Rome, Italy, 1996	Main issues: food, health, water and sanitation The Outcome: Rome Declaration on World Food Security
First World Water Forum, Marrakech, Morocco, 1997	Main issues: water and sanitation, management of shared waters, preserving ecosystems, gender equity, efficient use of water 'to recognize the basic human needs to have access to clean water and sanitation, to establish an effective mechanism for management of shared waters, to support and preserve ecosystems, to encourage the efficient use of water.' (Marrakech Declaration)

International Conference on Water and Sustainable Development, Paris, France, 1998	The outcome: Paris Declaration on Water and Sustainable Development 'to improve co-ordination between UN Agencies and Programmes and other international organizations, to ensure periodic consideration within the UN system … [To] emphasize the need for continuous political commitment and broad-based public support to ensure the achievement of sustainable development, management and protection, and equitable use of freshwater resources, and the importance of civil society to support this commitment.' (Paris Declaration)
Millennium Declaration, New York, USA, 2000	Millennium Development Goals include the following water-related goals: "To halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and the proportion of people who suffer from hunger and, by the same date, to halve the proportion of people who are unable to reach or to afford safe drinking water." "To stop the unsustainable exploitation of water resources by developing water management strategies at the regional, national and local levels, which promote both equitable access and adequate supplies."
Second World Water Forum, The Hague, The Netherlands, 2000	The Ministerial Declaration identified the following main challenges: • Meeting Basic Needs – access to safe and sufficient water and sanitation; • Securing the Food Supply, particularly of the poor and vulnerable; • Protecting Ecosystems – ensure the integrity of ecosystems through sustainable water resources management; • Sharing Water Resources, by peaceful cooperation between water users at all levels; • Managing Risks from floods, droughts, pollution and other water hazards; • Valuing Water – to manage water so that it reflects its economic, social, environmental and cultural values; • Governing Water Wisely, including involving the public and the interests of all stakeholders.
International Conference on Freshwater, Bonn, Germany, 2001	Water – key to sustainable development Main issues: governance, mobilizing financial resources, capacity-building, sharing knowledge The outcome: Ministerial Declaration Recommendations for action 'Combating poverty is the main challenge for achieving equitable and sustainable development, and water plays a vital role in relation to human health, livelihood, economic growth as well as sustaining ecosystems.' (Ministerial Declaration) 'The conference recommends priority actions under the following three headings: • Governance • Mobilising financial resources • Capacity building and sharing knowledge' (Bonn Recommendations for Action)

World Summit on Sustainable Development (WSSD), Johannesburg, South Africa, 2002	The Summit dealt with the following freshwater-related issues: • Decentralisation of Governance; • Community Empowerment; • Service Provision: Rural and Urban Challenges; • Information management; • Integrated Water Resources Management; • Education and awareness; • Financial and Economic Mechanisms. Regional challenges were particularly recognised and identified at the Summit.
Third World Water Forum, Kyoto, Japan, 2003	Forum outcomes included: • A Water and Climate Dialogue, including agreed action points; • A Water and Poverty Dialogue, including agreed action points; • A final report on Financing Water Infrastructure; • Outcomes from the Dialogue on Food, Water and Environment; • A detailed document on Water Actions.
G8 Evian Summit, France, 2003	One of the outcomes of the Summit was a G8 Action Plan on Water: • Promoting Good Governance • Utilising all financial resources • Building infrastructure by empowering local authorities and communities • Strengthening monitoring, assessment and research • Reinforcing engagement of international organisations
Water for Life Decade, 2005 – 2015	Launched by the United Nations System, the Decade aims to promote efforts to fulfil international commitments made on water and water-related issues by 2015, with special emphasis on the involvement and participation of women in these efforts.

Fourth World Water Forum, Mexico City, Mexico, 2006	The Ministers at the Forum reaffirmed commitments made at the UNCED, WSSD, and Commission on Sustainable Development during 2005, emphasizing the following items: • Expedite implementation in water, sanitation and human settlements; • The importance of enhancing the sustainability of ecosystems; • The importance of innovative practices such as rain water management and development of hydropower projects in some regions; • The involvement of relevant stakeholders, particularly women and youth in planning and management. They also expressed support to relevant UN water-related activities, including the coordinating role of UN-Water.
Fifth World Water Forum, Istanbul, Turkey, 2009	Bridging Divides for Water

713. As an example, the EU Water Framework Directive, negotiated by the member states of the European Union, requires intra-national, multi-level institutional structures, including legal systems that ensure the implementation of the Directive, not only for national river basins, but also for transboundary river basins and groundwater (Box 7).

Box 7: The European Union Water Framework Directive

The European Union Water Framework Directive (EUWFD, 2000/60/EC) for water protection and management provides for the identification of European waters and their characteristics, on the basis of individual river basin districts, and the adoption of management plans and programmes of measures appropriate for each body of water. It entered into force 22 December 2000.The EUWFD deals with management of inland surface waters, groundwater, transitional waters and coastal waters, in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems and mitigate the effects of floods and droughts. Within four years after the date of entry into force of this Directive, member states must complete an analysis of the characteristics of each river basin district, a review of the impacts of human activities on their water resources, and an economic analysis of water use, as well as compilation of a register of areas requiring special protection. Within nine years after the date of entry into force of the EUWFD, a management plan and programme of measures must be produced for each river basin district, including consideration of the results of the analyses and studies carried out. In a 2007 report (COM(2007) 128), the European Commission mentioned the considerable risk that several EU member states will fail to meet the targets set in the EUWFD for several reasons, particularly because of the extent of the physical deterioration of aquatic ecosystems as a result of overexploitation of water resources, and the disturbing levels of pollution from diffuse sources in European water systems. The Commission also cited problems in meeting the deadlines for incorporating the Framework Directive into national law, with shortcomings in the actual transposition process in some cases. However, establishment of river basin districts, and designation of competent national authorities, seems to be well under way (although progress is still not satisfactory in regard to international cooperation in some cases). The Commission also noted considerable differences in the quality of the environmental and economic assessments of some river basins, as well as shortcomings in their economic analyses. The Commission finished with a number of recommendations for its member states, related to addressing the reported shortcomings, integrating sustainable management of water resources into national policies, maximizing public participation, and giving advance notice its plans in regard to future European water management policy.

714. The bottom-up approach to water resources management was recognized in the Dublin and Rio de Janeiro processes. It is not clear that the 'village level' is necessarily the best place for all water related decisions to be made. Watersheds can contain many people and settlements, sometimes located many hundreds of kilometres from each other, sometimes even in different countries. Effective action involving such a complex group of interests requires conscious and open communication and coordination. Such coordination is facilitated by a legislative and regulatory framework. This was recognised by the Government of Australia in adopting the Commonwealth Water Act in 2007 and subsequent regulations.[28]

715. Legal approaches to holistic water resources management must be multi-layered. Examples of laws covering water rights and water management are given in Table 12, and for the provision of water services in Table 13.

Table 12: Laws Covering Water rights and Water Management

Legislative Requirement	**Options for Provision**		
	IWRM / River Basin Planning	**Water Rights & Abstraction Licensing**	**Water Quality & Water Pollution**
High Level Principles / Purposes / Duties	Primary Law; Ownership / trusteeship of resource; Equity, water Efficiency, Integration Priority uses in law or policy (eg basin plans)	Ownership / trusteeship of resource if not in WRM law; High level duties on water users eg sustainable / beneficial use Priority uses in law or policy (eg basin plans)	High level duties on water users eg sustainable / beneficial use, no waste / efficiency
Catchment Planning	Catchment based; Align with administrative boundaries; Coordination with other strategic planning processes eg land use, biodiversity	Licence in accordance with catchment plans if such exist	Licence in accordance with catchment plans if such exist
Define water	Surface and ground	Control all waters:	Control all waters:

[28] Water Act 2007 An Act to make provision for the management of the water resources of the Murray-Darling Basin, and to make provision for other matters of national interest in relation to water and water information, and for related purposes Act - C2007A00137 Department of energy and Water, Australia 2007

environment	waters; Coastal waters; Wetlands	Surface and ground waters; Coastal waters; Wetlands	Surface and ground waters; Coastal waters; Wetlands
Regulatory structure	Water authority: Government department, Agency, Stakeholder-led	Water authority: Government department, Agency, Stakeholder-led	Water authority or Environmental authority; Coordination mechanisms
Participation	Stakeholder engagement for planning in primary law	Stakeholder engagement through WRM framework	Stakeholder engagement through WRM framework
Licensing	Status of Plan: Regulatory (direct licensing) Indirect (sets targets); Managerial (sets targets, incentives)	Integrated water use licences for abstraction and discharge?	Integrated water use licences for abstraction and discharge? (Dependent on regulatory structure)
Tiered system (Proportionate)		Tiered system eg general rules and full licences Exemptions: eg Domestic use; Subsistence use; Volume limits	Tiered system eg general rules and full licences Emission / Quality / Ecological standards – progressive approach. Management of diffuse pollution.
Licence conditions		Duration, review periods and tests for grant / review / reallocation	Duration, review periods and tests for grant / review / reallocation
Water Trading		Water trading: Prohibit / Permit / Encourage	

Table 13: Laws covering provision of water services

Legislative Requirement	**Options for Provision**
Regulators Economic / duties of supply / quality standards Environmental	 Ministry / Sector agency (e.g. WIC, OFWAT) / Multi-utility (e.g. Competition Authority) Ministry / Environment agency Separate consumer body?
Providers	Local government Water board / agency Private company/s
Vertical dis / integration Horizontal dis / aggregation	Abstraction – treatment – distribution – supply Regional; ("competition by comparison"?)
Private sector involvement	Forbidden? Public sector preference? Short term contracts; BOT etc; Leases / Concessions; Divestiture; (rel. with

	integration)
Constitutional / Human Right	High level; additional enforcement mechanisms
High level duties (on regulators, providers, users)	Universal Service Obligation; Conservation, efficient use; (water efficiency) Sustainable & secure supply; Consumer protection; Competition; Economic efficiency; return on capital
Duties of supply	Universal (progressive?) In service areas Reasonable cost Drinking water, WWT, customer service standards
Tariffs, Metering and Disconnections	Banded; Two-Part; "Free Basic Service" Participation in tariff-setting; Presumption of metering; Powers to disconnect / limit supply for non-payment
Emergency Powers	Climate / drought; Pollution incident; Infrastructure failure; Ministers, Water Providers, Regulators
Storm water	Incorporate storm water management into water services provision (and potentially into abstraction licensing and pricing)
Conservation & Demand management	High level duties on conservation and efficient use; Highest appropriate standards for built environment, grey water reuse.

E. Key policy and regulatory issues

716. Managing competing water uses requires clear, widely-accepted rules to allocate water resources, especially under water scarcity conditions. Water allocation systems should work to balance equity and economic efficiency, with tradable water rights favouring the latter over the former and, therefore, being regulated to varying degrees. There are, however, tendencies to ignore environmental concerns from both perspectives. In Chile, for example, the environment is not granted any water licenses. A contrasting example is South Africa, where decisions-makers are debating how to put water law on environmental protection into practice. Regulated and un-regulated water trading is predicated on predictable, functioning water allocation systems, and de-coupling water rights from land rights. Lawmakers must address equity and other public policy implications, including water reallocations in times of drought or other emergencies. Further, a water permitting system should be sufficiently flexible to adapt to global changes and climate variability (e.g., granting permits for a defined time period and/or giving review powers to regulators.

717. Corruption with water needs to be seriously and systematically addressed. The Global Corruption Report (GCR, 2008) states that corruption in the water sector can raise the investment costs of achieving the MDGs on water and sanitation by almost US$50 billion.

F. Financing Water

718. Virtually all water-related activities or projects, whether structural (i.e., infrastructure) or non-structural (i.e., planning, data collection, regulation, public education, etc) cost money to develop, implement and carry out.. Even if all necessary policies, laws and institutions already exist, lack of adequate funding will ensure necessary actions/projects are inadequately (or not at all) carried out.

719. Although water is often described as a 'Gift of God', harnessing and managing water for the variety of human and ecological needs entails financial costs. These costs often are widely ignored, under-estimated or under-funded, with the result that important functions and assets are neglected and under-provided, while existing assets and services deteriorate.

720. There are three types of functions involved in water management, each with associated costs:

- Water resource management and development, including watershed and river-basin development, storage, flood-risk management, environmental protection and pollution abatement;
- Water services to municipalities and households, commerce and industry, agriculture, and other economic sectors, including costs of lacking infrastructure, wastewater treatment, rehabilitation costs, operations and maintenance;
- 'Integrative functions' such as water sector policy development, research, monitoring, administration, legislation (including compliance and enforcement), and public information.

721. The abovementioned costs fall into broad categories of capital investment costs and annual recurrent costs, while the latter can be further divided into variable and fixed overhead costs.

722. An ongoing problem is how to reflect the full suite of ecosystem services provided by freshwater ecosystems into more effective financing frameworks.

723. In the United States bringing water supply and sewerage infrastructure up to current standards will cost more than $1 trillion over the next 20 years, with hundreds of billions more required for dams, dikes and waterway maintenance (ASCE 2008). The World Business Council for Sustainable Development estimates that the total costs of replacing ageing water supply and sanitation infrastructure in industrial countries may be as high as $200 billion a year (WBCSD 2005).

G. Climate Change and Possible Futures

724. The main impacts of climate change on humans and the environment are delivered through water.

725. Anthropogenic climate change is a fundamental driver of changes in water resources and an additional stressor over and above other external driving forces.

726. Policies and practice aimed at adaptation to, or mitigating of, climate change can have direct and indirect implications on water resources.

727. Managing water has always been about managing naturally-occurring variability. Climate change threatens to make this variability greater, and to shift and intensify the extremes. Climate change introduces greater uncertainty into the picture. The decisions and policies put in place today regarding mitigation and adaptation can have profound consequences on the water resource (supply and demands) both today and over the long term.[29]

728. Almost 80% of diseases in developing countries are associated with water, causing about 1.7 million deaths every year. Whereas naturally occurring extremes such as floods and droughts can result in death or induce migration, more subtle variations in climate also can have significant impacts on

[29] IPCC, 2008, Technical Paper on Climate Change and Water http://www.ipcc.ch/meetings/session28/doc13.pdf

human populations by affecting access to safe drinking water and sanitation, further increasing the potential for water-borne diseases.

729. The recent Intergovernmental Panel on Climate Change (IPCC) report[30] states that coastal areas are particularly at-risk, where millions of people in densely-populated low-lying areas are at increasing risk of exposure to flooding by storm surges over the 21st century. The IPCC expects sea level rise to exacerbate inundation, storm surges, erosion and other coastal hazards. Global warming can expand the endemic zones of several water related infectious diseases like dengue, malaria or bilharzias.

730. The frequency of climate-related disasters is already rising, and anthropogenic climate change is expected to result in a further increase in the frequency and intensity of extreme events. Direct impacts associated with weather extremes, such as floods and droughts, affect the poor disproportionately, while indirect impacts can affect decision making processes, limiting their opportunities to otherwise maximize their incomes in order to hedge risks.

H. Economic growth

731. There is clear evidence supporting a relationship between climate variability and economic performance in countries heavily dependent upon agriculture for their GDP (Figure 62). Indeed, across many parts of the developing world, losses associated with disasters are of a sufficient scale to undermine development and poverty reduction goals. And yet, while infrastructure designs, agriculture investments and water management plans currently incorporate some awareness of climate variability, climate risks are seldom properly considered.

Figure 1. Relationship of rainfall variability and GDP growth in Tanzania (World Bank, 2006a) and Ethiopia (World Bank, 2006b).

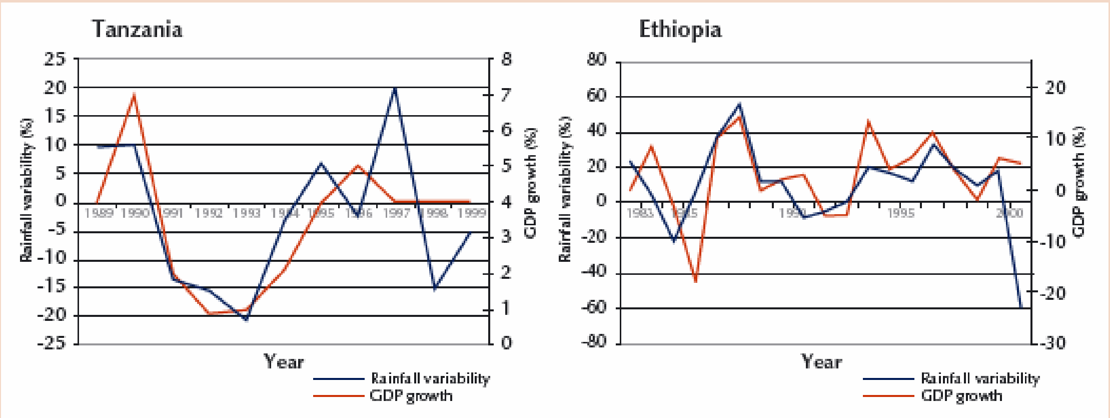


Figure 62: Relationship of rainfall variability and GDP growth in Tanzania (World Bank, 2006a) and Ethiopia (World Bank, 2006b).

732. A substantial amount of financial and other development resources is each year being diverted to post-disaster relief, emergency assistance, reconstruction and rehabilitation. Investors want to be able to rely on infrastructure, on the availability of human resources and on stable markets.

[30] Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe, 2007: Coastal systems and low-lying areas. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 315-356.

733. Estimates indicate that some 40% of development investments are currently at risk.[31] The Organization for Economic Cooperation and Development (OECD)[32] indicated that while many development efforts contribute to reducing vulnerability to climate variability and change, that climate risks are seldom explicitly factored into development projects and programmes. Clearly, similar issues also affect sector and national development strategies.

734. The costs of climate change (Box 8) will likely affect different countries in different ways, but would potentially lead to an overall drop in official development assistance (ODA), exacerbating the vulnerability of poor people and countries to adapt and develop their water resources.

Box 8: The cost of adapting to climate change

Estimates of the costs of climate change impacts vary because they depend somewhat on future greenhouse gas emissions, mitigation measures, and assumptions regarding the manner in which anthropogenic climate change will manifest itself, and also on how effective countries are adapting to it. Nevertheless, estimates of the costs of adaptation for developing countries have been made, as follows:

- World Bank[33] estimates of the additional costs to adapt or climate-proof new investments financed range from US$ 9 to 41 billion each year. A recent update by UNDP[34] put the mid-range of the costs of adaptation at about US$ 37 billion/year in 2015;

- UNFCCC[35] estimated that additional investments needed for adaptation to climate change as US$ 28-67 billion, and could be as high as US$ 100 billion per year several decades from now; estimates on the additional investment needed in water supply infrastructure in 2030 is estimated at USD 11 billion, 85 per cent of which will be needed in developing countries.

- Oxfam[36] estimated that the current costs of adaptation to climate change for all developing countries to be greater than US$ 50 billion per annum.

While there is considerable debate as to the reliability of these estimates, they provide a useful order of-magnitude against which current available resources for adaptation can be considered. In fact, current GEF funds (~US$ 160 million) are several orders of magnitude too low to meet these projected needs.

1. *Technological innovation*

735. Climate change is a major driver of technological innovation and transfer—both in terms of adaptation and mitigation strategies.[37] The relationship between climate change mitigation measures and

[31] OECD (Organization for Economic Cooperation and Development) (2005) Bridge over Troubled Waters. Linking Climate Change and Development. OECD, Paris.

[32] Ibid.

[33] World Bank 2006. Clean Energy and Development: Towards an Investment Framework. DC2006-0002, World Bank, Washington, DC, USA, x+146 pp.

[34] UNDP (2007): Human Development Report 2007/2008: Fighting climate change. Human solidarity in a divided world. http://hdr.undp.org/en/reports/global/hdr2007-2008/

[35] UNFCCC (2007): Investment and financial flows to address climate change. Background paper. http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/background_paper.pdf

[36] Oxfam (2007): Adapting to climate change - What's needed in poor countries, and who should pay. Oxfam briefing paper 104. http://www.oxfam.org.uk/resources/policy/climate_change/downloads/bp104_adapting_to_climate_change.pdf

[37] IPCC, 2008, Technical Paper on Climate Change and Water http://www.ipcc.ch/meetings/session28/doc13.pdf

water is a reciprocal one. Mitigation measures can influence the quantity and condition of water resources and their management. It is important to recognize this reality when developing and evaluating mitigation options. On the other hand, water management policies and measures can have an influence on greenhouse-gas (GHG) emissions and, thus, on the respective sectoral mitigation measures; interventions in the water system might be counterproductive when evaluated in terms of climate change mitigation.

736. Significant increases in the development of hydro-electric installations could be anticipated as the global community unites in fight to combat climate change. However, there is also published evidence that hydroelectricity can actually generate significant amounts of GHGs[38], as a consequence of the release of gases from the bottom waters of reservoirs, therefore making hydroelectricity not such a 'clean' alternative to fossil fuels.

737. The World Energy Outlook 2006[39] projects an average rate of growth of biofuels production of 7% per annum. By 2030, biofuels are expected to meet 4% of road-transport fuel demand on a worldwide basis, up from 1% today.

738. For developing countries, technology development and transfer will be key to adapting and mitigating climate change.

2. Institutions and financing

739. Historically, most of the discussions and subsequent efforts, including those initiated under the Kyoto Protocol on the reduction of GHG emissions, have focused on mitigation strategies. This approach will continue to have serious implications for energy policy (a major water use sector), as well as other key sectors such as international trade and transportation. For truly effective adaptation and mitigation measures to take effect, however, it will become increasingly necessary to shift the climate change portfolio into the authority of the ministries of finance and planning, especially with the emergence of regional carbon trading markets and an eventual carbon-constrained economy.

740. In terms of adaptation to climate change, which for developing countries is broadly about development, effective funding mechanisms for developing countries are woefully lacking. This is especially true for Africa, where the impacts of climate change will range from energy shortages, reduced agricultural production, worsening food security and growing malnutrition, to spreading disease, more humanitarian emergencies, growing migratory pressures and increased risks of conflict over scarce land and water resources.

3. Challenges

741. It is clear that climate change interacts with all the other drivers that individually and collectively impact water resources. One of the most pressing challenges in regard to climate change rests in how to address the vulnerability of human populations, particularly the poor, to the impacts of extreme hydrological events, in the form of floods, storm surges, droughts, and other weather extremes. Over the longer term, the effects of incremental climate change are likely to influence the decisions we make about food security, energy security and land use, all of which will have vital implications for water resources and their management. For water managers, however, anthropogenic climate change does pose a new set of challenges because they can no longer plan, design and operate hydrological systems based on historical statistics. For example, the concepts of a "20 year" or a "100 year" flood are no longer applicable.

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[38] Jim Giles, 2006, *Methane quashes green credentials of hydropower*, Nature 444, 524-525.
[39] International Energy Agency, 2006, World Energy Outlook. 2006

742. Although water is an important component in most energy-generating processes, the overall role of water in climate change mitigation policy is quite minimal. Where water and climate change are most strongly linked is through adaptation policy. Water adaptation takes place in highly dynamic hydrological, social, economic and demographic contexts. Water adaptation is key, but measures outside the water sector, that is mitigation measures, are paramount to make adaptation more effective and less costly. Hence, both adaptation and mitigation are critical, but it can be argued that adaptation should be given priority over mitigation in developing countries and particularly so in fragile states.

743. But because the poor are the most vulnerable and the least able to cope, it is particularly important to strengthen the link between adaptation to climate change and economic development.

744. The relationships between the different drivers and different uses of water are complex (Table 14).

Table 14: Drivers create pressures on different water uses

Water use/ sector	Drivers					
	Demographic Growth	**Economic Growth**	**Social Change**	**Technological Innovation**	**Governance**	**Climate Change**
Food	Increasing demand and competition for basic crops and arable land	Increasing demand for meat, fish and high value crops New markets for the poor (e.g. peri-urban crops)	Food choice awareness can lower demand Consumptive lifestyles can increase demand	Increasing production efficiency Increasing competition for water and land (e.g., export crops, biofuels)	Agriculture and trade policy (subsidies, import/export quotas, etc.) dictate yield requirements	Changing sources/quantities of production (regions) Increased water demand in drier regions for same unit of production
Energy	Increasing demand, pressure to develop more sources	Increasing demand, pressure to develop more sources, sometimes 'dirty' resources(e.g., tar sands)	Awareness can lower demand Consumptive lifestyles can increase demand	Increasing efficiency (production and supply) Potential development of new or 'dirty' sources	Energy policy (and price speculations) will dictate supply sources (hydro and renewables, fossil, nuclear)	Different production patterns with different water demands (quantity and quality implications)
Health	Urbanization and potential for increased disease transmission	Increasing access to medical services, safe water and sanitation	Education increases good health possibilities	Increasing quality of healthcare Unexpected negative impacts (e.g., pesticides)	Healthcare and education policy (universal coverage, subsidies, etc.),	Shifting limits and timing of vector-borne diseases Increasing vulnerability of the poor (floods, droughts disease outbreaks)

Industry	Increased demands for basic goods and services	Positive feedback loop Increasing resources needs and environmental degradation	Change in demand for consumer products	Can increase or decrease environmental impacts (both in some cases)	Can promote or impose standards	Increases uncertainty and risk Can prompt energy and water efficiency
Environment	Increases competition for land and resources	Usually requires increasing quantities of natural resources and increases pollution	Awareness can lower impact Consumptive lifestyles can increase impact	Can increase or decrease impacts (both for some issues)	Can impose protection measures	Threatens ecological balances Shifting habitats
Poverty Focus	Growth of informal human settlements	Can aid in poverty reduction, provided services and opportunities are available Increased need for natural resources to fuel economic growth	Increasing expectations for poor communities	Low cost technologies are increasingly accessible	Can impose equity rules on allocation and pricing policies May hinder efficient provision of needed services	Will affect the poor the most Impacts will affect developing countries (with limited resources) more than developed countries

H. Water's many benefits

745. Water is an element of nation-building and has always played a key role in economic development. Economic development has always been accompanied by water development.

746. Records show that poverty reduction is closely linked to enhanced access to water (DFID, 2005; World Bank, 2008b for agriculture).

747. A critical aspect of the water issue and solutions is to look at water storage and ways to achieve this (

Box 9: Storage for development

Experience has shown that smaller decentralized and participatory water harvesting systems have proved effective in increasing water availability and consequently agricultural production at household and community levels. It is important to diversify storage capacities to reduce vulnerability to catastrophic events.

Projects should strive to balance the desired objectives – economic growth as well as reduced vulnerability – with the likely associated environmental and social costs. Each storage project must be evaluated individually to evaluate the tradeoffs involved. The World Commission on Dams has provided a basic framework for such an assessment (WCD, 2000).

Source: 'Water Storage in a Changing World: Options and Alternatives', Report of the WWAP Expert Group on Storage, March 31, 2008.

1. Benefits of water investments

748. The cost of a series of major typhoons and resulting flood damage in post-war Japan has been estimated at between 5% and 10% of GNP. Rising investment in soil conservation and flood control in response to legislation in the early 1960s saw the impact of flood damage reduced to significantly below 1% (Japan Water Forum 2005).

749. Examples of the economic cost of lack of investment in water are even more prevalent. In Kenya, the combined impact of the winter floods of 1997/98 and drought between 1998 and 2008 has been estimated at US$4.8 billion – effectively a 16% reduction in GDP (Gichere et al. 2006). Evidence suggests that in Kenya, floods and drought translate into a direct annual fiscal liability of 2.4% GDP per annum. The Mozambique floods of 2000 caused a 23% reduction in GDP and a 44% rise in inflation. Inability to tackle hydrological variability in Ethiopia has been estimated to cause a 38% decline in GDP and a projected 25% increase in poverty for the period 2003–2015. This was due to the persisting detrimental economic impact of a single climate event: a one-year drought resonating throughout the following ten to twelve years of economic performance (World Bank 2008). More than 7,000 major disasters have been recorded since 1970, causing at least $2 trillion damage and killing at least 2.5 million people (DESA, 2008). Figure 58 shows the economic costs of flooding expressed in percentage of global GDP. These cases underline the purpose of improving water management: to enable current economies to eliminate the damaging variability out of their systems, as far as possible. This agenda is not aimed only at overcoming extreme events (albeit possibly worsening in frequency and/or magnitude due to the direct and indirect effects of climate change), it aims to overcome the ordinary variability in hydrology that cripples economies year-on-year.

750. A multiple-use approach to meeting the water needs of poor communities can bring multiple benefits.

2. *Water and health*

751. Access to sufficient water and sanitation has proved to be one of the most efficient ways of improving human health. Some major diseases attributable to environmental factors are listed in

Table 15: Major diseases attributable to environmental factors (sources: adapted from Prüss-Üstün and Corvalán, 2006; Prüss-Üstün et al, 2008).

Disease	**Annual global burden attributable to water, sanitation, hygiene**		**% of total burden attributable to environmental factors**	**Environmental pathways**
	Deaths (thousands)	DALY[40] (thousands)		
1. Diarrhoea	1,523	52,460	94	Water supply, sanitation, hygiene
2. Malnutrition	863	35,579	50	Water supply, sanitation, hygiene, water resources management
3. Malaria	526	19,241	42	Water resource management
4. Lymphatic filariasis	0	3784	66	Water supply, sanitation
5. Intestinal nematode infections	12	2948	100	Sanitation
6. Trachoma	0	2320	100	Water supply, hygiene, flies
7. Schistosomiasis	15	1698	100	Water supply, sanitation, water resource management
8. Japanese encephalitis	13	671	95	Water resource management
9. Dengue	18	586	95	Water supply, sanitation

752. The transmission of malaria varies widely over space and time. In some places, where mosquito vectors have specific ecological breeding requirements, transmission of malaria can be interrupted by reducing vector habitats –mainly by eliminating stagnant water bodies, modifying the contours of reservoirs, introducing drainage, or improving the management of irrigation schemes.

753. Owing to the variations in vector habitats, the fraction of malaria that could be eliminated through managing the environment varies across regions, with a global average of 42% (Table 15). Malaria control programmes that emphasize environmental management are therefore highly effective in reducing malaria morbidity and mortality (Keiser et al, 2005). Developing new tools and approaches for malaria prevention and control, including vector control innovations is essential, but receive little attention at the moment from the international malaria research and control community in comparison to medical solutions such as drugs and vaccines.

[40] The DALY (Disability Adjusted Life Year) is a summary measure of population health. One DALY represents a lost year of healthy life.

3. Maintaining ecosystem services

754. Increasing pressures on water resources affects ecosystems, and threaten the ecosystem goods and services on which life and livelihoods depend. The way water is managed impacts on the protection of the ecosystems.

The Nakivubo swamp, for example, provides wastewater treatment services to the citizens of Kampala in Uganda worth US$363 million (Worldwatch Institute, 2008). In Uganda alone, the use of inland water resources is worth almost US$300 million a year in terms of forest catchment protection, erosion control and water purification services. Here, almost 1 million urban dwellers rely on natural wetlands for wastewater retention and purification services (UNEP, 2007). Work carried out in the Zambezi Basin in Southern Africa shows that natural wetlands have a net present value of more than US$64 million. That is US$16 million in terms of groundwater recharge, US$45 million in terms of water purification and treatment services, and US$3 million in reducing flood-related damage costs (Turpie et al, 1999). Rice fields – human-made wetlands in the Ramsar Convention typology – offer a large range of ecosystem services that can be enhanced or decreased depending on the management decisions taken regarding water supply and its productive functions (Figure 63Figure 6.4.1). Benefits gained from ecosystem services are dependant on the health of these systems.

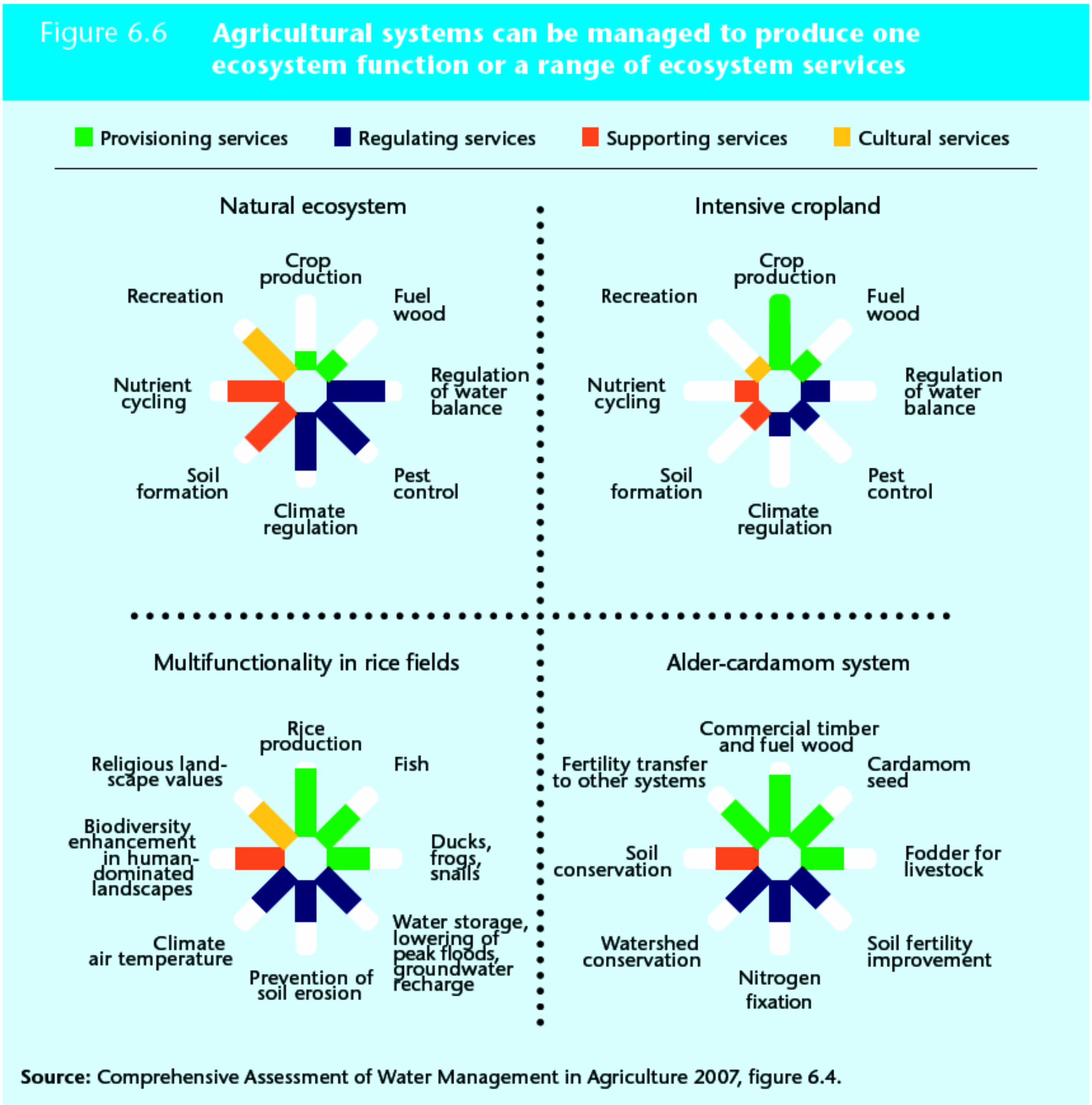


Figure 63: Types of ecosystem services of different systems (CA, 2007)

755. In the developing world, 10% of the undernourished depend on direct access to natural resources, in particular, freshwater ecosystems (CA, 2007). They are immediately vulnerable to the degradation of these ecosystems, or to any changes in the water cycle that affect their functioning. This is the case for pastoralists moving with their herds from one water source and pasture area to another, for capture fishers vulnerable to water pollution and river water depletion, but also forest-dependent people vulnerable if denied access to forest, to clearing of land for agriculture, or deforestation linked to construction of large infrastructures such as dams. Those people are often as voiceless as the ecosystems and marginalised in the water allocation debate.

756. Because of the inter-connectivity of freshwater ecosystems and their services, developing one service (e.g. food production through increased irrigation) automatically has impacts on other services.

The management objective, therefore, is to balance the delivery of all these services collectively so that ecosystems are used optimally and development becomes sustainable. Nature has to be recognized as a water stakeholder because it performs important services to society. Understanding its functioning and value is essential. However, ways of valuing ecosystem services remain highly controversial. The definition of an environmental water requirement (e.g. environmental flows) – even if imperfect – provides a voice for nature regarding allocation decisions for water withdrawal at the basin level. It is critical that allocations to the 'environment' or 'nature' are not considered 'wasted water', as most can be considered in terms of benefits to people. These in situ uses put a constraint on other uses, particularly in the driest periods. Concerns for environmental services often happen too late, when water use has gone beyond the capacity of the environment to cope, and when competition is critical. This is the result of failures in trade-off making at the planning stage. In particular, too often our decision processes do not promote informed, impartial and balanced outcomes and would not do so even if better valuations were on-hand. Water still continues to be allocated on a first-come first-served sector basis.

757. Figure 64 pinpoints some of those areas where respecting environmental requirements has become most urgent because we are reaching limits which threaten to undermine our life and development support base – particularly for those most vulnerable and dependant on the environment for their livelihood.

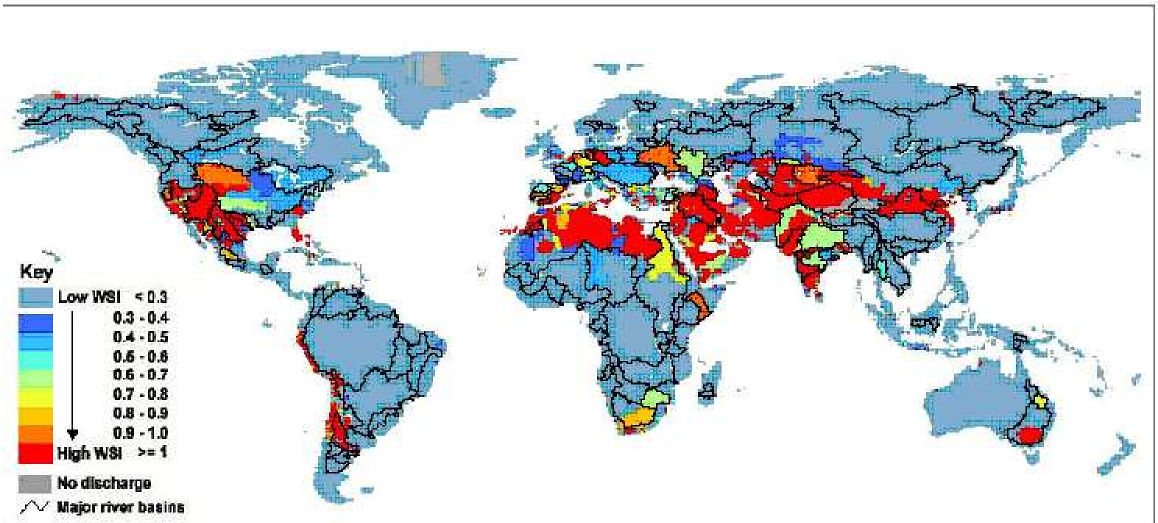


Figure 64: Hot spots of environmental water requirements (Smathkins et al, 2004

758. The magnitude of humans' reliance upon nature and its abundance must be matched by the care we take of the agro-ecosystems upon which we depend. There are pastures in the Alps, oases in Morocco, and irrigation systems in the Philippines that have been used for centuries with no diminution of their productive capacities or beauty. Rice terraces cascading down the Ifugao in the Philippines represent the collective efforts of countless generations of farmers who developed an ingenious irrigation system that allowed them to share water and develop rice varieties that survive at over 1000 m. In the combination rice-fish systems of the Zhejiang province in China, which date from the Han Dynasty 2000 years ago, fish not only provide food, they also eat larvae and weeds in the flooded fields, reducing the cost, labour and pollution risks needed for fertilizing and insect control (Lu and Li. 2006.)

I. Water use in the world

759. Competition for water exists at all levels, and is forecast to increase with demand in almost all countries; in 2030, 47% of the world population will be living in areas of high water stress. Water management around the world presents major shortcomings in terms of performance, efficiency and equity. Water-use efficiency, pollution mitigation, and implementation of environmental measures are low in most sectors. Access to basic water services – for drinking, sanitation and food production – remains insufficient in a large part of the developing world, and more than 5 billion people – 67% of the world population – may still be without improved access to sanitation in 2030.

760. Population growth and fast economic development have translated into accelerated freshwater withdrawals. Our somewhat patchy knowledge of water usage shows high variability of patterns of use globally, both within sectors and among users. Growing uncertainty regarding water resources – linked to climate change – is expected to place additional burdens on current water scarcity trends.

761. Despite the importance of water use – we know very little about it (Box 10).

<u>Box 10: How much do we know about water uses?</u>

Our knowledge of current water usage is as poor as, if not worse than, our knowledge of water resources. Information is largely incomplete – particularly for agriculture, the largest user – and is lacking altogether for certain countries. Only limited disaggregated information exists, and even this shows deficiencies of validity, homogeneity and extremely poor information regarding trends.

The quality of information systems varies with each country but there are common difficulties:

- Available statistics on the volume of demands and withdrawals are often estimated rather than metered or collected from censuses. The level of uncertainty varies, but is particularly high for the agricultural sector.
- Sectors of use are not defined everywhere in a homogeneous way and are not well disaggregated.
- Historical data sets are rare and the dates of the statistics are not always explicit in the available statistics.
- Lack of agreed terminologies lead to discrepancies in data compilation (see Box 7.1.3).

The table below presents the level of metering of agricultural water use and self-supplied industries in France. The country is divided by 6 river basins. Only half of the water used in agriculture is effectively metered by a volumetric device.

Table: Uncertainty of existing statistics on water uses: example of agriculture and industrial withdrawals in France (from IFEN, 2006 on the basis of Data from the basin agencies of 2001)

	share of withdrawals that is metered				
	used for agriculture/ irrigation		used for self-supplied industries		Total uses
French river basins	from surface water	from groundwater	from surface water	from groundwater	
	%	%	%	%	km3/yr
Basin Adour garonne	72	62	82	66	2.30
Basin Artois picardie	90	100	95	100	0.67
Basin Loire Bretagne	80	95	40	69	3.62
Basin Rhin Meuse	0	0	90	81	5.05
Basin Rhone mediterranee Corsica	30	57	87	86	17.13
Basin Seine Normandie	75	89	37	91	3.06
Total	43	74	73	84	31.81
Total volume by supply source (km3 / year)	3.39	1.38	2.72	1.48	
(red)	no metering				
(orange)	less than 45 % of withrrdawals are metered				
(yellow)	less than 75 % of withdrawals are metered				

762. Total global freshwater use is estimated at about 4000 km3 per year (Margat and Andréassian, 2008). Another 6400 km3 of rainwater is also used 'directly' in agriculture, often called 'green water'. Nature is the most important user of water and evaporates an estimated 70,000 km3/year from forest, natural vegetation – not cultivated – and wetlands (CA, 2007).

763. The consumptive uses of freshwater from agriculture, industry and domestic sectors place the greatest pressures on natural systems, both in quantity (withdrawals) and quality (returns of lower quality) (Figure 65).

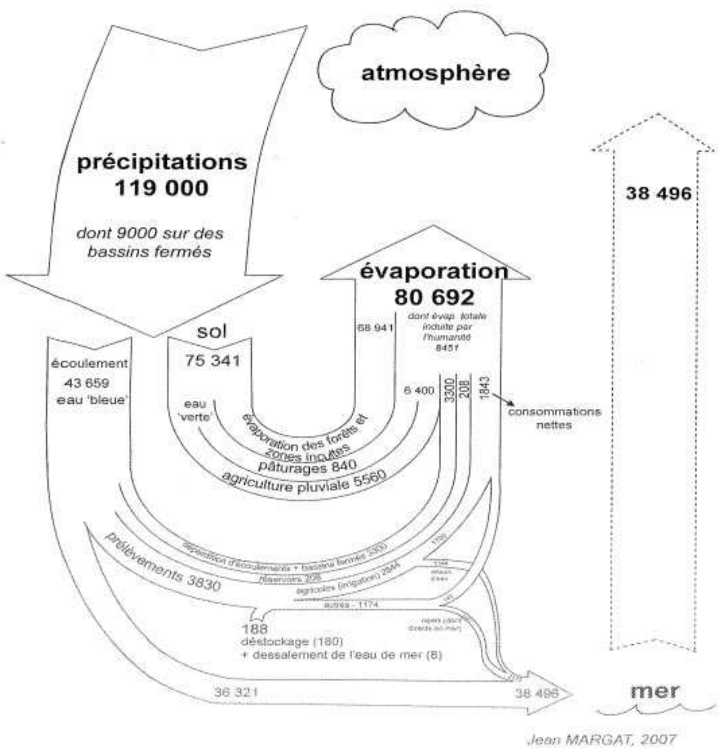
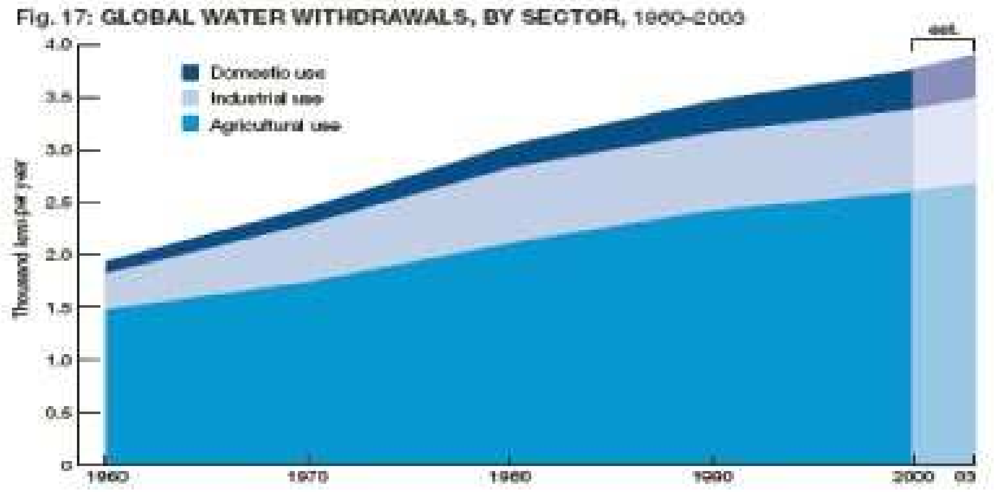


Figure 65: The world water cycle and use (after Margat 2007).

1. Trends in water use

764. The rapidly escalating use of water is illustrated in Figure 66.



<u>Figure 66: Global water withdrawals by sector</u>

765. Water use is uneven across sectors. Irrigated agriculture is by far the main user of water. It represents 70% of water withdrawals (mainly irrigated agriculture), which can rise to more than 90% in some countries (Figure 66 and Figure 7.1.3 and Table 16). Although increasing in urbanised economies, industrial (including energy) and domestic usage represents respectively only 20 and 10% of total water use (CA, 2007).

<u>Table 16: Freshwater resources and withdrawal, 2000 (cubic kilometers per year unless otherwise indicated) – (FAO 2006a, cited in CA, 2007)</u>

		Freshwater withdrawals							
Region	**Renewable freshwater resources**	**Total freshwater withdrawals**	**agriculture**		**Industry**		**Municipalities**		**Withdrawals as share of renewable resources**
	cubic kilometers per year		amount	share (%)	amount	share (%)	amount	share (%)	%
Africa	3936	217	186	86	9	4	22	10	5.5
Asia	11594	2378	1936	81	270	11	172	7	20.5
Latin America	13477	252	178	71	26	10	47	19	1.9
Caribbean	93	13	9	69	1	8	3	23	14.0
North America	6253	525	203	39	252	48	70	13	8.4
Oceania	1703	26	19	73	3	12	5	19	1.5
Europe	6603	418	132	32	223	53	63	15	6.3
World	43659	3829	2663	70	784	20	382	10	8.8

766. The importance of agriculture to an economy and the extent of irrigation clearly create a divide between countries in terms of water use. In the first group of countries (comprising Africa, most of Asia, Oceania, Latin America and the Caribbean), agriculture is by far the main water-use sector, while in the other group (Europe and North America) withdrawals are mostly related to industry and energy – up to 59%. The demand for domestic supply is essential to life (drinking, hygiene and bathing) but remains the smallest for both groups.

767. Groundwater represents already 20% of total use and is increasing fast, particularly in dry areas (CA, 2007).

768. With rapid population growth, freshwater withdrawals have tripled over the last 50 years. This trend is explained largely by the rapid increase in irrigation development stimulated by food demand in the 1970s, and the continued growth of agricultural-based economies (World Bank 2008b typology).

769. What trends can we expect over the next 50 years? There is general agreement that population growth, economic growth, urbanization, technology and changes in consumption patterns are the main factors influencing water use.

770. One of the most significant uncertainties is the effect of climate change on water resources, uses and users, which calls for a complete revisiting of past scenarios (World Water Vision scenarios developed in 2000, Millennium Ecosystem scenarios in 2005, CA water use in agriculture scenarios 2007). At the national level, countries are already revising their long-term plans. With the rapid growth of globalization, examining water issues in the national context alone is no longer sufficient, as local decisions on water use (in agriculture and industry) are increasingly driven by decisions outside the water domain. For example, the 'water footprint'– the total volume of water used and polluted during the production of commodities – of European and North American citizens has been significantly externalised to other parts of the world (Figure 67). Europe is a large importer of cotton – one of the thirstiest crops produced in many water scarce areas. Coffee is imported from countries such as Colombia, soybean from Brazil, and rice from Thailand. Through the global market, European consumption strongly relies on the water resources available outside its boundaries and thereby influences agricultural and industrial strategies elsewhere. 'About 80% of the virtual water flows (water imported embedded in the crops transported) relate to the trade in agricultural products. An estimated 16% of the existing problems of water depletion and pollution in the world relate to production for export. The prices of the traded commodities seldom reflect the costs of water use in the producing countries' (Hoekstra et al, 2007).

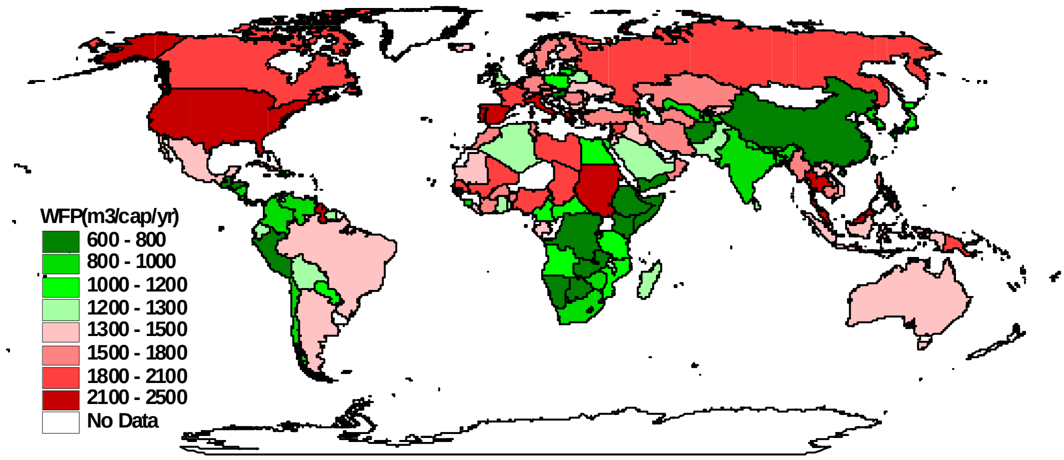


Figure 67: Average national water footprint per capita (m3/capita/yr). Period: 1997–2001 (Hoekstra and Chapagain, 2007 and 2008)

771. The concept of a water footprint is used to show the extent and locations of water use in relation to people's consumption patterns. The water footprint of a community is defined as the volume of water used for the production of the goods and services consumed by the members of the community. The water footprint of a product refers to the sum of water use in the various steps of the production chain. For example, the production of 1 kilogram of beef requires 15,000 litres of water, and one cup of coffee requires 140 litres of water. For individuals or countries, water footprints are estimated by multiplying the volumes of goods consumed (whether produced or manufactured) by their respective water requirement. The United States appears to have an average water footprint of 2480 m3/cap/yr, while China has an average footprint of 700 m3/cap/yr. The global average water footprint is 1240 m3/cap/yr.

2. Domestic water supply and sanitation

772. While rapid progress has recently been made in water supply in all regions, except sub-Saharan Africa, sanitation is still lagging behind. To highlight the problem of sanitation, the UN General Assembly declared 2008 the International Year of Sanitation in response to the recommendations of the Hashimoto Action Plan (2006) prepared by the UN Secretary General's Advisory Board on Water and Sanitation (UNSGAB). The goal is to raise awareness and accelerate progress towards the target set for the Millennium Development Goal (MDG) – to reduce by half the proportion of people without access to basic sanitation by 2015.

773. The Joint Monitoring Programme (JMP) for Water Supply and Sanitation, managed by WHO and UNICEF, is the United Nations mechanism for monitoring progress towards Millennium Development Goal 7, Target 10, which is to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. More details can be found in the latest (2008) JMP report and in UN-Water's first Global Annual Assessment on Sanitation and Drinking Water GLAAS (WHO/UN-Water, 2008). Current trends indicate that while drinking water target is largely on track globally-, not even half the sanitation target will be met by 2015 (WHO/UNICEF, 2008a).

774. In 2006, 54% of the world's population had a piped connection to their dwelling, plot or yard, and 33% used other improved drinking water sources (WHO/UNICEF, 2008a). The remaining 13% (884 million people) still relied on unimproved sources. In terms of progress, Eastern Asia stands out with an increase in coverage of improved drinking water sources – from 68% in 1990 to 88% in 2006.

775. Except for sub-Saharan Africa and Oceania, all regions of the world are on track to meet the MDG drinking water target. However, if current trends continue, 2.4 billion people will still be without access to basic sanitation (WHO/UNICEF, 2008a).

3. Agriculture

776. Steadily increasing demand for agricultural products to satisfy the needs of a growing population continues to be the main driver behind agricultural water use. The world's population growth has slowed since the 1970s and is expected to continue its downwards trend. However, steady economic development, in particular in emerging economies, has translated into a demand for a more varied diet, including meat and dairy products, putting additional pressure on water resources in a context of increasing water scarcity. To meet the future food needs and rural socio-economic aspirations of the world, pressure to develop new supply sources or increase water allocation to agriculture will continue. The challenge highlighted in WWDR1 and WWDR2 remains, with its implication for a necessary emphasis on water for agriculture as recommended by IWMI (CA, 2007) and World Bank (World Bank, 2008b). The recent acceleration in the production of biofuels and the prospect of climate change bring new challenges to agriculture and further pressure on land and water resources.

777. However many irrigation systems do return large amount of water into the system (including surface irrigation, still the most common system in the developing world).

778. Examples of the daily water requirements of foods are provided in Box 11

Box 11: How much water is needed to produce food for one day?

We can estimate how much water is necessary to sustain our diets by calculating the water lost in evapotranspiration on the basis of knowledge of crop physiology. Depending on local climate, varieties and agronomical practices, it takes between 400 and 2000 litres of evapotranspiration daily to produce 1 kg of wheat, and about 1000 to 20,000 litres per kilogram of meat, depending on the type of animal, feed and management practices. Based on those estimates, researchers have estimated values of daily water requirements to support diets, ranging from 2000–5000 litres of water per person per day (Renault and Wallender, 2000). FAO estimates that, on average, 2800 kcal /person need to be produced to ensure a reasonable level of food security. As a rule of thumb, it can therefore be estimated that 1 litre of water is needed to produce 1 kcal of food. Because of the low energy efficiency of the food chain, protein rich diets require substantially more water than vegetarian diets.

779. Most crop production comes from rainfed agriculture, where precipitation is the only source of water for production. Rainfed agriculture covers 80% of the world's cultivated land, and contributes about 60% of crop production. In rainfed agriculture, the soil acts as a reservoir to store the rain and release it slowly to the plants. Rainwater used in agriculture, sometimes called 'green water', is a characteristic of the land on which it falls and is not subject to competition from other sectors.

780. However as stated in the first Asian Pacific summit (2007), there is still major improvement that can be made in the way assets are managed, enhancing their multi-functionality, and integrating social and environmental responsibilities, that will impact on water use efficiency .

781. Irrigation development is ancient but the last 50 years have seen rapid acceleration in water resource development for agriculture (see CA, 2007). Development in hydraulic infrastructure (dams and large-scale public surface irrigation), as well as private and community schemes (particularly groundwater pumping) have put water at the service of populations as been part of the global effort to rapidly increase staple food production, ensure food self-sufficiency, and avoid famines. While the world population grew from 2.5 billion in 1950 to 6.5 billion at the beginning of the 21st Century, food production outstripped population growth (WWDR, 2006), the irrigated area doubled (particularly in Asia), and water withdrawals tripled.

782. The emergence of an increasing number of areas where water has become a limiting factor for irrigated agriculture, associated with increasing claims for releasing water to guarantee or restore environmental services, has made the food production situation tighter in an increasing number of regions. The Middle East, for example, can no longer satisfy its food requirements and needs to rely increasingly on food imports.

783. Around 10% of the total energy supply comes from biomass, out of which some 80% comes from 'traditional' biomass, in other words, wood, dung and crop residues. These represent a significant part of the energy used in many developing countries and, in particular, biofuel for transport. Commercial or 'modern biofuel' represents the remaining 20% of total biomass used for energy. Two-thirds of it is made of fresh vegetable material and organic residues used to produce electricity and heat. The remaining part of biomass, amounting to about 5%, is actually used to produce liquid biofuel for transport, and currently accounts for less than 2% of the total needs of transport energy worldwide.

784. The quest for greater energy autonomy amid concerns over the impacts of greenhouse gas emissions in OECD countries have pushed the significant and recent surge in transport biofuel (Schmidhuber et al, 2007; Fraiture, 2007; FAO/OECD 2007; OECD-FAO, 2008), and explains the concomitant sharp increase in liquid biofuel production, also favoured by high fossil fuel prices. This new situation has led to increased interlinkages between food and energy production and possible impacts on natural resources, including land and water. The production of bioethanol, made from sugarcane, corn, sugar beet, wheat and sorghum, has tripled between 2000 and 2007 and was estimated at 77 billion litres in 2008 (OECD-FAO, 2008) – Brazil (using sugarcane) and the United States (using mostly corn) are the main producers, accounting for 77% of global supply. Biodiesel production, derived from oil- or tree-seeds such as rapeseed, sunflower, soybean, palm oil, coconut or jatropha, increased by a factor of 11

between 2000 and 2007 with 67% produced in the European Union, mostly from rapeseed in Germany, France and Italy.

785. The global potential of conventional biofuel is limited by the availability of suitable land and water for crops, and the relatively high cost of most conventional technologies. Technically, up to 20 EJ from conventional ethanol and biodiesel and 1% of total demand for liquid fuels in the transport sector could be possible by 2050 (OECD, 2007).

786. The potential impact of biofuel production on land and water resources varies substantially according to local agro-climatic conditions and the policies in place. The main factor affecting freshwater use is the share of biofuel production coming from irrigated agriculture.

787. Globally, irrigation water allocated to biofuel production is estimated at 44 km3, or 2% of all irrigation water (Fraiture et al, 2007). Under current production conditions, it takes on average roughly 2500 litres of water (of which about 820 litres is irrigation water) to produce 1 litre of biofuel (incidentally, the same amount is needed on average to produce food for one day for one person). But regional variations can be significant, depending primarily on the relative percentage of irrigation in biofuel crop production. The share of irrigation water used for biofuel production is negligible in Europe and Brazil, but is estimated at 3% of irrigation withdrawals in the United States , and 2% in China (Fraiture et al, 2007). In India, where sugar cane is fully irrigated, water withdrawals for every litre of ethanol produced are nearly 3500 litres. The market for biofuel and agricultural products are strongly entangled. Because of crop substitutability, all crops tend to compete for the same inputs, land, fertilizers and water (where irrigation is necessary), and farmers select crops that offer the best return on their investment (Doornbosch and Steenblik, 2007).

788. In summary, the potential impact of biofuel production on freshwater resources is most severe in places where agricultural production cannot take place without irrigation, while it is practically negligible in places where rainfed production is practiced. In such places it could result in reduced allocation to other crop commodities. This situation explains the current hostility of some of the most arid countries to the global trends towards increased reliance on bio-energy.

Box 12 Impact of biofuel production on water in the US

Because of a strong US national interest in greater energy independence, biofuel has become increasingly important as liquid transportation fuel and is likely to remain so for the foreseeable future. Currently, the main biofuel in the United States is ethanol, derived from corn kernels. Recent increases in oil prices in conjunction with subsidy policies have led to a dramatic expansion in corn ethanol production with prospects for further expansion over the next decade. Among concerns about large-scale biofuel development are its effects on water and related land resources. A report by the US National Research Council (NRC, 2007) indicates that in the next 5 to 10 years, increased agricultural production for biofuel is not expected to substantially alter the national-aggregate patterns of water use. However, there are likely to be significant regional and local impacts in places where water resources are already stressed. In terms of water quality, the conversion of other crops to corn is likely to increase nitrogen pollution in major water courses.

789. If all current national policies and plans on biofuels were successfully implemented, 30 million additional hectares of cropland would be needed along with 180 km3 of additional irrigation water withdrawals. Although globally this is less than a few percentage points of the total area and water use, the impacts for some individual countries could be highly significant, including China and India. There could also be significant implications for water resources with possible feedback into global grain markets. The extent to which China and India, the largest producers and consumers of many agricultural

commodities, will be able to pursue biofuel options based on traditional crops is subject to considerable debate. The volume of water and area of land used for biofuel production changes with the crop used to produce biofuel (maize, sugarcane, sugar beet, cassava), and with the agricultural system (Table 17). Private investments are showing increasing interest in land and irrigated schemes in Africa for agricultural products for the production of biofuel.

Table 17: Different types of biofuels and water needed to produce them in rainfed or irrigated conditions

crop:	fuel product (energy density: Bio-diesel 35 MJ/l Ethanol 20 MJ/l)	annual obtainable yield in l/ha (indicative):	I/R	Evapo-transpiration in litre / litre fuel (indicative)	Irrigation water withdrawn in litre / litre fuel (indicative)
Sugar cane	Ethanol (from sugar)	6000	I/R	2000	1333
Sugar beet	Ethanol (from sugar)	7000	I/R	786	571
Cassava	Ethanol (from starch)	4000	R	2250	-
Maize	Ethanol (from starch)	3500	I/R	1357	857
Oil palm	Bio-diesel	5500	R	2364	-
Rapeseed / Mustard	Bio-diesel	1200	R	3333	-
Soybean	Bio-diesel	400	R	10000	-

Source: Hoogeveen, FAO/NRLW

790. According to OECD (2007), the growth of the biofuel industry is likely to place additional pressure on the environment and biodiversity. While theoretically attractive, the climate change mitigation potential of biofuel production is complex and varies extensively according to the type of crop and farming system. Among current technologies, only sugarcane-to-ethanol in Brazil, ethanol produced as a by-product of cellulose production (as in Sweden and Switzerland), and manufacture of biodiesel from animal fats and used cooking oil, can substantially reduce GHG compared with gasoline and mineral diesel. The study concludes that all other conventional biofuel technologies typically deliver GHG reductions of less than 40% compared with their fossil-fuel alternatives. When such impacts as soil acidification, fertilizer use, biodiversity loss and toxicity of agricultural pesticides are taken into account, the overall environmental impacts of ethanol and biodiesel can very easily exceed those of petrol and mineral diesel (OECD, 2007) (Box 13).

Box 13: Overall environmental impacts of biofuel

The Swiss Institute, EMPA (Zah et al, 2007), performed a full life-cycle assessment of a large number of biofuel and compared the environmental footprint with those of transport fuels derived from petroleum and natural gas. The whole environmental impact was calculated using measures of damage to human health, ecosystems degradation and the depletion of natural resources aggregated in a single indicator. Most biofuel has an overall environmental performance that is worse then gasoline, although their relative performance differs considerably. EMPA gave maize-based ethanol in the United States a poor environmental score. Biodiesel scored negatively as well. Biofuel made from woody biomass rated better than gasoline in all cases. A key question is how to ensure that production will indeed be sustainable. One answer currently being explored is certification of the conformity of biofuel to a set of environmental and social standards on a life-cycle basis (OECD, 2007).

791. Climate change is expected to alter hydrological regimes and patterns of freshwater resource availability with impacts on both rainfed and irrigated agriculture (FAO, 2008d) (Table 18).. Projections converge in indicating a general reduction in precipitation in semi-arid areas, higher variability in rainfall distribution, increase in the frequency of extreme events, and increase in temperature, affecting in particular agriculture in low latitudes. Severe reduction in river runoff and aquifer recharge is expected to occur in the entire Mediterranean basin, as well as the semi-arid areas of Southern Africa, Australia and America, and will consequently affect water availability for all uses (see Box 14).

Box 14: Prospects for agricultural production in the Near East: coping with water scarcity and climate change

The Near East Region is characterized by arid and semi-arid conditions and widespread water scarcity. Agricultural production in the region is projected to grow by more than 60% between 2003/05 and 2030 and to more than double by 2050 as a result of increased food demand. Most of this increase will result from yield increases and higher cropping intensities (FAO, 2008c).

Irrigation plays a major role in the region's agriculture. While irrigated land accounts for about one-third of all arable land, roughly 80% of production originates from irrigated agriculture. For the region, it is expected that irrigation water withdrawals could increase by some 29% by 2050. Under pressures of water scarcity, water use efficiency is expected to increase from 52% in 2003/05 to 66% by 2050, while irrigation water requirements are expected to grow from 64% to 83% of renewable water resources – all very high values compared to global averages.

Taking into account the expected impacts of climate change by 2050 including the combined effect of changes in precipitation and evapotranspiration, the situation may become significantly worse. These changes will translate directly into shifts in the existing pattern of soil moisture deficits, groundwater recharge and runoff. Second order impacts on streamflow, groundwater, lake and dam storage levels will translate into reduced availability of water for irrigation and other purposes. Under the B2 Scenario (IPCC, 2000), the overall availability of renewable water resources may decrease from 416 km3 in the base situation to some 397 km3 in 2050, while at the same time irrigation water withdrawals would need to increase by an additional 20 km3. This combined effect would result in an expected additional stress on the scarce water resources of 9%, with total water withdrawals representing the equivalent of 92% of the region's renewable water resources. It may even be higher if we consider also the leaching requirements in agricultural areas affected by salt/sea water intrusion and upwards leakages from brackish aquifers.

Table 18: Typology of climate change impacts on major agricultural systems (FAO, 2008d)

System	Current status	Climate change drivers	Vulnerability	Adaptability
Snow Melt Systems				
Indus	Highly developed, water scarcity emerging. Sediment and salinity constraints	20 year increasing flows followed by substantial reductions in surface water and groundwater recharge. Changed seasonality of runoff and peak flows. More rainfall in place of snow. Increased peak flows and flooding. Increased salinity. Declining productivity in places	Very high (run of river); medium high (dams)	Limited room for manoeuvre (all infrastructure already built)
Ganges Brahamaputra	High potential for groundwater, established water quality problems. Low productivity		High (falling groundwater tables)	Medium (still possibilities for groundwater development)
Northern China	Extreme water scarcity and high productivity		High (global implications, high food demand with great influence on	Medium (adaptability is increasing due to increasing wealth)
Red and Mekong rivers	High productivity, high flood risk, water quality		Medium	Medium
Colorado river	Water scarcity, salinity		Low	Medium: excessive pressure on resources
Deltas				
Ganges Brahmaputra	Densely populated. Shallow groundwater, extensively used. Flood adaptation possible; low productivity	Rising sea level. Storm surges, and infrastructure damage. Higher frequency of cyclones (E/SE Asia); Saline intrusion in groundwater and rivers; Increased flood frequency. Potential increase in groundwater recharge.	Very high (flood, cyclones)	Poor except salinity
Nile river	Delta highly dependent on runoff and Aswan Storage – possibly to upstream development		High (population pressure)	Medium
Yellow river	Severe water scarcity		High	Low
Red River	Currently adapted but expensive pumped irrigation and drainage		Medium	High except salinity
Mekong river	Adapted groundwater use in delta - sensitive to upstream development		High	Medium
Semi-arid / arid tropics: limited snow melt / limited gw				
Monsoonal: Indian sub continent	Low productivity. Overdeveloped basin (surface water and groundwater)	Increased rainfall. Increased rainfall variability. Increase drought and flooding. Higher temperature.	High	Low (surface irrigation); Medium (groundwater irrigation)
Non monsoonal: sub-Saharan Africa	Poor soils; Flashy systems; over-allocation of water and population pressure in places. Widespread food insecurity	Increased rainfall variability. Increase frequency of droughts and flooding. Lower rainfall, higher temperature. Decreasing runoff	Very high. Declining yields in rainfed systems. Increased volatility of production.	Low
Non monsoonal: Southern and Western Australia	Flashy systems; overallocation of water; competition from other sectors		High	Low
Humid Tropics				
Rice: Southeastern Asia	Surface irrigation. High productivity but stagnating	Increased rainfall. Marginally increased temperatures. Increased rainfall variability and occurrence of droughts and floods	High	Medium
Rice: Southern China	Conjounctive use of surface water and groundwater. Low output compared to northern China		High	Medium
Mediterranean				
Southern Europe	Increasing pressure on water	Significantly lower rainfall and higher temperatures, increased water stress, decreased runoff, loss of groundwater reserves	Medium	Low
Northern Africa	High water scarcity		High	Low
West Asia	Heavy pressure on water		Low	Low
Small islands				
Small islands	Fragile ecosystems; groundwater depletion	Sea water rise; saltwater intrusion;increased frequency of cyclones and hurricanes	High	Variable

792. Changes in runoff affect water availability, either in rivers or aquifer recharge, will represent an additional burden on areas where human pressure on water resources was already high and is expected to further increase (Figure 58Figure 7.3.10). In addition, temperature change and reduction in precipitation associated with diminishing runoff will increase crop water demand in irrigated areas. The impacts of climate change on irrigation water requirements may therefore be significant (IPCC WGII 5.4).

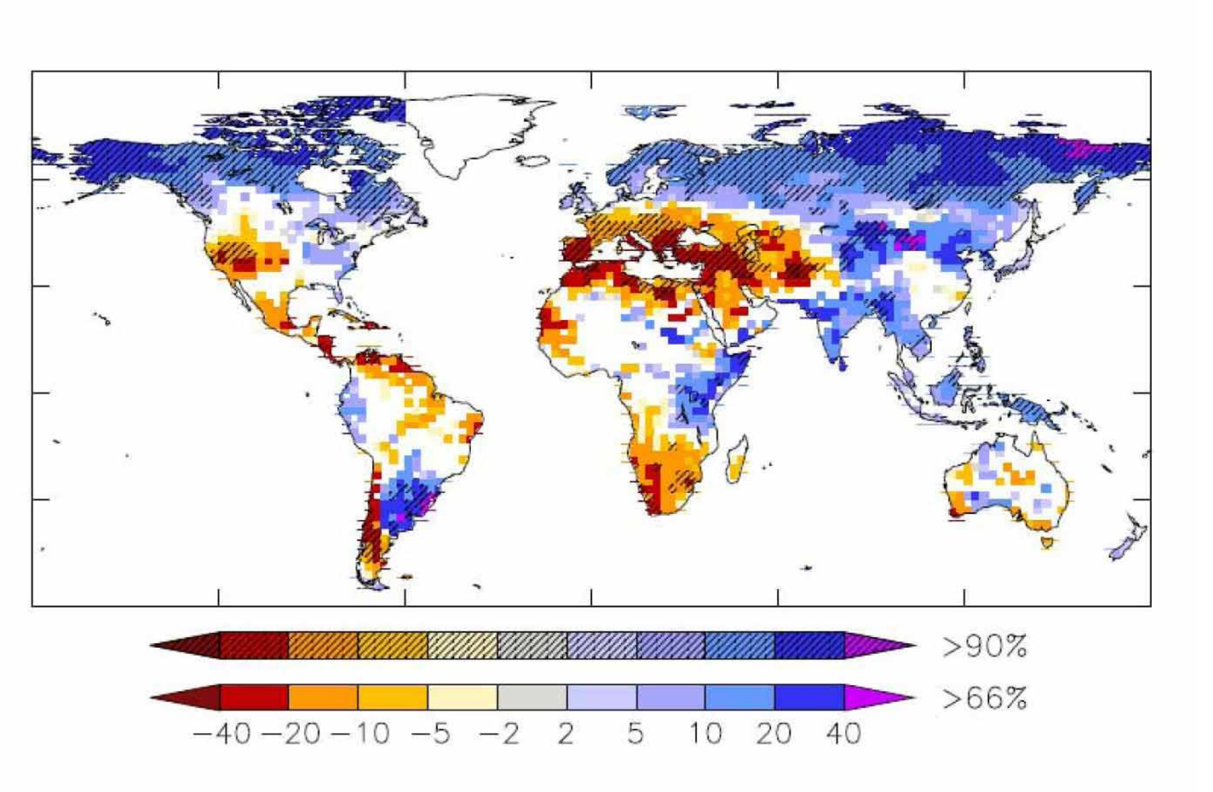


Figure 68: Map of expected change in runoff (IPCC)

793. In large irrigation systems relying for their water on high mountain glaciers (Himalaya, Rocky Mountains and Andes), temperature changes will bring a shift in runoff regime, with high runoff periods shifting towards periods earlier in spring, when irrigation water demand is still low (Bennett et al, 2000). Such anticipated changes may influence decisions concerning the construction of new water-control infrastructure to compensate for changes in river runoff. The example of Indonesia shows how climate change will add onto existing weather variability and may lead to unsustainability of current farming and cropping systems (Box 15).

Box 15: Impacts of water shortage on rice production in Indonesia(Boer and Heij, 2008, from Indonesia Country Report, 2007)

Many of the extreme climate events in Indonesia, particularly droughts, can be associated with El Niño Southern Oscillation (ENSO). The influence of ENSO on inter-annual rainfall variability in Indonesia reveals that (i) the end of the dry season occurs later than normal during El Niño and earlier during La Niña years, (ii) the onset of the wet season is delayed during El Niño and advanced during La Niña years, (iii) a significant reduction of dry season rainfalls could be expected during El Niño and a significant increase during La Niña years, and (iv) long dry spells occur during the monsoon period, particularly in Eastern Indonesia.

Data on the historical impacts of El-Niño events on national rice production indicate that the national rice production system is vulnerable to extreme climate events. Whenever El Niño occurred, rice production loss due to drought increased significantly. On average, production loss due to drought during the period 1991–2000 was three times higher than during the period 1980–1990 (Boer and Las, 2003).

It is very likely that in Java and Bali the length of the rainy season may shorten as a result of climate change and amount of rainfall may be higher than in the past. This suggests that most of these regions will be exposed to higher flood and drought risks in the future. For regions north of the Equator, however, the general pattern of change will be the opposite.

Changes in rainfall pattern and length of the rainy season will have serious implications for the future of the agriculture sector, with the current cropping pattern potentially no longer being be practicable. At present, the cropping pattern used in most rice-growing areas of Indonesia is based on two rice crops per year. The second rice planting depends heavily on irrigation water. In years of extreme drought, the availability of irrigation water becomes very limited and this causes severe production loss. Under a changing climate, drought occurrence will be more frequent than under current conditions. As a result, retaining this cropping pattern in the future may expose Indonesian farmers to more frequent crop failures.

794. The potential exists at the global level to produce enough food and other agricultural products to meet demand while reducing the negative impacts of water use in agriculture (CA, 2007). However, today's food production and environmental trends, if continued, will lead to crises in many parts of the world. Only through a combination of supply and demand-side measures will it be possible to address the acute freshwater challenges facing humankind over the coming 50 years. The challenge is to manage the additional water supply in a way that minimizes the adverse impacts – and where possible enhances – ecosystem services and aquatic food production, while providing the necessary gains in food production and poverty alleviation.

795. From its scenario analysis, the Comprehensive Assessment of Water Management in Agriculture (CA, 2007) shows that there are opportunities and options – in rainfed, irrigated, livestock and fisheries systems – for preserving, even restoring, healthy ecosystems. But gains require significant changes in the way in which water is managed. Central to these changes will be the ultimate water managers: farmers. The behaviour of different categories of farmers are shaped not only by agricultural policies but also by the capacity to ensure allocation of water according to wider financial restrictions, and local capacity to overcome pollution and environmental damage in countries with emerging economies. Box 16 provides the example of China which has succeeded over the last 10 years in improving its water use efficiency by around 10% without increasing its water allocation to agriculture.

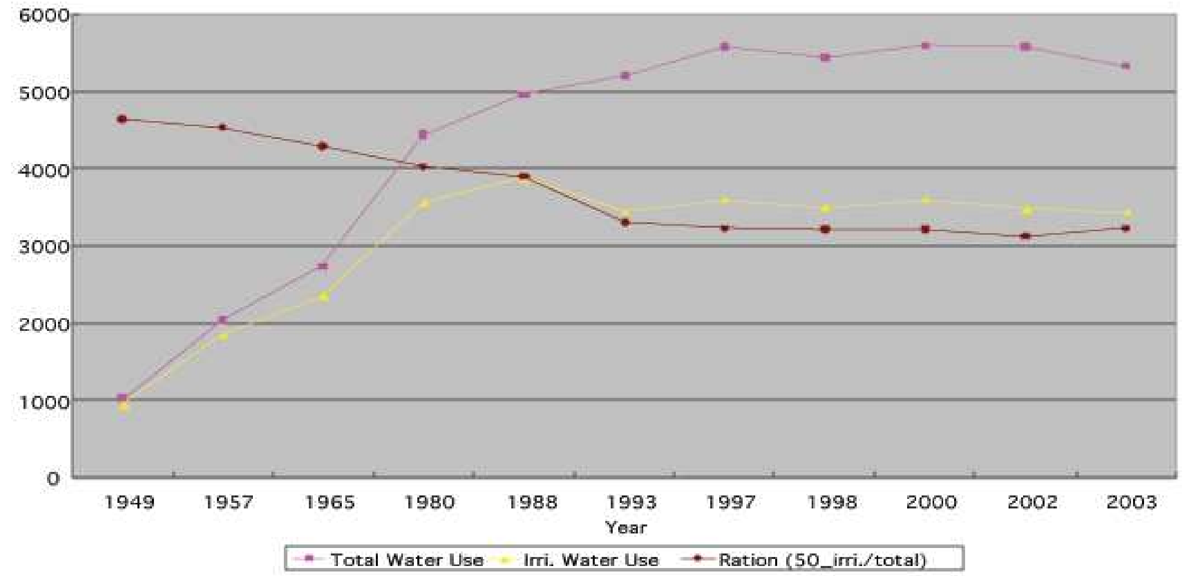
Box 16: China is maintaining food security and reduces irrigation water withdrawals by 25 % (Thierry Facon, from Li Yuanhua, Ministry of Water Resources, 2006; ICID, 2008)

China projects a need to increase, by 2020, its national food production by 200 million tons to maintain national food security, which requires increasing its irrigation area by 6.67 million ha. It is projected that newly developed water resources over the next two decades will be mainly allocated to domestic and industrial users; the agriculture sector will have to maintain food security for a larger population with the current amount of water allocation.

Water conservation and increased water use efficiency have become the driving force of China's irrigation development. The country has adopted a series of strategic, policy, institutional and technical innovations over the past two decades to facilitate nationwide "Water Saving Irrigation" development, with significant achievements. From 1980 to 2004, while national total water diversion increased by 25%, irrigation water use remained at 340–360 billion m3, and the proportion of irrigation water use as a percentage of total water use declined from 81% to 65%. Meanwhile, national irrigation area increased by

5.4 million ha, food production capacity increased by 20 million tons, and 200 million additional people gained food security. During the past decade, China's average unit irrigation water use was reduced from 7935 to 6450 m3/ha and nationwide irrigation water use efficiency improved by around 10%.

Figure: Irrigation water use in China



796. While on average it is estimated that only 37% of all the water withdrawn for agriculture is effectively consumed by plants, a substantial share of the unused water returns back into rivers and aquifers and is available for downstream uses. The net loss of freshwater due to irrigation is therefore substantially less than expected and potential gains through programmes aimed at increasing water-use efficiency are often over-estimated unless water is lost in salt sinks.

797. In the current global irrigation context, it is unlikely that programmes aimed only at reducing losses in irrigation will have a substantial impact on freshwater usage. The majority of large irrigation schemes also serve other functions, such as providing water for drinking, bathing, swimming, fishing and livestock drinking; savings may take water away from these and therefore it is suggested to rather move to ' multiple use' strategies.

798. Greater impact on irrigation efficiency can be expected from external drivers influencing the evolution of irrigation than from demand management programmes. The trend and prospects for irrigation are that it will serve an increasingly market-oriented agriculture, with progressive increase in the value of production, and where precision irrigation will become increasingly important. This will lead to progressive adoption of pressurised irrigation, thus reducing losses (CA, 2007).

4. Industry and energy

799. Water for industry (Table 19) and energy are growing in line with rapid development, and in so doing are transforming the patterns of water use in emerging economies. The water footprint has become a useful tool to assess the impacts and implications of globalization.

800. After agriculture, the two major sectors in terms of consumptive use for development are industry and energy, which together represent 20% of total water demands. In reality, however, this figure may be larger as many industries self-supply themselves (these volumes are only partially metered and reported), or get their water directly from the urban distribution system (which is difficult to separate from total volume of domestic use).

Table 19: Different industries, different water use per ton of product (Margat and Andreassian, 2007)

Product	Water use in m3/ton
Steel	2 to 350
Paper	80 to 2000
Petrol	0.1 to 40
Soap	1 to 35
Sugar	3 to 400
Beer	8 to 25

801. The degree of water consumption for most industrial uses – apart from what is incorporated in the products – is generally low (less than 10% of withdrawals). Instead, industrial uses put pressure on water resources more by the impacts of the wastewater discharged and their pollution potential.

802. Diminishing quality of water supplies, increasing water purchase costs, and strict environmental effluent standards are forcing industries to target increased water-efficiency and report on their progress (Global Reporting Initiative).

803. The tourism sector is a case in point. It is a factor of growth of domestic water demand and can lead (on coastlines, islands or mountain areas) to supply difficulties in peak seasons. Around the Mediterranean Sea, it is estimated that seasonal water demands from the tourism industry increase annual water demands by 5 to 20% (Box 17).

Box 17: Tourism water demand in the Mediterranean coastal area

With 364 million tourists in 2000, the Mediterranean region is the number one world tourism destination, and by 2025 the number of tourists could reach 637 million (Blue Plan, 2005). Tourism brings in 12% of the region's income and up to 50% in some countries.

Knowledge of the specific water demands of tourism – mostly domestic water – is limited as the national statistics of the water economy rarely distinguish between 'domestic water' use and water for tourism. The annual additional demands from the tourism sector, in relation to the demands of the local populations, are relatively modest: for example, 20% of domestic supply in Cyprus in 2006; 5% of total water demands in Malta between 1995 to 2000; and 5% of domestic demand in Tunisia in 2003.

However, it is less the annual demands of tourism that are important than the daily demands as these represent mostly seasonal and peak demands. The daily demands of a tourist are in general a lot higher than the demands of a local resident. Tourism also creates a demand for seasonal services and leisure activities that demand a lot of water, such as golf courses that can use up to 10,000 m3/ha/year.

The demands induced by tourism often occur at the same time as peak demand for agriculture, which is also seasonal, during periods when resources are at their lowest. Satisfying such peak demands requires over-sizing of the drinking water production and distribution system as well as the wastewater collection and treatment infrastructure that fall under the responsibility of the local or regional administrations. In many places, water supply for tourism relies on desalination of seawater, a promising option, as is the case in Malta, Cyprus, the Balearic Islands, Tunisia and certain Greek islands.

Source: Margat adapted from Blue Plan, 2005 and Blue Plan, 2007

5. Water and Energy

804. Energy and water are inextricably linked. On the one hand, water is an integral part of energy resource development and utilization; it is used for cooling, energy production (Figure 69), but is also consumed passively as reservoirs built for energy production and other purposes evaporate a significant amount. Margat estimates that the total evaporation from reservoirs in the 22 countries of the Mediterranean Action Plan comes to around 24 km3 per year – nearly the water use of Argentina — of which nearly half evaporates in Egypt (Blue Plan, 2008). In the case of hydropower, wave or tidal energy production, water offers an 'active' medium for transferring kinetic energy into electricity. In other cases, such as cooling thermal and nuclear plants or the production of biofuel, water plays a more 'passive' role, which is not to say it is any less important. The demand for energy is therefore a major driver of water and agriculture development, creating pressures which have significant impacts on the quantity and quality of freshwater resources.

Figure 7.4.2:

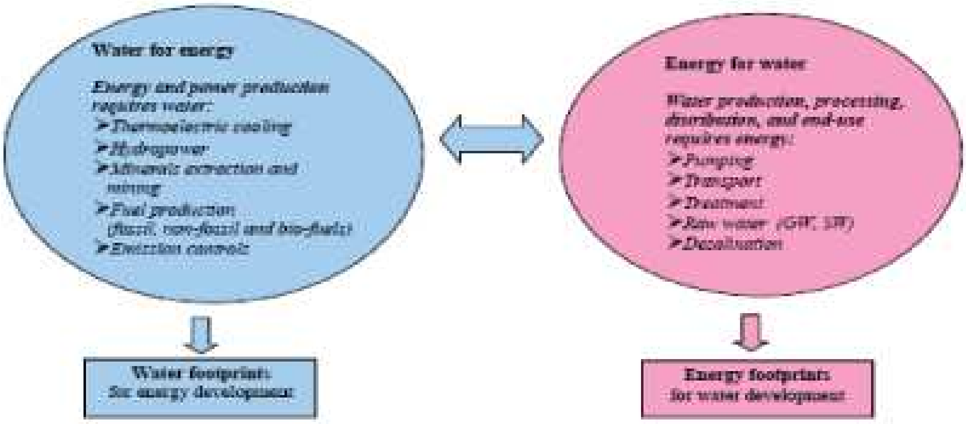


Figure 69: Inter-linkages between water and energy (DHI, 2008)

805. The link between energy and water is further strengthened by the fact that the water sector is an important user of energy. For example, the pumping, transport, processing and use of water can necessitate very large amounts of energy. The generation of drinking water through desalination is also an energy-intensive process. Energy demand is driven by many of the same drivers that are putting direct pressure on water resources: demographic, economic, social and technological processes, including changes in consumption patterns. Energy consumption is also the main driver behind climate change (Part 1), which threatens the sustainability of our water resources. Growing pressure to curb the emissions of greenhouse gases (GHG) is leading to increasing demand for 'cleaner' sources of energy. Hydropower has been earmarked as one of the most important of these sources.

806. Energy can represent 60 to 80% of water management costs and 14% of water utility costs (Global Water Market, 2008). In 2005–06, water and wastewater companies in England and Wales spent US$632 million on electric power (7700 GWh), making this the largest non-staff operating cost item

(OECD, 2007b). Efficiency and conservation are, therefore, not only good for water resources; they are also a means to conserve energy. Until recently, water management systems depended mostly on the force of gravity. In fact, the use of energized pumping of water is relatively recent. In irrigation for example, it is only since the 20th century that fuel and electrical systems have been used for the pumping and distribution of water at the field level. Energy has also been important for drainage purposes, particularly on polders land[41]. The advent of rural electrification, particularly in South Asia, has introduced the widespread use of pumps to provide irrigated areas with groundwater. In the agricultural industry, further demands in energy are anticipated as food cold chains develop and become more sophisticated. Energy use increases constantly too in the industrial and municipal sectors, for transport, water, desalination and wastewater treatment.

807. Cooling in the energy sector is one of the main industrial water users, with a final consumption (evaporation) estimated at around 5%. The cooling of nuclear plants also means that outflows have a much higher temperature, while ecological constraints state that sufficient river flow must be ensured in order to mitigate this impact. As is the case for pollution dilution, this entails the availability of non-directly productive but substantial flows.

808. The production of electrical power, in particular, requires large quantities of water. However, unlike other major water-use sectors (agriculture and domestic), the majority of the water used for electrical power generation is not consumed. Rather the water is returned to its source after being used, a process referred to as non-consumptive use. This is particularly the case for hydropower generation, in which water is returned to the river after having passed through turbines. However, this type of use can lead to significant loses due to evaporation, and is thus not entirely non-consumptive. In fact, the rates of water use, for hydropower in particular, can be considerable, as shown in Table 20, which shows the amount of water used to produce electricity by a selection of energy types in the United States.

Table 20: Water use rates for different types of energy production (US estimates; DHI, 2008)

Energy Type	**Approximate Total Water use (m3/MWh)**	**Water use for US Daily Energy Production (millions of m3)****	**US Personal Daily use Equivalents*** (people)**
Solar****	0.001	0.011	44 thousand
Wind****	0.001	0.011	44 thousand
Gas	1	11	44 million
Coal	2	22	88 million
Nuclear	2.5	27.5	110 million
Oil/Petrol	4	44	176 million
Hydropower	68	748	3 billion
Bio-fuel (1st gen.)	178	1,958	7.8 billion

*Based on: water used for production/extraction of raw materials; water used for refining fuel; water used at energy plant; and average totals by plant types. ** If the entire energy production of the US were based on one energy type only, this column illustrates what the use of water for that production would be (based on current US production of approximately 11 million MWh/day. *** Corresponding to the average annual use of water from the indicated number of people and an average US use rate of 250ltrs/person/day). For example, if the US immediately switched to 100% wind power the water used daily would be the equivalent to the daily use of 44,000 Americans. **** Water use is primarily for maintenance in the form of cleaning. While the amount of water required is highly dependent on local conditions, in comparison to other energy types water use is minimal.

809. Hydropower currently supplies about 20% of the world's electricity (ICOLD, 2007) report dams and water resources), a relative contribution that has remained constant since the 1990s. Hydropower

41 Polder: An area of low-lying land, especially in the Netherlands, that has been reclaimed from a body of water and is protected by dikes.

stations are being built in virtually all parts of the globe, and have shaped many of the world's water infrastructures. Some of the first countries to develop hydroelectricity on a large scale were Norway, Sweden, Switzerland, Canada, the United States, Australia and New Zealand. The largest hydropower station in operation is the Itaipu dam, built on the Rio Parana River between Brazil and Paraguay, with a power capacity of more than 14,000 MW (Mega Watt or 1 million watts). Brazil produces more than 90% of its electricity from hydropower. On a smaller scale, projects were built many years ago in Asian countries where conditions were good; India's first small hydropower plant, for example, is more than 100 years old.

810. According to the IEA (2007), electricity generation from hydroelectric and other renewable energy resources is projected to increase at an average annual rate of 1.7% from 2004 to 2030, representing an overall increase of 60% through 2030. Although this increase is highly significant with respect to its potential impact on water resources, it is expected that renewable energy production will still only cover a small part of total energy demand (Figure.7.4.3c).

811. With respect to hydropower, future development will be limited by two main factors. The first limiting factor relates to the spatial and geophysical potential for new hydropower installations. In many developed countries, including the United States, Australia and most of Western Europe, the majority of the 'best' sites for hydropower installations have already been developed. The second limiting factor is investment capacity, which explains why so little hydroelectric potential has been tapped in countries with developing or emerging economies, which includes most of Africa.

812. The renewable share of world electricity generation is projected to fall slightly, from 19% in 2004 to 16% in 2030. There are a number of complex, and partly competing, challenges associated with energy production, environmental issues and water resources management. The pressure to extend hydropower on the basis of its comparative sustainability will stir discussions of environmental and social impacts, including the regulation of hydropower dam releases to optimize downstream uses and maintain aquatic ecosystems. Likewise, expansion of thermal power-producing facilities will require cooling water, with the need to discharge heated wastewaters. Although none of these activities are water consumptive in nature (apart from evaporation from reservoirs), the environmental impacts can still be considerable and complex.

813. Emerging challenges will have an effect on both the energy sector and water resources. The most obvious such example is climate change, which may influence the global energy future to a greater and faster extent than has been perceived to date. The pressure on the political system is mounting and there are likely to be increased calls for action to deal with GHG emissions over the coming decades. This can ultimately change the energy production landscape. Yet, the IEA in its 2007 World Energy Outlook forecasts that fossil fuels represent the brunt of the demand for increased energy resources. However, the pressure for further hydropower development may also increase due to climate change.

6. Water for transport

814. The 25 largest cities, the 25 largest production locations, the 25 most prosperous areas, and the 25 most densely populated areas are all located near waterfronts, and almost all of them by the sea (BVB, 2008). This has been the case for 2000 years. River navigation has been found in the Indus Valley Civilization, in Northwest India around 3300 BC, and riverine navigation is still used extensively in major rivers of the world like the Ganges, Nile, Mississippi, Rhine, Danube and Indus. The development of waterways for transport lies behind many large-scale river transformations and dam constructions. 'Of 230 major rivers in the world around 60% are considered to be seriously or moderately "cut-up" by dams, dikes and dredging, with improved river transport often being one of the main objectives' (WWF, 2008).

However, inland shipping is an underdeveloped sector on most of the existing waterways of the more than 10,000 km that exist in over 50 countries worldwide (Table 7.4.3 and Figure 7.5.1). China alone has more than 110,000 navigable kilometers (BVB, 2008), the longest in the world.

815. Inland navigation is the most cost-effective and least polluting means of transportation (PIANC, 2008), and with improved trade and exchanges has contributed to the development of mature economies (PIANC, 2008). A principal value of inland waterways is their ability to efficiently convey large volumes of bulk commodities along long distances. However, the development of rivers for navigation often leads to irreversible transformation of river courses, and negative impacts on vulnerable groups of people as well as ecosystems (e.g. fish larvae mortality from propeller impact, and larvae stranding due to drawdown). "Western Europe's Rhine River is perhaps the best-known example of navigation schemes that alter a river forever. It is arguably the busiest shipping route in the world – over 1 million containers travel up and down it each year (Figure 7.5.2). To make an 880 kilometre stretch of the river navigable, no less than 450 dams were built on its course and thousands of kilometres of banks were built. Meanders were removed and the Rhine has become 25% shorter as a result" (WWF, web site).

7. *Fisheries and aquaculture*[42]

816. The situation of capture fisheries together with the presence or absence of some endemic species in a river are good indicators of the health of a system. Aquatic ecosystems sustain capture fisheries. If the system is damaged, the quantity of fish decreases; this is therefore a good indicator of the health of the ecosystem. Lack of water at a certain flow for critical periods of fish life can be detrimental. Aquaculture benefits from aquatic systems, but these can be detrimental if they allow over-use of inputs or over-population of fishponds, and can damage the natural ecosystem.

817. Fishing activities in freshwaters represent a significant activity for many poor people in rural areas (CA, 2007) and contribute significantly to the economy (and a source of protein for the poor)– even if a full estimation is difficult, as many fishing activities do not fall within the economic domain. Attempts have been made to demonstrate the contribution of fisheries, both large- and small-scale, to national economic development, poverty alleviation and food security (Table 21).

Table 21: The different dimensions of poverty alleviation in relation to small-scale fisheries, including the specific issue of vulnerability (Béné et al, 2007)

	Poverty alleviation				
	Poverty reduction: Fisheries contribute to lift people out of poverty		*Poverty and vulnerability prevention:* Fisheries contribute to maintain a minimum standard of living		Fisheries as a source of vulnerability
Level	Contribution	Mechanisms	Contribution	Mechanisms	Causes
Individual/intra-household	Livelihood support to other household members, particularly dependents	Fishing income spent on children's education and building other household assets (e.g. farm inputs, investment in small enterprises for other household members to run)	Household subsistence	Fishing income contributes to household budget – expenditure on food, clothing and health care	Strongly gendered roles and frequent absence of (migrant) male fishers may limit intra-household income distribution. Absence from home and fishing lifestyle may increase vulnerability of partners to HIV infection.
Household level/ sector	Wealth generation	Effective capture of fishery rent (capital accumulation) High level of commercialization Access to effective market mechanisms Fish as cash crop for investment and diversification	Safety net function (transient poverty) Activity of last resort for the poorest (chronic poverty)	Fisheries reduce vulnerability and mitigates poverty effects Fisheries contribute to food security through direct contribution (subsistence), but also fish being an immediate cash crop acts as safety net	High occupational risk Risks of losing physical assets
Local level	Engine for rural development	Increased demand for goods and services Rise in wages and employment opportunities (income and employment multipliers)	Social-redistributive system (welfare)	Fisheries provides alternative sources of income, food and/or employment	Unpredictability of the natural resource availability Natural disaster risk Conflicts
National level	Economic growth	Trickle up to government through taxes and foreign exchange earnings (regional or international trade)	Redistributive	Government expenditure on poverty alleviation measures is drawn from fisheries-related tax and foreign exchange earnings	High susceptibility to macro-economic fluctuations

42 Based on FAO/SOFIA, 2008.

818. In the case of small-scale fisheries, although no authoritative quantification exists as yet because data remains patchy or not disaggregated enough to allow detailed analysis, case study information is available and some general indicators of the importance of the sector to national economies have been compiled.

819. At household levels, fisheries – in particular small-scale – are a central element in livelihood strategies providing not only direct and indirect employment for some 100 million people, most of which live in developing countries, but also a safety net activity for the poor through catch and trade. Not included in these estimates, however, are the other hundreds of millions of people engaged in temporary fishing activities, most typically in inland areas. In Africa, active men and boys are involved in seasonal fishing along rivers or reservoirs between cropping seasons or when other agricultural activities are low (Sana, 2000). In the Tonle Sap Lake area, thousands of households share their time between fishing and the cultivation of rice and other crops (Ahmed et al, 1998). Occasional fishing, carried out by non-leading members of the household such as children, elders or women in male-headed households on the margins of water bodies or in waterways (e.g. irrigation canals) can involve up to 70–80% of the households during the flood seasons in the floodplain areas of the Indian sub-continent (Thompson and Hossain, 1998; Hoggarth et al, 1999).

820. Fish[43] consumption has undergone major changes over the past four decades (+34.5% in France as indicated in IFEN, 2006). World fish capture and aquaculture production has been steadily increasing (Figure 7.5.4). The apparent global per capita fish consumption has changed from an average of 9.9 kg in the 1960s, to about 16.7 kg in 2006 (preliminary estimate).

821. However, this increase has not been equal across all regions. Over the last three decades, the per capita fish supply has remained almost static in sub-Saharan Africa. In contrast, the per capita fish supply has risen dramatically in East Asia (mainly in China, Figure 70) and in the Near East/North Africa region. The share of fish in total protein intake was 7.8% in 2005, back at levels prevailing in the mid-1980s. The contribution of fish to total protein intake grew significantly in the period 1961–89 (between 6.5% and 8.5%), before gradually decreasing following the growth in consumption of other animal proteins. Although consumption in Low-Income Food-Deficit Countries (LIFDCs) excluding China has increased in the last four decades, and in particular since the mid-1990s (+1.3% per year since 1993), per-capita fish intake represents only half that of industrialized countries. Despite this relatively low level of fish consumption, the contribution of fish to total animal protein intake in 2005 was significant at about 20%, and may be higher than indicated by official statistics in view of the unrecorded contribution of subsistence fisheries. Fish contributes to food security in many regions of the world providing a valuable supplement for diversified and nutritious diets. Fish is highly nutritious and not only provides high-value protein, but also represents important sources of a wide range of essential micronutrients, minerals and fatty acids.

[43] The term 'fish' indicates fish, crustaceans and mollusks, excluding aquatic mammals and aquatic plants.

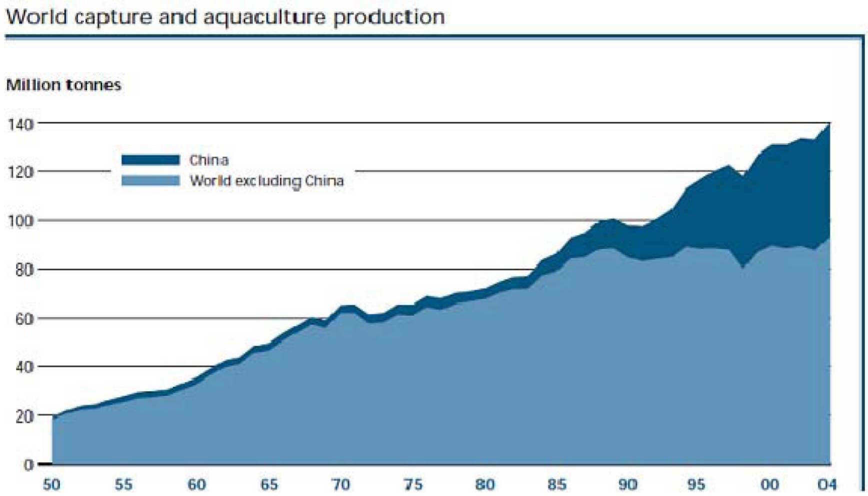


Figure 70: World capture and aquaculture production (SOFIA, 2006)

	2000	2001	2002	2003	2004	2005[1]
	(million tonnes)					
PRODUCTION						
INLAND						
Capture	6.6	6.7	6.5	6.6	6.8	7.0
Aquaculture	6.0	6.5	7.0	7.6	8.3	8.8
Total Inland	12.6	13.3	13.5	14.2	15.1	15.8
TOTAL CAPTURE	78.6	76.6	76.7	73.8	78.1	76.7
TOTAL AQUACULTURE	10.9	11.9	12.6	13.8	14.9	15.4
TOTAL FISHERIES	89.5	88.4	89.3	87.5	93.0	92.1

822. By landing more than 10 million tonnes in 2006, inland fisheries contributed 11% of global capture fisheries production. Although low in comparison to marine fisheries, fish and other aquatic animals from inland waters remain essential and irreplaceable elements in the food of both rural and urban people in many parts of the world, and especially in developing countries. For demographic and cultural reasons there are, however, significant differences in the levels of exploitation between the major geographic regions. Although statistics are improving in some countries, collecting accurate information on inland fisheries can be extremely costly and many public administrations still do not gather such information or make assessments of the status of inland fishery resources.

823. Aquaculture production is playing an increasing role in satisfying demand for human consumption of fish and fishery products. The average contribution of aquaculture to per capita fish available for human consumption has grown from 15% in 1996 to 47% in 2006 and can be expected to reach 50% within the next decade. Aquaculture production has pushed the demand and consumption for several freshwater species such as tilapia and catfish, including *Pangasius* species, as well as for high-value species such as shrimp, salmon and bivalves. Since the mid-1980s, these species have shifted from being primarily wild-caught to being aquaculture-produced, with a corresponding decrease in their price and a strong increase in their commercialization. Aquaculture has also had a major role in terms of food security in several developing countries, particularly in Asia, for the significant production of certain low-value freshwater species, which are mainly destined for domestic consumption. In addition, the demand for fish is price-elastic and with stable or declining fish prices, rising incomes and the ensuing diversification of diets, there is a shift towards significantly higher fish consumption in developing countries. These trends in fish consumption are expected to continue for the foreseeable future, especially under the impulse of population and income growth, together with urbanization and dietary

diversification. However, aquaculture has also contributed to serious water pollution when not well-managed.

824. Inland fisheries and aquaculture from lakes, reservoirs, rivers, ponds and wetlands contributed about 25% (34 million metric tons) to the world production of fish in 2003 (FAO, 2004). This value may be underestimated as contributions from smaller systems may have been overlooked (Coates, 2002). Competition for water and aquatic habitats is a critical challenge facing inland fisheries in many countries.

825. Growing recognition of the multiple uses of water within many established irrigation systems has revealed many other productive and non-productive uses. Aquaculture is a water-dependent activity, which is productive, but non-consumptive and therefore, in principle and with appropriate technological adaptations, not in competition with irrigation (Gowing, 2006).

826. A move to fish and aquaculture farming on brackish groundwater is a must, especially in coastal areas affected by seawater intrusion and upward groundwater leakage affecting soil productivity. This is essential to minimize inland seawater intrusion in coastal lands (deltas) which will be affected by increased sea water level.

8. Other environmental uses

827. Inadequate attention to the environment in policy-making remains. Freshwater ecosystems or ‘the environment’, provide an extensive array of services to support human well-being, many of which are extremely valuable. The issue is not how much water the environment needs, but how much water is required to sustain the services that people want from the environment. Shifting attitudes away from considering the environment as an unfortunate victim of human uses of water and towards environmental sustainability being central to sustainable development remains a significant challenge.

J. Impacts of water use on water and the environment

828. Human activities, through the misuse or pollution of resources, lead to increased degradation of natural ecosystems, over-exploitation, and conflicts that adversely affect people and economic development. Progress is slow in mitigating the negative effects of water development, while accelerated economic growth places additional burdens on resources.

829. The world is a patchwork of unique situations with regard to water use and the challenges it poses for humans and nature, particularly, given the fact that freshwater is a fundamentally scarce resource less than 3 % of the total water on earth. There is also clear evidence of degradation in quantity and quality: drying rivers, aquifers and groundwater basins, bio-accumulation of agro-chemicals and heavy metals in fishes, algal blooms from high nutrient loads, silting dams, nutrient loss and the fragmentation of rivers. Many of these impacts are caused by cities, industry and agriculture, which lack incentives or obligations to act and report on their performance regarding water use and mitigation of pollution. Over-exploitation and pollution are mainly externalities of the activities of users and polluter: in other words, polluters or users do not directly suffer the consequences of their actions. ‘Internalizing these effects’, for example, by using the polluter pays principle, therefore seems the best way to reduce pollution and misuse. An increasingly popular approach is to implement arrangements whereby stakeholders receive incentives through payments for ecosystem services (e.g. local communities maintaining the integrity of forested watersheds) for sustaining benefits provided to others.

1. How water use impacts on resources

830. Proximity of water bodies has been an incentive for the location of human settlements for millennia and the human alteration of coastlines, rivers, lakes and wetlands (frequently drained) has gone hand-in-hand with social and economic development. Urban growth and industrial development pushed cities to look increasingly further for the water they needed (Box 18). Water taken for cities is often taken away from other uses – agriculture and nature – that may be negatively affected.

Box 18: New York fetches water from afar

New York relied on local supplies until 1842, and thereafter brought water from the Croton river basin, 75 km away. Between 1907 and 1927 it transferred water from two creeks in the Catskill Mountains, and later, between 1937 and 1965, tapped three upper tributaries of the Delaware River (Molle and Berkoff, 2006).

831. Water scarcity occurs when the amount of water withdrawn from lakes, rivers or groundwater is so great that water supplies are no longer adequate to satisfy all human or ecosystem requirements, bringing about increased competition among potential users. In keeping with this concept of water scarcity, the ratio of water withdrawal to water availability on an annual basis is used as an indicator for both the MDG and CSD processes to monitor human pressure on water resources (Figure 71). An increasing number of river basins do not contain sufficient water to meet all the demands placed upon them, and competition among users can be intense (Figure 72).

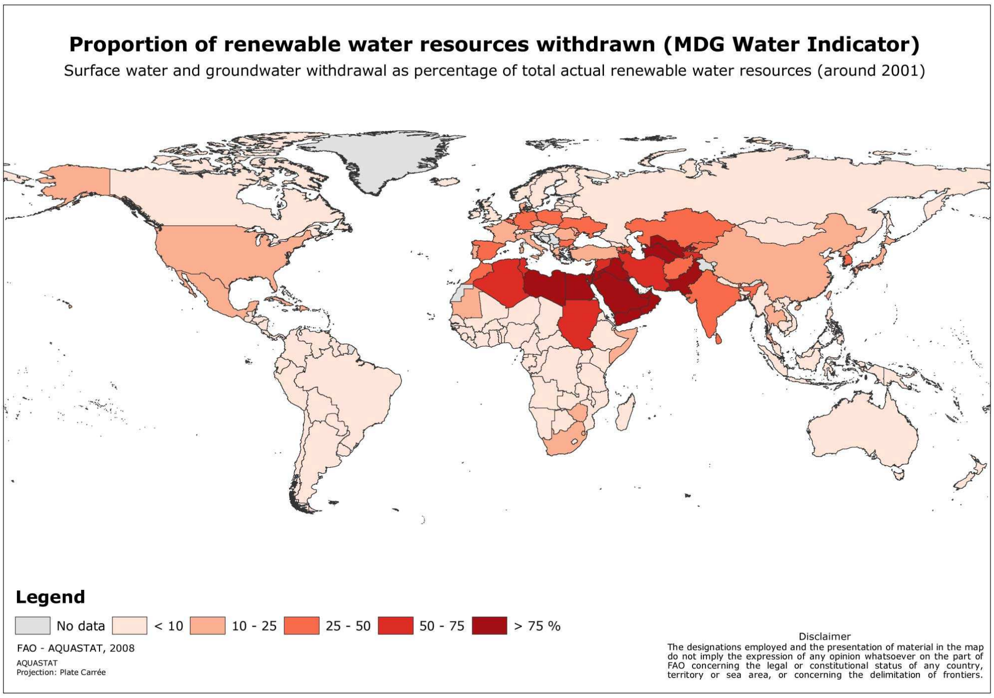


Figure 71: MDG Water Indicator: proportion of renewable water resources (surface and groundwater) withdrawn around 2001 (Aquastat)

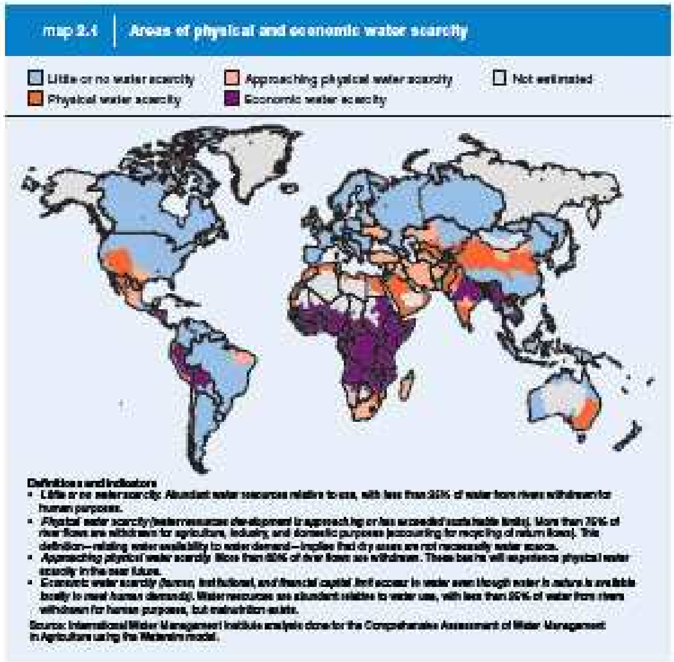


Figure 72: Increasing water scarcity (adapted from CA, 2007)

832. However, available information fails to reveal the realities of scarcity occurring at local or basin levels. This is particularly true in large countries such as the United States, where water use accounts for only 25% of the available resources. Figure 73 shows a very different reality inside the country's boundaries and indicates that water stress and shortages exist.

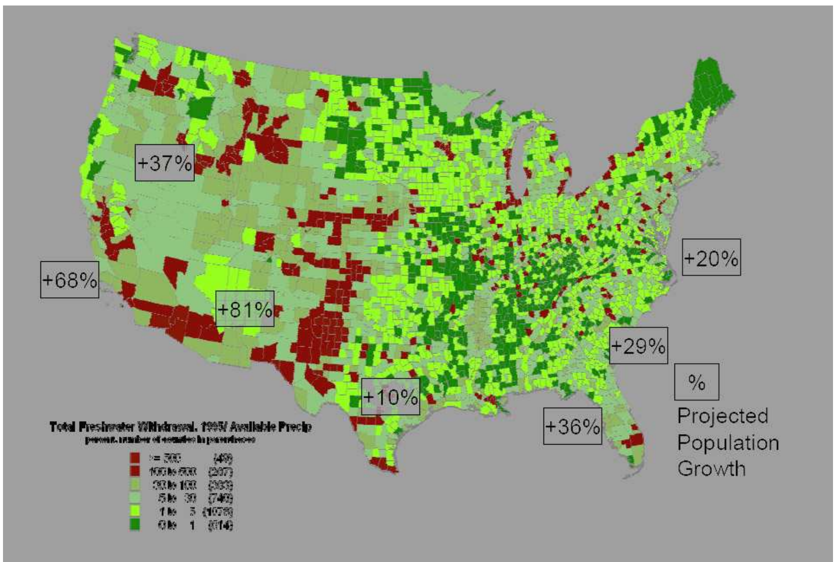


Figure I-2. Water Shortages and Population Growth
(Water shortage is defined as total freshwater withdrawal divided by available precipitation. Water withdrawal data are taken from Solley et al., 1998; ratios shown are taken from EPRI, 2003a; and projected population growth is taken from Campbell, 1997.)

Figure 73: Water shortages and population growth (US Department of Energy, 2006)

833. The Millennium Ecosystem Assessment (MEA, 2005) has demonstrated how modifications to the landscape to increase food production and allow development have resulted in adverse ecological changes in many ecosystems, with concomitant loss and degradation of ecosystem services. Synergistic and cumulative effects, however, can make it difficult to attribute change to a single cause. Losses have adverse effects on livelihoods and economic production (CAMWA, 2007), and in some cases, ecosystems have passed thresholds through regime shifts, leading to a collapse in ecosystem services, making the cost of restoration (if possible) very high.

834. There are many instances where consumptive use and water diversion have contributed to severe degradation of downstream wetlands or closed seas. Emblematic examples include the shrinking Aral Sea in Central Asia and Lake Chapala, the world's largest shallow lake in Mexico. Some of the largest rivers have become small streams close to their mouth (e.g. the Nile River, Colorado River, Yellow River, Murray-Darling River, etc.), and flows are no longer sufficient to maintain aquatic ecosystem health.

835. Water regulation and drainage for agricultural development are the main causes of wetland habitat loss and degradation (CA, 2007). Yet recovery can occur quickly if the right mechanisms are put in place. One example is the Mesopotamian Marshlands that were deliberately drained but are now in the process of being reclaimed (Figure 74). 'Following more than decade of decline more than 20% of the original marshland area has been re-flooded in less than one year (May 2003-March 2004).' (UNEP report[44])

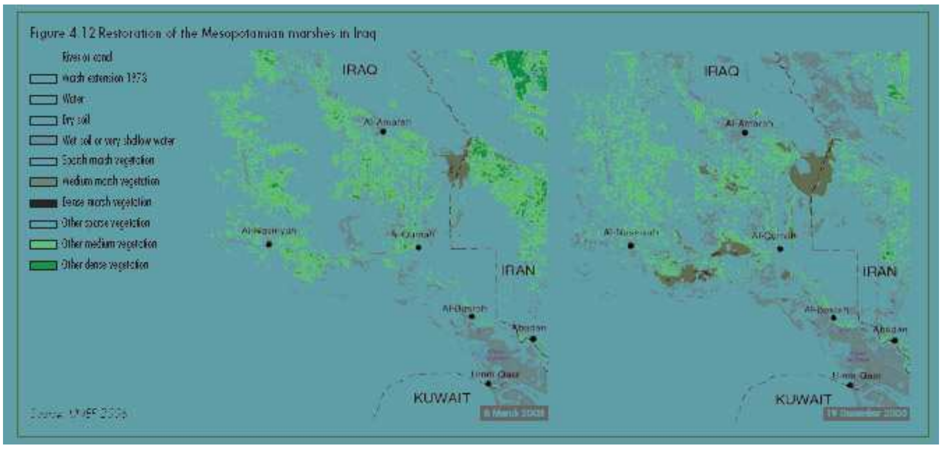


Figure 74: Mesopotamian Marshes (UNEP GEO 4, 2007)

836. The Living Planet Index (LPI) is based on trends in populations of vertebrate species. The analysis of trends in the evolution of the LPI shows that on average freshwater species populations fell by about 50% between 1970 and 2000, a sharper decline than for other biomes (Figure 75).

[44] http://www.grid.unep.ch/activities/sustainable/tigris/index.php

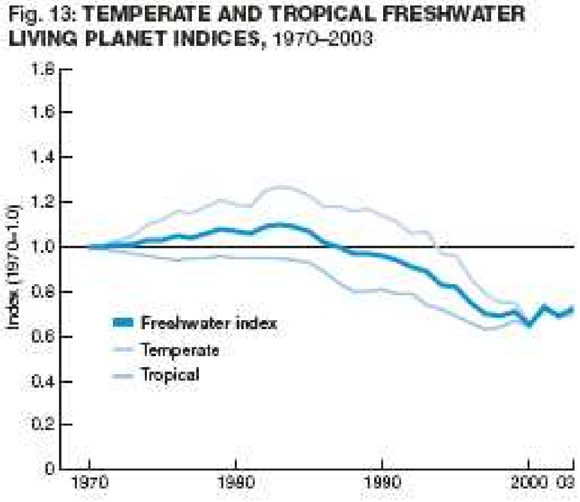


Figure 75: Loss of biodiversity (WWF, 2006)

837. During the last century river modifications have massively increased in number. As of 2000, there were more than 50,000 large dams in operation (ICOLD register) and it is expected that demand for reservoirs – of all sizes – will continue to grow, particularly in regions with high water demands and where there is a need to cope with increased variability due to climate change (see Figure 76). At present, more than 270 dams of 60 m or over are planned or under construction (WWDR, 2006).

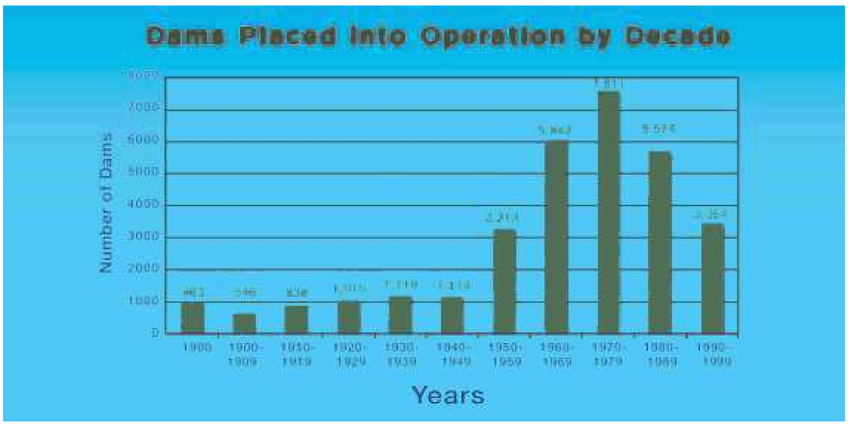


Figure 76: Cumulative capacity of large dams worldwide (ICOLD, 2007)

838. Water-related development modifications (dams, irrigation development schemes, urban extension, over-fishing, etc.) have major consequences for the key ecological components or processes of rivers, lakes, floodplains and groundwater-fed wetlands. Regulation of the world's rivers with dams are reported to play a major role in altering water regimes, with substantial declines in ocean discharge, modifying aquatic habitats, and transforming flowing systems (rivers) into still or semi-still systems (wetlands). Some ecosystems can disappear when rivers are regulated or impounded because of the alteration of flow and the creation of barriers to the movement of migratory species. Not only animals and plants suffer but also humans; forced migration and population displacement are well-documented social impacts of dams (WWDR-2, 2006).

839. The river fragmentation index is an indicator of the importance of the anthropogenic modifications of river regimes. In 2005, out of the world's 292 largest river systems[45] (accounting for 60% of the world's runoff), more than a third (105) were considered to be strongly affected, and 68 moderately affected (WWDR-2, 2006)[46]. The ecosystems upon which impacts are strongest are wetlands, but terrestrial ecosystems such as forests and grasslands are also affected (Figure 8.1.5).

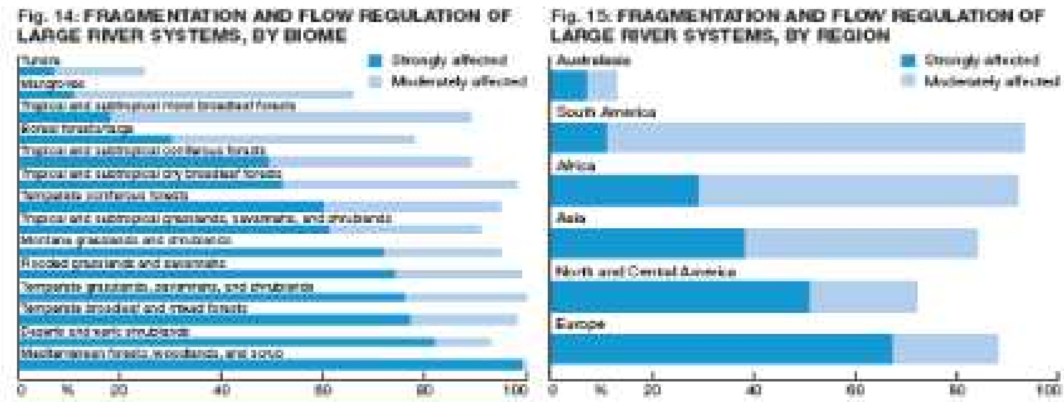


Figure 77: a) river fragmentation and b) flow regulation by biome type (WWRD-2, 2006).

840. The speed of change in many ecosystems has increased rapidly, and there is now concern that large-scale changes will increase the vulnerability of some ecosystems to water-related agricultural activities. The non-linear dynamics of ecosystems may lead to abrupt changes that can affect their resilience and their capacity to absorb disturbances (CA, 2007).

45 A large river system (LRS) is defined as a river system that has a river channel section with a virgin mean annual discharge (VMAD, the river discharge before any significant direct human manipulations) of at least 350 cubic metres per second (m^3/s) anywhere in the catchment (Dynesius and Nilsson, 1994 cited in WWDR, 2006 p. 176)

46 The fragmentation and flow indicator was developed by Umea University in Sweden, in collaboration with the World Resources Institute, assessing the state of large river systems as defined above. Unaffected river systems are those without dams in their catchments, although dams in tributiaries may not disqualify a river from being classified as 'unaffected' if flow regulation is less than 2% of the VMAD. A river system is never considered unaffected if there are dams in the main channel, and is never classified as strongly affected if there are no dams in the main channel. All river systems with no more than one-quarter of their main channel length left without dams are considered strongly affected.

841. Variability and flexibility are needed to maintain ecosystem resilience. Attempts to stabilize systems in some perceived optimal state, whether for conservation or production, have often reduced long-term resilience, making the system more vulnerable to change (Holling and Meffe, 1996). The modifications of landscapes and reduction of other ecosystem services have decreased the capacity of ecosystems to cope with larger scale and more complex dynamics through reduced ecosystem resilience locally and across scales (Gunderson and Holling, 2002).

842. Increased turbidity and salinity of water and soil reflect some of the impacts of water resource development as well as withdrawals. These changes increase the difficulty of land and water management. Siltation and increased sediment load in rivers, partially due to river regulation and the resulting erosion of river banks and the sides of reservoirs, has resulted in reservoirs becoming sediment traps and a decreased amount of sediment being carried out into the delta areas.

843. Water can accumulate in the soil profile through runoff and groundwater recharge, or if the rate of input through irrigation exceeds the rate of crop consumption; this can lead to water-logging (when the pores are filled with water and oxygen is lacking) and salinization (when the rising water in the soil profile is bringing diluted salts to the surface). Worldwide, about 10% of all irrigated land suffers from water-logging. As a result, productivity has fallen by about 20% in water-logged areas (Muir, 2007).

844. Salinization is a worldwide problem, which is particularly acute in semi-arid areas that use lots of irrigation water, are poorly drained, and where the salt is never completely flushed from the land. These conditions are found, for example, in parts of the Middle East, in China's North Plain, in Central Asia, and in the Colorado River Basin in the United States.

2. Groundwater use

845. While groundwater is a significant source of water, it is not evenly distributed around the world. From the water cycle, of the total precipitation (577,000 km3) falling on the Earth, 79% falls on the ocean, 2% on our lakes and only19% (110,000 km3) on our landmass. Of this, most evaporates or runs off into our streams and rivers. Only 2,200 km3 or 2% is infiltrated into our groundwater. This highlights the need to manage groundwater use. The development of the energised pump in the mid-20th century led to the emergence of many groundwater-dependent economies (Burke and Moench, 2000; CA, 2007). However, there have been warnings of the potential impacts of excessive abstraction and of the pollution of aquifers (Foster and Chilton, 2003). Reference is made for contemporary groundwater issues and specific management options on the respective web sites and publications of the World Bank-Global Water Partnership program GW-MATE and UNESCO's Groundwater Resources Assessment under the Pressures of Humanity and Climate Change (GRAPHIC) program. A partnership led by UNESCO and International Association of Hydrogeologists (IAH) implements ISARM (Internationally Shared Aquifer Resources Management) initiative as a multi-agency effort aimed at improving the understanding of scientific, socio-economic, legal, institutional and environmental issues related to the management of transboundary aquifers.

846. A more sobering conclusion drawn from detailed local aquifer studies is that where groundwater services are in heavy demand, much of the good quality groundwater has already been used. Contemporary recharge to shallow aquifers has become seriously (perhaps irrevocably) polluted, and relaxing abstraction and pollution pressure on aquifers will take considerable time (Margat, in press).

847. The historical progression of groundwater development, and the related response of groundwater systems, has not been uniformly documented. Even in post-industrial countries, political realisation of the economic and social impact of access to groundwater has tended to come late (generally after some

damage to groundwater systems has been done) and water resource management agencies, in most cases, have to play ‘catch-up’. Compared with surface water resources, there has been significantly less, and more dispersed, public investment in groundwater development and protection. In particular, it is investment in change in human behaviour that is needed, and this requires a completely different, and much less technocratic, approach (WHYMAP, 2008).

848. The groundwater implications of accelerated climate change have been highlighted (IPCC 4th Assessment) and it is anticipated that changes in excess rainfall (recharge and runoff patterns) will place an additional burden on resource management – and will concern increases in both groundwater depletion and water-table rise in different geographical regions. However, these impacts are likely to be small (and possibly negligible) in relation to the stresses placed on groundwater systems by current socioeconomic drivers.

849. In spite of the good efforts and results achieved in many countries, it is not possible to make objective worldwide estimates of the current state of groundwater use by country, economic sector or aquifer. The constraints of so doing in relation to growing importance for agricultural use through AQUASTAT have been highlighted (Burke, 2003) but also for domestic water as investigated by World Bank-GW-MATE program. Indeed, there has been little systematic updating and collection of global (national) groundwater use and resource status inventories[47]. The situation is improving in Europe with the push given by the monitoring requirements of the Water framework Directive and a joint information system to share data (The European Environment Information and Observation Network (EIONET).

850. Irrigated agriculture is the principal user of the major sedimentary aquifers of North America, North Africa, the Middle East and the Asian alluvial plains of the Punjab and Terai. But less evident is the conjunctive use associated with the concentration of irrigated agriculture and urban development in many alluvial fan/delta environments (such as those of the Mekong, Yangtze, Yellow River, Chao Praya, Godavari, Krishna, Indus, Narmada, Ganges/Brahmaputra, Nile, Mississippi, Po, etc). Reducing stress on these groundwater systems involves more than just ‘groundwater resource management’, and will also entail reducing land-based pollution, rehabilitating degraded habitats, and conservation of freshwater resources.

851. The relationship between groundwater use and socioeconomic indicators is not necessarily intuitive, and some broad paradoxes are apparent at the global level – for example, rural poverty does not appear to be linked to scarcity of groundwater resources. Some vibrant rural groundwater economies appear to thrive in spite of limited availability of groundwater; much of peninsular India is a case in point, but one in which levels of groundwater abstraction in the recent past may not prove sustainable for much longer.

852. Socioeconomic drivers of groundwater development show substantial geographical differences unrelated to resource availability. The agricultural demand for groundwater has often been spurred by both explicit and hidden subsidies for rural electrification, irrigation equipment and occasionally water well construction. Subsidised rural electrification in South Asia has been a key driver of groundwater use within existing irrigation demands and especially in ‘dryland areas’ with no surface water services. The concentration of drilling, pumping and water well maintenance services here has progressively reduced the cost of groundwater exploitation. The flat-rate electrical energy policy in parts of South Asia (and subsidised rural electricity elsewhere) is not the cause of groundwater resource overexploitation per se, but has allowed grossly inefficient use of energy in pumping groundwater from shallow low-storage aquifers in hard-rock terrains, effectively bankrupting state electricity providers (Shah et al, 2006). While the rate of agricultural growth has slowed generally over the past 25 years, the progressive adoption of

[47] UN work of Robert Dijon in the 1970s and 1980s (UN, 1983–1990), and recently of Jean Margat in UNESCO, in press.

precision agriculture (requiring on-demand, just-in-time irrigation) has considerably intensified the use of groundwater and its productivity.

853. Groundwater is a major source of urban water supply around the world (not just in megacities but also in thousands of medium-sized towns). An intimate but often little recognised interrelation between groundwater and urbanisation exists through the cycle of urban development. Some cities (e.g. Mexico DF, Lima, Dhaka, Beijing and Lusaka) are located on or near major aquifers and the corresponding urban water utilities have drawn heavily on groundwater for their supply. In others (e.g. Buenos Aires, Bangkok and Jakarta), the proportion of overall water supply derived from groundwater has reduced greatly as a result of aquifer depletion, saline intrusion and/or groundwater pollution).

854. A recent study of the water economics of the MENA region (World Bank, 2007a) noted that groundwater resource depletion appears to have reduced significantly the GDPs of certain nations – Jordan by 2.1%, Yemen 1.5%, Egypt 1.3% and Tunisia 1.2% – whilst Morocco has not experienced any impact – at least as yet.

855. Sharp points of competition over groundwater resources between urban and rural users are also now becoming more apparent. Expanding municipalities and light industrial/commercial expansion in peri-urban and linked rural areas are competing with agriculture over groundwater quantity and quality. All evidence points to an enormous disconnect between water and land-use regulations, which needs to be resolved in order to implement groundwater quality protection measures.

856. The highest management priority, though, will always be protection of the main recharge zones

857. Population and income-growth projections and associated increase in water demand will place unprecedented demands on aquifer systems. Further depletion and aquifer degradation should be anticipated unless much more investment in effective governance arrangements and management practices are widely achieved. In addition, it can be anticipated that some key aquifers will be put under further pressure as a result of climate change.

858. Economic pressure for high-quality groundwater will likely enhance regulation and protection with greater stakeholder involvement in most post-industrial economies. Some intermediate countries are also likely to follow suit if able to prioritize their efforts, but at the same time numerous opportunities for conservation of high-quality resources have already disappeared and few countries have the financial resources for wholesale remediation of aquifers.

859. In the vicinity of large urban areas, economic competition for raw water is forcing agriculture to adapt by raising its productivity and minimizing its environmental impact – or simply stop farming. The demand for ‘precision agriculture’ will be unrelenting and we can reasonably expect further concentration of agricultural activity as market chains become reinforced.

860. The tension between private and public services derived from aquifers remains. More convergent and sustainable resource use will only be achieved through substantial investment in management operations on the ground, which work primarily through community consultation and cross-sectoral policy dialogue

3. Pollution and water quality degradation

861. In spite of improvements in some regions, water pollution globally is on the rise. All economic sectors contribute to point or non-point sources, and global trade of manufactured goods continues to create more pollution.

862. Information about pollution loads and water-quality changes is lacking in large parts of the world due to inadequate monitoring systems. As a result, the often-serious impacts of polluting activities on human and ecosystem health remain largely unreported or under-reported. It is anticipated that in the absence of substantial progress in regulation and enforcement of strict pollution control, pollution will increase as a result of economic development driven by cities, industries and intensive agriculture systems. Another trend is the shifting of many industries – some of which are known to be very polluting in nature (e.g. leather and chemical industries) – from high income to emerging countries (Box 19). where they can benefit from various incentives, a cheaper workforce and less stringent environmental regulations. This represents an additional challenge.

Box 19: Asian tigers and the hidden tip of the pollution iceberg (UNESCAP, Ti)

Industrial and economic development in Asia – especially in the 'Asian Tiger' economies which have seen the highest growth rates of any single generation in history – has in many cases been at the expense of water resources. Increasing urbanization rates across Asia and the Pacific will continue to shape the parameters of water-use trends which affect the prospects for water scarcity management. While the Asian rural population is estimated to remain stable at current levels over the next 20 years, urban population is likely to increase by 60% before 2025. While attention focuses on the multiple challenges of 'mega-cities' (populations over 10 million), smaller urban areas, drawing few financial and technical resources due to their subdued political clout, are set to continue current trends of poor wastewater management practices, posing a real threat to water resources, more important than physical scarcity.

Current strategies for economic development force river degradation to the top of the water-use agenda. Malaysia, for example, recently witnessed an increase in the number of rivers deemed slightly polluted, compounded by a decline in the number of rivers considered clean. As recognition of this problem rises, efforts are increasingly being directed towards river rehabilitation.

863. The most important water-quality contaminants created by human activities are microbial pathogens, nutrients, oxygen-consuming materials, heavy metals and persistent organic pollutants (POPs), as well as suspended sediments, nutrients, pesticides and oxygen-consuming substances, mainly from non-point sources. The most important water quality issue affecting human health is microbial contamination. Inadequate sanitation facilities, improper wastewater disposal, and animal wastes are the major sources of microbial pollution. More than 80% of the wastewater discharged into freshwater and coastal areas in five of UNEP's Regional Seas Programme regions, for example, is untreated, with the figure being no better than 50% in at least eight of the regions (UNEP-GPA, 2006).

864. The most prevalent freshwater quality problem on a global scale is eutrophication, namely a result of high-nutrient loads (mainly phosphorus and nitrogen), which significantly impacts beneficial water uses (e.g. the Baltic Sea, Box 20). Major nutrient sources include agricultural runoff, domestic sewage (also a source of microbial pollution), industrial effluents and atmospheric inputs from fossil fuel burning and bush fires. Lakes, aquifers, groundwater basins and reservoirs are particularly susceptible to the negative impacts of eutrophication, given their relatively longer water residence times, complex dynamics and their role as an integrating sink for pollutants from their drainage basins (ILEC, 2005; UNEP, 2005). Nitrogen concentrations exceeding 5 mg.L-1 often indicate pollution from human and animal wastes, as well as fertilizer runoff from agricultural areas (Figure 78).

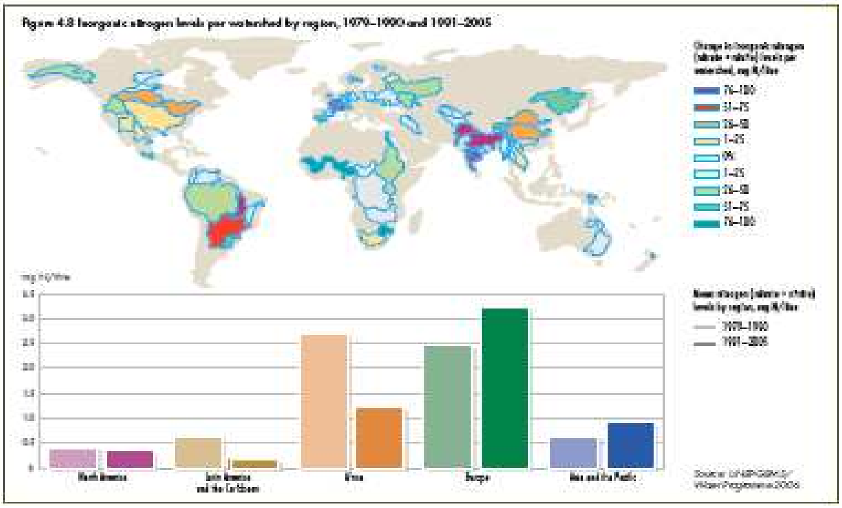
Box 20: Addressing eutrophication and its effects in the Baltic Sea

In 1998, approximately 90% of the coastal and marine biotopes in the Baltic Sea were threatened by loss of area, or by reduction in quality (HELCOM 1998). The main threats were eutrophication, contamination, fisheries and settlements. The root causes of eutrophication were considered to be:

1) Agriculture: mainly inadequate adoption of modern agricultural technology and inadequate integration of environmental and agricultural practices;
2) Urbanization: lack of investment in wastewater facilities and high urbanization rates;
3) Atmospheric deposition: from energy production and transport due to population growth and urbanization, increased sea and road traffic, ineffective laws and regulations to control emissions and lack of an adequate transport policy.

However, several activities and programmes initiated in the region and the implementation of environmental protection legislation have resulted in some improvement, as reported in the HELCOM 2003 Assessment. In the case of eutrophication, phosphorus inputs have decreased considerably in the Baltic Sea, following the implementation of measures by the Baltic Sea riparian countries. However, eutrophication still remains an urgent problem in most coastal areas (UNEP, 2005).

Figure 78: Inorganic nitrogen levels per watershed by region, 1979–1990 and 1991–2003 (UNEP GEMS/Water Programme in WWDR-2, 2006)



865. Excessive nutrient inputs also can cause a phenomenon known as harmful algal blooms. The main cause is cyanobacteria, which have increased in freshwater and coastal systems over the past two decades (e.g. East China Sea, Figure 79). The toxins produced by the excessive algal blooms are concentrated by filer-feeding bivalves, fish and other marine organisms, and can cause fish and shellfish poisoning. The toxins also have human health implications, since they also can cause acute poisoning, skin irritation and gastrointestinal illnesses. There are global warming implications associated with this phenomenon, as cyanobacteria have a competitive advantage over other types of algae at higher temperatures.

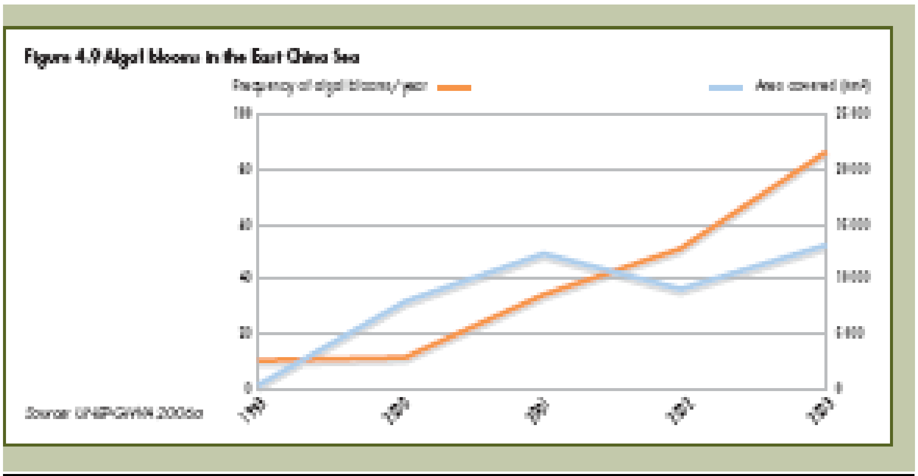


Figure 79: Increasing frequency of harmful algal blooms in East China Sea associated with increasing fertilizer use in upstream and coastal provinces (UNEP/GWA, 2006)

866. Organic materials, particularly from domestic wastewater treatment plants, food-processing work discharges and algal blooms, are decomposed by oxygen-consuming microbes in water bodies, as measured by Biochemical Oxygen Demand (BOD). Thermal stratification in nutrient-enriched lakes with high BOD levels can produce chemical conditions allowing nutrients and heavy metals in lake-bottom sediments to re-enter the water column. Lake Erie's oxygen-depleted bottom zone, for example, has expanded since 1998, with negative environmental impacts on the lake's fisheries. The eastern and southern coasts of North America, the southern coasts of China and Japan, and large areas around Europe (WWDR-2, 2006) have also undergone oxygen depletion. In addition, the world's second largest 'dead zone' has appeared off the mouth of the Mississippi River in the Gulf of Mexico, attributed to excessive nitrogen loads from the river, and with negative impacts on biodiversity and fisheries (MA, 2005). The projected need for increased food production, as well as increasing wastewater effluents, associated with increasing population over the next three decades, suggests an increase in the river input of nitrogen loads into coastal ecosystems of 10–20%, continuing a trend observed between 1970 and 1995 (MEA, 2005).

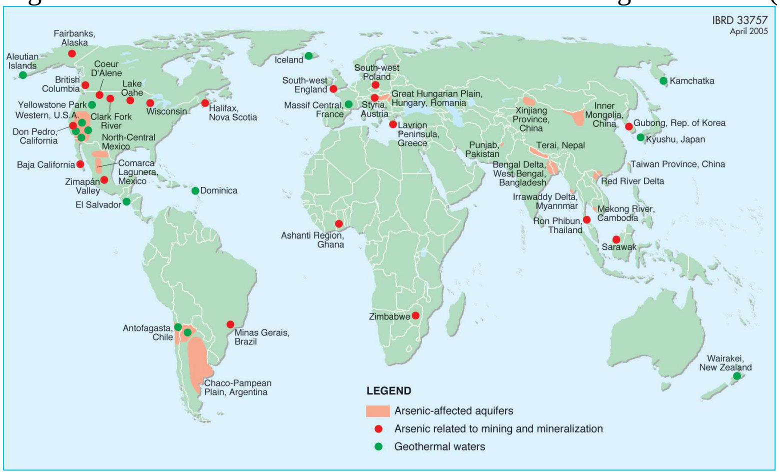
867. Some heavy metals of both natural and anthropogenic origin can accumulate in the tissues of humans and other organisms. A noteworthy example is the high natural arsenic concentration in groundwater in parts of Bangladesh and adjacent parts of India (World Bank, 2005), which is having significant human health impacts in these regions (Box 21). Mercury and lead from industrial activities, commercial and artisanal mining, and landfill leachates are also major human and ecosystem health concerns in some locations, with emissions from coal-fired power plants being a major source of mercury accumulating in the tissues of fish that reside at the top of fish trophic levels.

Box 21: The arsenic crisis: no solution as yet

It is now some 10 years since the extent of the arsenic poisoning disaster in Bangladesh became known to the international community, when high levels of arsenic were found in tube wells that were constructed for drinking water purposes. Today, up to 70 million people in Bangladesh are exposed to water that contains more than the threshold value of 10 micrograms arsenic per litre as indicated in WHO guidelines. Up to half of the estimated 10 million tube wells in Bangladesh might be contaminated with arsenic.

An additional reason for concern is the large amount of arsenic-contaminated groundwater used for irrigation with the resulting appearance of arsenic in the food chain. Natural arsenic pollution of drinking water, although originally linked to Bangladesh and the State of West Bengal in India, is now considered a global threat with as many as 140 million people affected in 70 countries on all continents.

Figure –Documented zones with excessive arsenic in groundwater (World Bank, 2005)



868. An emerging water-quality concern revolves around the potential impacts of personal-care products and pharmaceuticals (e.g. birth-control residues, painkillers and antibiotics) on aquatic ecosystems. Little is known about their long-term human or ecosystem impacts, although some are believed to be endocrine disruptors. Only time and further study will provide the necessary data and information to further analyse this potential environmental and human health threat.

869. The human-generated water pollution problem is a serious threat to human and ecosystem health, but its importance is hard to quantify. Despite monitoring inadequacies, there are local signs that decreased quality of domestic water supply sources are becoming a major concern in many countries (Figure 80).

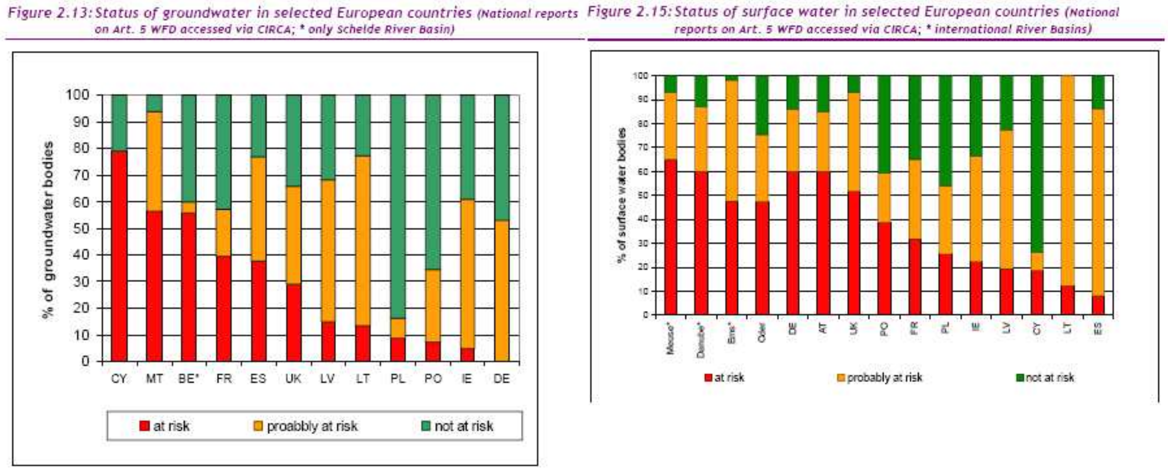


Figure 80: Groundwater and surface water at risk in Europe and the Mediterranean (AQUAREC, 2006b)

870. The ecological footprint of consumption (WWF, 2006) shows the regions where human activity needs are well above the respective regions' biocapacity, effectively implying that such regions are running an ecological deficit, and are increasingly dependant on the natural wealth and resources of other countries.

871. The level of pollution is a function of the structure of a country's economy and its institutional and legal capacity to address it. Groundwater systems are the most vulnerable freshwater resource as contamination, once present, is difficult and costly to reduce – if technically feasible at all. Non-point sources, such as leaching of excess nitrates or pesticides used on agricultural lands or heavy metals in mines can take decades to reach the aquifers and when they do, it is often too late to act or too expensive. With an increasing load of chemical substances being discharged into receiving water systems and agricultural lands, uncertainties persist about the long-term effects of these chemicals on human and ecosystem health. A recent study on drinking water in France considered that more than 3 million people (5.8% of the population) were exposed to drinking-water quality that does not conform to WHO standards (for nitrates, non-conformity above 50 ml/g were found for 97% in groundwater samples[48].

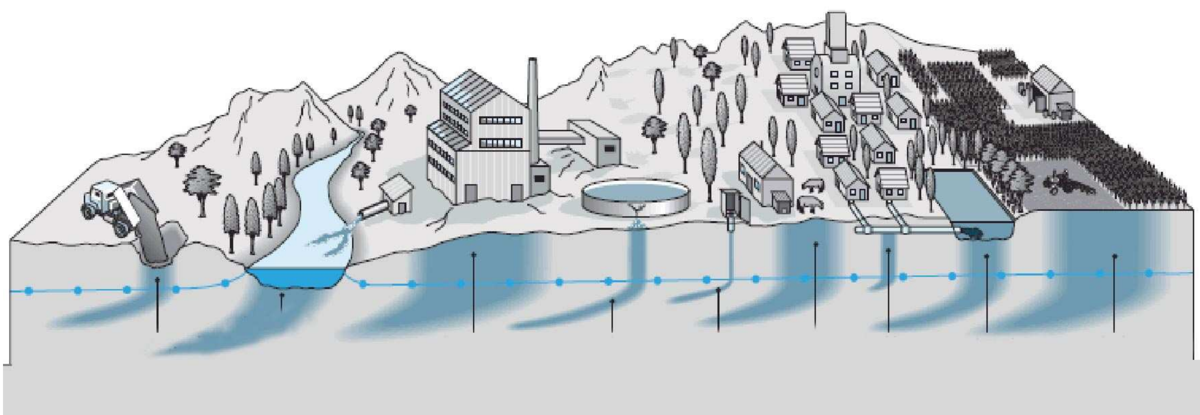


Figure 81: primary sources of groundwater pollution (WWDR-2, 2006, p. 140)

[48] RE: (Ministere de la santé et des solidarités, République française, l'eau potable en France, 2002-2004, eau et santé, guide technique H2O).

872. Water quality monitoring is one of the most serious monitoring challenges that the water community needs to address. The pollution threat is evident (OECD, 2008), but hard to quantify globally. This is because there is little globally-comparable monitoring data and information on pollution flows and loads, particularly with regard to non-point pollution. UNEP's Global Environment Monitoring System (GEMS/Water), hosted by Canada, has maintained a global water quality-monitoring programme for several decades, but has been limited in its spatial coverage and the water quality parameters being measured. For high-income countries, regulations on water pollution are increasingly strict, leading to investment in water treatment, reduction of discharged pollutant loads, monitoring of performance and subsequent higher water costs. For developing countries, local pollution from cities and agriculture are usually not monitored, therefore, measurements of its impact on human and ecosystem health are largely non-existent. Nevertheless, known local pollution events and disasters, the importance of some pollution sources, and limited levels of treatment of discharges in many developing countries, collectively indicate continuing pollution problems in many regions of the world.

873. Storm-generated runoff from agricultural and urban areas is the most important non-point pollutant source (e.g. leaching of nitrates with runoff accumulated in rivers) in both developed and developing countries. Further, as point sources (e.g. sewage discharge of a city) are becoming more controlled, the greater importance of non-point pollutant loads is increasingly becoming recognized. The US Environmental Protection Agency, for example, indicated that agricultural activities contribute the largest quantity of pollutants to receiving water bodies in the United States, and the situation is probably similar in many other countries (e.g. Quebec in Canada, Box 22).

Box 22: Quebec's lakes, rivers in sorry state (The Gazette, 5 August 2008)

Recent counts indicate that 156 lakes and rivers are affected by algal blooms (cyanobacteria also known as blue-green algae) – an increase of 49 from last year and 106 from 2005. This is not a new problem but over the last decade, algae seem to have flourished out of control because of an excess of nutrients in the water – mainly phosphorus, nitrogen and carbon. Liquid fertilizer from agricultural lands is an often-cited culprit, but other sources include run-off from golf courses, phosphates in dishwashing detergent, human waste from badly maintained septic tanks or hole-in-the-ground toilets, shoreline erosion caused by deforestation and even nitrogen and carbon settling in water.

874. Localized pollution occurs frequently with mining activities. UNECE considers that mining activities have severe impacts on water and the environment in Eastern Europe, Southeast Europe, the Caucasus and Central Asia. In some basins (e.g. in Belarus, Kyrgyzstan and Tajikistan), the mining industry (copper, zinc, lead and uranium mining) represents a major past or current pollution source, with numerous storing facilities (e.g. tailing dams for mining wastes) representing significant risks (UNECE, 2007; Box 23).

Box 23: Mining: long-term impacts on ecosystems in transitional economies

While pollution-abatement technologies exist for hazardous substances, their use in countries with economies in transition is limited to the minority of economically-viable industrial plants.

A well-known mining-related accident took place in Baia Mare in Romania. A dam holding tailings from gold extraction overflowed in January 2000, leading to the release of about 100,000 cubic metres of waste, including about 70 tonnes of cyanide and other heavy metals. The spill affected local rivers, interrupting the drinking water supply for about 24 communities in Romania, and causing the death of several thousand tons of fish. After this accident, several EU directives and national laws were enacted to improve the safety of mining facilities, and most mining companies are now using improved technology (UNEP, 2000; UNEP-GRID, 2007).

On August 29, 2003, the Sasa lead and zinc mine, located in the north-eastern part of the FYR Macedonia, released approximately 486,000 tons of mine tailings into the Kamenicka River. Large quantities of toxic heavy metal deposits, including lead, zinc, cadmium, manganese, copper, nickel, arsenic and cyanide, and the release of acid rock drainage to surface and groundwater, led to acidification, degradation of water resources, accumulation of metals in sediments, and bioaccumulation, with severe ecological impacts. This industrial pollution accident contaminated the water source that supplies irrigation water for 25,000 ha of farmland, with negative consequences to the economic and environmental and agricultural viability. The figure below shows the multiple pollution hotspots around mining sites – the result of a long history of mining and industries with limited pollution prevention (FAO project document; UNEP-GRID, 2007).

4. Mitigating Pollution: progress in urban and rural areas

875. There are signs of progress in the way pollution and risks are addressed in and across different sectors.

876. The 'polluter pays' principle has stimulated changes in attitudes towards the pollution problem. There is well-documented evidence that the costs of inaction are high (high rehabilitation costs of polluted rivers, health-related costs, etc.) and that some impacts are nearly irreversible (contamination of groundwater drinking water, ecosystem lost) (OECD, 2008). Polluted water has a high human health cost. One-tenth of the global burden of disease (measured in DALYs -Disability-Adjusted Life Years -) can be attributed to water, sanitation and hygiene (WASH), and water/environmental factors (Fewtrell et al, 2007). Other pollution costs include clean-up outlays, increased treatment, and damage to fisheries, ecosystems and recreation, and costs to public health. Most countries have introduced legislation to protect their water resources, but implementation often lags behind because of the spread of responsibilities between the various institutions involved, and the costs entailed by a control and monitoring role.

877. Improved sanitation by itself is insufficient to achieve pollution mitigation objectives and requires the addition of sewage treatment[49] in order to mitigate impacts on both the environment and human health. Conventional sewage treatment consists of reducing biodegradable organic material, suspended solids and nutrients, such as nitrogen and phosphorus. Sewage treatment thereby protects the aquatic environment. Over 80% of sewage in developing countries is today discharged untreated, thereby polluting rivers, lakes and coastal areas (Scott et al, 2004) (Box 24 and Box 25).

Box 24: The realities of wastewater treatment and use

Results from a nationwide survey in Pakistan:

[49] Definitions: **Sewage treatment, or domestic wastewater treatment**, is the process of removing contaminants from wastewater, both runoff and domestic. It includes physical, chemical and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce a waste stream (or treated effluent) and a solid waste or sludge also suitable for discharge or reuse back into the environment. This material is often inadvertently contaminated with toxic organic and inorganic compounds. There are three main types of wastewater treatment systems. **Primary treatment** (mechanical treatment technology) removes part of the suspended solids, but no ammonium, while **secondary treatment** (biological treatment) uses aerobic or anaerobic micro-organisms to decompose most of the organic matter and retain some of the nutrients (around 20–30%) and removes around 75% ammonium; **Tertiary treatment** (or advanced treatment technology) removes the organic matter even more efficiently than secondary treatment. It generally includes phosphorus retention and in some cases nitrogen removal.

- Percentage of cities (population of over 10,000) with wastewater treatment facilities – 2%
- In cities with treatment facilities, estimated percentage of wastewater that receives treatment – less than 30%
- Amount of wastewater used directly for irrigation – 2,400,000 m3/day
- Amount of untreated wastewater disposed of in irrigation canals – 400,000 m3/day
- Percentage of wastewater generated daily that is used in agriculture: 36% (direct use – 31%, through contaminated canal water – 5%)
- Percentage of wastewater generated daily that is disposed of in rivers or the Arabian Sea – 64%

Source: IWMI, 2003.

Box 25: A wastewater river

The Musi River runs through the city of Hyderabad, one of the fastest growing cities in India with a population of 6.8 million in 2005, which is expected to exceed 10 million in 2015. The mostly untreated domestic and industrial wastewater from the city fills the dry riverbed, converting it into a perennial wastewater river. The wastewater from the Musi in the (peri-) urban areas provides livelihoods to low-income groups of urban dwellers and migrants from rural areas in a hidden economy, neither recognized nor supported by the local government. Downstream of the city, Musi water is retained in large and small reservoirs with the help of weirs and, from there, diverted into irrigation canals and village tanks to be used by farmers for crop production, mainly rice.

A clear improvement in appearance and smell of the river water can be observed. A water quality survey conducted over a 40 km transect of the Musi River downstream with increased distance from the city indeed showed an impressive improvement in water quality.

Infection rates of farmers with intestinal nematodes are significantly higher close to Hyderabad than further downstream. Prevalence of hookworm infection was more than 50% along the most polluted stretch close to the city against around 20% at 10 km and 40 km distance. At all sites, the risk of hookworm infection was significantly associated with the use of untreated wastewater.

Water from the Musi River sampled at 0, 5, 10, 14, 18, 20, 30 and 40 km downstream of Hyderabad.

Sources: Ensink et al, 2007; Buechler and Devi, 2003; van Rooijen et al, 2005.

878. The level of treatment of urban wastewater is far from satisfactory in the world – even in developed countries – but for most countries sufficient data is lacking to adequately report on it. OECD (2007) indicates a broad range of tertiary treatment from 3.6% in Turkey to 90% in Germany.

879. In most medium and low-income countries, the wastewater collected is discharged directly into the sea or rivers without treatment. Urban wastewater constitutes a significant pollution load, and is particularly hazardous when mixed with untreated industrial wastes – a common practice. Many large

cities still have no treatment plant or plants quickly undersized as investments do not seem to cope with urban population growth. In many areas of the developing world, waterborne sanitation systems and pollution mitigation facilities may not be the most sustainable option, and other improved facilities may be more suitable (e.g. using lagoons – a simpler and cheaper option for collective units; eco-sanitation units for rural households, etc).

880. Pollution in developed countries is progressively coming under control. Europe's Urban Wastewater Treatment Directive has resulted in significant improvements in urban wastewater treatment capacity over the last 20 years, with more advanced wastewater treatment becoming increasingly common (Box 26).

Box 26: Setting target for pollution mitigation and limits for reuse – the example of Europe

The Urban Wastewater Treatment Directive (UWWT) of the European Union (EU) prescribes the level of treatment required before discharge. It requires Member States to provide all agglomerations of more than 2000 population equivalents (p.e.) with collecting systems. Secondary treatment (i.e. biological treatment) must be provided for all agglomerations of more than 2000 p.e. discharging into fresh waters and estuaries and for all agglomerations of more than 10,000 p.e. discharging into coastal waters. Special requirements are placed on the performance of the treatment on 5 different determinants (BOD, COD, TSS, Ntot and Ptot).

For agglomerations smaller than those described above and those equipped with a collecting system, the treatment must be appropriate, meaning that the discharge allows the receiving waters to meet the relevant quality objectives. Recent developments through a European project (AQUAREC) propose seven categories of water quality for different types of reuse, and compile microbial and chemical limits for each category. The limits are based on recently published guidelines and risk estimations for the available information, including the most important microbial parameters.

(EEA website; Salgot et al, 2006)

881. Although the European Environment Agency has welcomed the improvements, it has stressed the low performances of southern European wastewater, where less than 50% of the population is connected to a treatment plant, and only between 30 and 40% to a secondary or tertiary treatment system (e.g. 24% in Italy, 10% in Greece and only 3% in Spain). In northern Europe, most of the population is connected to tertiary wastewater plants. Similar situations are observed in the OECD countries. For example, Turkey reports in 2004, 69% of the population connected to a collection system with only 38% to a joint collection and treatment plant (Eurostat, online data base, consulted 1 July 2008).

882. Increasingly, sewage is being seen as a resource. It is already reused in water-stressed countries and for different purposes when actively enforced. Farmers in peri-urban areas use their streams for agriculture and aquaculture as in the past, but now increasingly alongside wastewater and the nutrients in it – often because it is the only water they can access. Wastewater flows are typically more reliable than freshwater sources and nutrient-rich for the cultivation of high-value crops. Authorities mostly reject this practice due to the potential human health risks and because it interferes with the operation of installing wastewater treatment plants. However, wastewater treatment almost always has a lower priority than the provision of safe drinking water and improved sanitation, particularly in municipalities with limited financial and control capacities. Enforcement of water quality standards is often complicated by the fact that it is unclear who should enforce these standards: health, agricultural or water supply and sanitation agencies?

883. In Phnom Phenh, Hanoi and Ho Chi Minh City, the most important health problem perceived by farmers themselves as being related to wastewater exposure was skin disease (Anh et al, 2007a). In

subsequent epidemiological studies it was confirmed that contact with wastewater was an important risk factor for dermatitis[50] among farmers engaged in wastewater-fed peri-urban aquatic food production (Anh et al, 2007b). Water spinach cultivated in the wetlands that receive wastewater from Phnom Penh, was highly contaminated with faeces, as indicated by high concentrations of indicator bacteria and the presence of protozoan parasites. However, a reduction in bacterial numbers almost to WHO guideline levels for irrigation water occurred through natural biological and physical processes in the lake, as shown by differences in bacterial counts at wastewater entry and exit points (Anh et al, 2007c).

884. Industrial wastewater, expressed in terms of the volume of Biological Oxygen Demand (BOD) per year, has stabilized over the past 20 years in industrialized countries, or even decreased slightly, as seen in Eastern Europe.

885. Industrial pollution is expected to increase in emerging economies with the economic and industrial development boom. More than half of China's 21,000 chemical companies have factories along the country's two major river basins – the Yellow River and the Yangtze River – which supply drinking water for tens of million of people. This means that industrial accidents could have disastrous consequences in these regions. (http://www.minesandcommunities.org/Action/press973.htm).

886. OECD (2008) reports evidence of larger investments in Change in Production Process technologies (CPP). There is a steady growth of companies seeking certification through ISO 14001 (the current international environmental standard administered by the international organization for standardization). By the end of 2002 (IFEN, 2006), nearly 50,000 companies in 118 countries had received this certification; Japan and China have the largest number of certified companies (Figure 82). The globalisation of the economy can contribute to cleaner production even with the delocalisation of polluting activities to countries with lower environmental standards. Many multinational enterprises apply high environmental standards to their activities worldwide, introducing environmental management systems to increase environmental performance, thus contributing to the globalisation of better corporate practices (WBCSD, 2005).

[50] Dermatitis (eczema) is an inflammation of the skin, which causes itching, with a red rash often accompanied by small blisters that weep and become crusted.

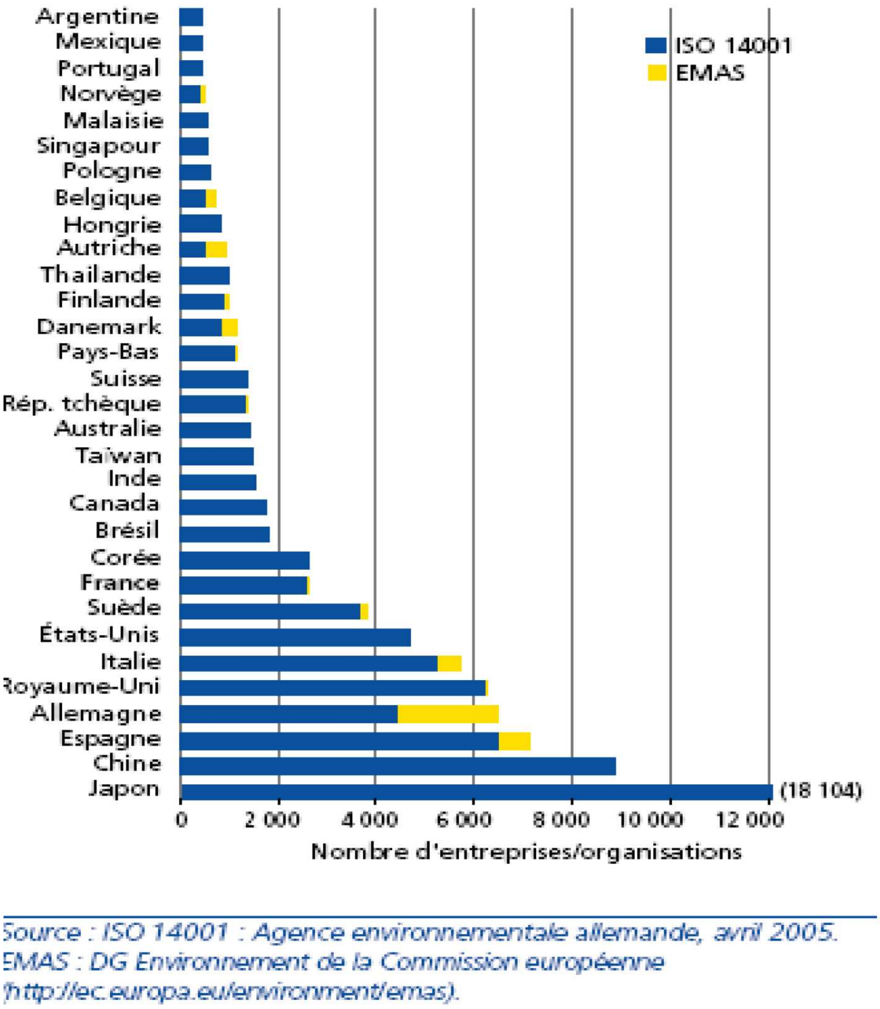


Figure 82: International comparison of companies having a system of environmental management in 2005 (IFEN, 2006 based on data from ISO 14001 certification and on European certification systems EMAS)

887. Non-point pollution from agricultural land-use practices and urban areas often presents a greater problem in terms of total pollutant loads than industrial point-source pollution – and is certainly more difficult to control when leached into aquifers. Certain types of agricultural monoculture and in-situ sanitation may be incompatible with groundwater quality protection (alternatives like more balanced agricultural land-use and alternative sanitation measures will be required in these priority areas). Pesticides, in particular, tend to migrate throughout the environment, with the ultimate sink being fatty tissues (fish) and sediments. Pesticide contamination has increased rapidly, particularly in freshwaters of developing countries since the 1970s, despite increased regulation of the use of these bio-accumulating and highly persistent substances, with the result being adverse effects on the environment and human beings. Rivers that drain major catchment areas, which have intensive agriculture (e.g. Danube, Yellow River, Po, Ebro, Nile and Mississippi), are main vectors for transmitting pollutants to the sea and often cause serious eutrophication problems. It is estimated that the nitrate load in the 80 main rivers flowing into the Mediterranean Sea, for example, doubled between 1975 and 1995 (Blue Plan, 2006).

888. Total commercial fertilizer consumption in the agricultural sector in some high-income countries has stabilized, or even decreased, since the 1990s, after a period of high growth between 1960–1990

(FAOSTAT). Other countries still exhibit a high increase in fertilizer use (4% per year in Syria between 1985–1997; 2% in Turkey, 1.3% in Egypt); while use could be increased by 50 to 70% by 2025 in Turkey (Blue Plan, 2006). Information on pesticide consumption is less available, although pesticide consumption has stabilised in France (the world's second biggest user). These data provide only very indirect information on the discharge of pollutants into the environment.

889. To improve its environmental performance, non-point sources activities – such as agriculture – need to act at the source and limit the use of nutrients and change production processes. In fact, there is a growing interest in sustainable farming approaches (e.g. conservation agriculture, integrated plant protection and plant nutrition management). The situation regarding phosphorus as an algal-growth nutrient was stabilized after its use in washing detergents was restricted in many locations.

890. While charging polluters for the damage they impose on society is now widely accepted under the 'polluter pays' principle, pollution charges have had only a partial impact on polluters' behaviour, partially because the charges are rarely set high enough to affect behaviour, but also because authorities have difficulty knowing at what level the charge should be set.

891. An alternative form of pollution control is to create trading systems for water pollution quotas. Authorities can begin by setting overall limits on the emissions of pollutants into a specific water body. These could be reduced over time in order to progressively improve water quality. Polluters would be allocated emissions quotas based on current or recent practices. Alternatively they could bid for quotas, which would raise revenue for public authorities. Polluters who were able to reduce emissions would be able to sell their quotas to others who were less able to do so. Thus, all polluters would have an incentive to reduce emissions, and the bulk of abatement would be carried out by those who could do it more efficiently and cheaply. However, such trading should respect land zoning, and such areas be monitored and controlled to protect in particular ' invisible' aquifers.

892. In practice, trading schemes for water pollution quotas are rare, and, for essentially practical reasons, difficult to apply successfully. This model is also difficult to apply to farmers – an important source of non-point (diffuse) water contamination (Kraemer et al, 2003).

5. Progress in achieving environmental sustainability

893. Our capacity to achieve environmental sustainability has improved but remains constrained by several factors including a lack of full understanding of the impact of pollution and the resilience of ecosystems; a lack of monitoring of negative impacts of water use of the environment; and in many developing countries, the institutional weaknesses that prevent effective implementation of legal instruments. Some promising developments, however, exist and are discussed below.

894. The concept of environmental services is now widely acknowledged as a way to recognise the services provided by nature, although economic valuation of these services, estimates of environmental flows (IWMI–GEFC tool; IUCN, 2003), and benefits remain problematic (Box 8.5.1). The process is based upon multi-stakeholder dialogue and negotiation where ecosystem services are valued and recognized. (Box 27).

Box 27: Environmental flow assessment in Asia: from concept to reality

'Environmental flows' (e-flows) is an emerging concept in Asia. It refers to a water regime within a river, wetland or coastal zone necessary for maintaining ecosystems and their benefits where there are competing water uses. The e-flows concept is targeted at reversing trends that disconnect ecosystems from livelihoods, instead placing emphasis on how water management strategies may impact water.

Research in Asia and the Pacific shows that 23 out of 48 countries are currently undertaking some activity on environmental flows (funded by Australia, Japan and New Zealand). These countries are moving towards integrating and implementing an e-flows approach into local, regional and state planning processes and national legislation and policies. China, Korea, India, Nepal, Pakistan, Cambodia, Lao PDR, Malaysia, Thailand and Viet Nam have all adopted the approach (IWMI, 2005) and, in some cases, may incorporate e-flows within national legislation and policies. Explicit consideration of e-flows in the national water accounts is a further step towards recognition of environmental water demands. Interest in adopting e-flows is also growing roots in Bangladesh, Iran, Sri Lanka, Indonesia and the Philippines, as well as a number of Central Asian countries. In the Huai He River basin in Northern China, about 0.4% of total water use is devoted to the maintenance of the environmental flow (table below).

Composition of water uses in the Huai He River basin in China:

Haihe River system water uses	Uses	Percentage of total use (%)
Total water uses	43.2 km3	
Domestic	2.6 km3	6
Industry	7.05 km3	16.3
Agriculture	33.41 km3	77.3
Environmental flow	0.14 km3	0.4

Source: adapted by UNESCAP from Ministry of Water Resources of China, and Newsletter on environmental flow management in Asia.
(Newsletter on environmental flow management in Asia.
http://www.iwmi.cgiar.org/health/ef_news/index.htm)

895. However, evidence of effective implementation of environmental flows is still limited. Lessons drawn from where e-flows have gained ground indicate political support is perhaps the most crucial element. Strong community interest, pressures from a river basin critically degraded due to over-allocation, and donor-driven or instigated overdevelopment projects have each played important functions in the operationalization of the concept. E-flow adoption and implementation was particularly strong where national legislation and policies placed e-flows as a priority within an IWRM framework, and where it was also integrated into natural resource management plans at the basin scale.

896. Inversely, examples abound where interest in e-flows has failed to be converted into legislative implementation. Chief among these is lack of understanding of the socioeconomic benefits of e-flows, of political will to support implementation, and a lack of proper legal, institutional and monitoring arrangements. In Asia and the Pacific, large transboundary river basins present a special challenge in the application of e-flows. With 38 major watersheds, 21 of which are shared between two or more countries, increased cross-border collaboration is needed despite the higher cooperation costs of addressing e-flows in river restoration and other projects.

897. Increasing attention to ecosystem services provides an opportunity to emphasize multi-functionality within agro-ecosystems and the connectivity between and within agro-ecosystems and other ecosystems. Paddy fields are a well-documented example of the multi-functionalities of agriculture (CA, 2007; Barker et al, 2006).

898. In the urban environment, productive sanitation is an example of improved management of domestic wastewater, making it a resource. Productive sanitation closes the loop on sanitation where human excreta are processed into safe fertilizers, which can then be used to safely grow crops. Experiences are still scattered, but there is strong evidence that such practices offer multiple advantages (SIWI and Box 28).

Box 28: Developing productive sanitation systems in West Africa

The Regional Centre for low-cost Water Supply and Sanitation (CREPA) is an inter-state institution covering 17 countries in West and Central Africa. CREPA is currently developing an action-research project on the reuse of hygiene-proof urine and faeces for agricultural purposes, known as productive sanitation systems (PSS). PSS represents a strategic opportunity to improve the food-security situation in rural West Africa. The average human produces 500 litres of urine and 50 litres of faeces per year (Jönsson et al, 2004). This is equivalent to about 5.5 kg of fertilisers per capita per year varying from region to region, depending on food intake. The rule of thumb is that one day of urine from an adult is sufficient to fertilize 1 square metre of cropped area.

The main methodology used by CREPA was first to raise interest among farmers and local stakeholders of PSS, and secondly to technically-support the pilot projects with adapted and low-cost technology.

After two years of demonstration activities, farmers in all seven countries participating in the project now use urine as a fertilizing agent on different types of crops (e.g. cassava, cotton, lettuce, tomatoes, cabbage and gombo).

(CREPA website: http://www.reseaucrepa.org/page/778)

899. Managing the multiple ecosystem services of water use to optimize benefits and minimize impacts is another promising avenue. Urban wastewater use for agriculture production could be an example whereby farmers act as environmental stewards re-using the water, avoiding pollution direct discharge in nature, and safeguarding quality water for domestic uses (ICID working group on Use of Poor Quality Water for Irrigation in Ragab Ragab and Sasha Koo-Oskima, 2006). This multiple role played by the farmer should be recognized and valued through economic incentives from other sectors[51](ICID, 2006). This is the aim of programmes such as Green Water Credits in Kenya (Box 29).

Box 29: Green Water Credits in Kenya (IFAD)

Over the last 25 years, much of the cropland in Kenya has lost its topsoil while over the same time period the population has roughly doubled, increasing demand for domestic food and power. The IFAD-supported Green Water Credits (GWC) initiative is an innovative mechanism for rewarding rural people for sustainable water management practices. The long-term goal of this Paid Environmental Services programme is to help empower upstream rural communities so that they can better manage their land and water resources.

The primary results are improved food and water security both upstream and downstream in the watershedIn the Tana River Basin project, Kenya, key by-products were:

- Asset-building of rainfall management
- More stable and productive soils (less silt downstream)
- Decreased flood and erosion potential
- Diversified rural livelihood income sources
- Improved water resource delivery downstream.

The timing of this market-based scheme to improve land and water management is particularly appropriate, since Kenya is actively reforming its entire water sector with an eye to sustainability. The GWC programme in the Tana River Basin in Kenya was strategically aligned with recent Kenyan water sector reforms (REF).

[51] A reference to the ICID working group on Use of Poor Quality Water for Irrigation is available in the ICID Publication No.86 (September 2006 Kuala Lumpur IEC International Workshop)

REF: http://www.isric.org/UK/About+ISRIC/Projects/Current+Projects/Green+Water+Credits.htm

900. At the international level, multiple frameworks (often born after a major crisis) support the protection of freshwater systems and the mitigation of impacts. The OECD monitors the level of commitment to these instruments by its member countries (OECD environment online compendium). Some of the most important instruments for pollution mitigation and water resources conservation are:

- Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1972), which obliges parties to prevent, control and reduce water pollution from point and non-point sources.
- RAMSAR convention for wetlands protection (1972), and Convention on Biodiversity (date to add) for all ecosystems.
- Convention to Promote Environmental Impact Assessment (ESPOO convention, 1991).
- Convention for the Reduction of Pesticides (Rotterdam, 1998),
- -Conventions or agreements focused on pollution in shared receiving bodies, such as regional conventions (Barcelona Convention on the Protection of the Mediterranean Sea Against Pollution set in 1976; Baltic in 1992) and basin agreements (Rhine Cooperation).
- Processes such as the CSD process, the outcomes of the Rio and Johannesburg Summits (provide the full names) including Agenda 21 (Chapter 18), which support 'sustainable use', or IWRM plans that promote integrated water resource management and monitoring.

901. The International Commission for the Protection of the Rhine (ICPR) gathered together nine states in the 1950s. It stimulated major improvements in river quality by setting quantified pollution reduction targets for some key parameters in its Rhine Action Programme, together with a monitoring programme to control performance (ICPR web). Point-source pollution has been significantly reduced so that, today, efforts to further improve the water quality are directed towards reducing pollution of diffuse origin. Unfortunately, in most cases, such quantified targets are lacking, which limits the assessment of progress – as can be undertaken with air emissions (Kyoto Protocol) – that stimulate political actions, monitoring and reporting performance.

902. At regional and national levels there are also specific regulations on pollution control or water rights/allocation. In Europe, member states have to comply with various European legislations focused on water issues (Figure 83) including the Water Framework Directive (2000) and the Urban Waste Treatment Directive (1991), as well as set deadlines for implementation (few countries are yet in conformity with the directive, Figure 84).

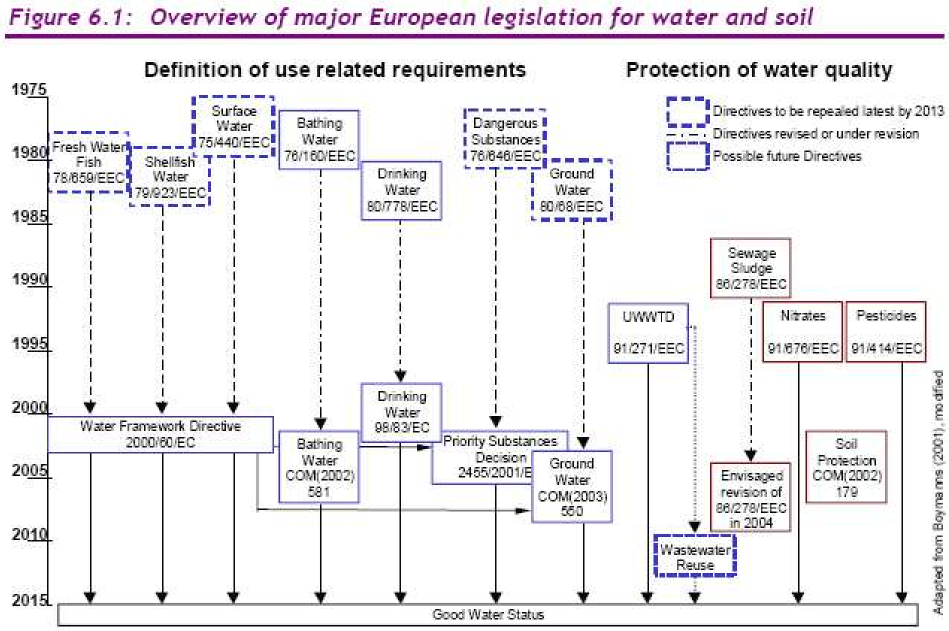


Figure 83: Overview of major European legislation for water and soil (AQUAREC, 2006b)

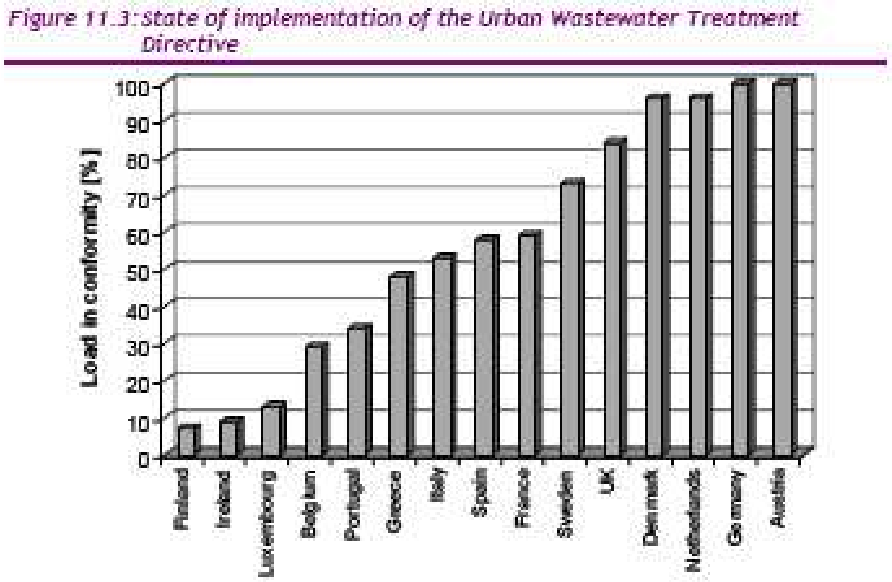


Figure 84: State of implementation of the urban wastewater treatment directive (AQUAREC 2006b)

K. Why Stepped-up Societal Responses Are Needed to Manage Competition and the Pressure on Ecosystems

903. Competition for water and shortcomings in its management to meet the needs of society and the environment call for stepped-up societal responses through improved water management. Challenges include wise planning for our water resources, the evaluation of the availability and needs in a watershed, possible needs for reallocation or addition of storage to existing reservoirs, the increasing emphasis on

water management, the need to balance equity and efficiency in water use, the inadequacy of existing legislative and institutional frameworks, and the increasing financial burden of aging infrastructure. Substantial efforts are needed in regulation, mitigation and management operations, primarily through community consultation and cross-sectoral policy dialogue.

904. Competition for water exists at all levels, and is forecast to increase with demand in almost all countries; in 2030, 47% of the world population will be living in areas of high water stress (OECD, 2008). Water management around the world presents major shortcomings in terms of performance, efficiency and equity. Water-use efficiency, pollution mitigation, and implementation of environmental measures are low in most sectors. Access to basic water services – for drinking, sanitation and food production – remains insufficient in a large part of the developing world, and more than 5 billion people – 67% of the world population – may still be without improved access to sanitation in 2030 (OECD, 2008).

905. The growing abstraction of water by individual users and state-initiated projects has approached and, in some cases, exceeded the threshold of renewability of water resources in a number of river basins, leading to widespread damage to ecosystems. The demand for water is often highest when availability of resources is lowest, and water shortages and conflicts have increased accordingly. This trend has been paralleled by degradation in quality of both surface water and groundwater due to the combined effluents of cities, industries and agricultural activities. This has compounded water scarcity by rendering water unfit for certain uses and has impacted human and ecosystem health.

906. Water resources become increasingly diverted, controlled and used as development takes place. Water flowing out of sub-basins is often committed to other downstream uses, impacting outflow to the sea, which has several often overlooked functions: flushing-out sediments, diluting polluted water, controlling salinity intrusion, and sustaining estuarine and coastal ecosystems. When river discharges fall short of meeting such commitments during part of, or throughout, the year, basins (or sub-basins) are said to be closing or closed (Molle et al, 2007). Hydrology, society and ecology are all interconnected. As water in a basin increasingly is allocated, this can lead to basin closure. In other words, water no longer flows out from the basin – as is happening in the River Jordan (Box 1).

Box 30: The closure of the lower Jordan river basin

The lower Jordan River, downstream of Lake Tiberias, flows through the Jordan rift valley before emptying into the Dead Sea. Due to the redirection of the upper course by Israel, the river now mostly receives water from the Yarmouk River, a tributary originating in Syria, and from a few lateral wadis that incise the two mountain ranges that run parallel to the valley on each side. The catchments of these wadis and the Jordanian part of the Yarmouk river basin form the Jordanian part of the Lower Jordan river basin (LJRB). These highlands concentrate most of the population and the cities, together with the bulk of the country's rainfed agriculture and increasing groundwater-based irrigation. The eastern bank of the Valley developed 23,000 ha of irrigated land as a result of derivation of the Yarmouk and side wadis.

Today, the LJRB has undergone a drastic squeeze with 83% of its flow consumed before it reaches the Dead Sea (diversions in Israel and Syria; 45,000 ha of irrigated land, mushrooming cities swollen by waves of refugees from Palestine, Gulf countries and, more recently, Iraq, and finally the new Wehdah dam reservoir on the Yarmouk River).

The consequences of this squeeze include: a limited (albeit desirable) scope for efficiency improvement; increased recycling and use of treated wastewater in irrigation; reallocation of water from the valley (irrigation) to the highlands (cities); environmental degradation (overdraft of aquifers in Azraq oasis; a declining Dead Sea that now receives less than 250 Mm3); a surge of costly supply-augmentation projects aimed at tapping distant aquifers (Disi), transferring water from the Red Sea to the Dead Sea, or desalinating saline water; increased irregularity and uncertainty in supply for the residual user (irrigation

in the valley); and a more politicized and contested water policy, whereby costs and benefits are apportioned across social/ethnic group and sub-regions that yield different levels of power.
(Courcier et al, 2005)

907. But water also connects aquatic ecosystems. Relationships between land, water and biota are very complex and cross-impacts are often not easily discernible at first sight. Groundwater abstraction generally reduces flows from underground reservoirs back to the surface: in many instances springs have been affected and wetlands have been depleted. In Azraq, Jordan, for example, groundwater use for cities and agriculture has resulted in the desiccation of a Ramsar wetland associated with a high biodiversity and migratory birds. Impact of dams on flood-pulse regimes have altered complex ecosystems that were providing valuable services and supporting livelihoods (fisheries, receding agriculture, pastures, reeds, medicinal plants, etc). The Senegal Valley or the Hadejia' Jama'a plains in northern Nigeria are classic examples (Narreteau et al, 2001; Neiland et al, 2000).

908. The conflict between agriculture and cities (urban and domestic sectors) is paramount. This reflects the fact that half the world lives in cities – a percentage due to increase in the future – while agriculture is generally the largest user.

909. Another common inter-sectoral conflict lies between hydropower and other sectors, notably agriculture and fisheries.

910. Dams, irrigation schemes and cities all consume water or change flow pathways. Negative consequences are disproportionally borne by the poor and the environment, which appears to be the residual user. Massive upstream diversions have typically impacted downstream lakes or deltas, such as in the Colorado or the Indus basin. Diversion of the lower Ganges River by the Farraka Dam damaged the ecology of the Sunderbands wetlands and the interlinking of northern and southern rivers in India would dramatically compound these impacts on the whole Ganges-Brahmaputra delta. Excess use of groundwater in many large-scale coastal cities (Lima, Jakarta, Chennai, Tel Aviv, etc.) has depleted local aquifers and allowed seawater to intrude and salinize these aquifers.

911. Experience has shown that countries do not resort to concurrent and coordinated use of options unless pressure over the resource becomes really severe. In the Mediterranean region (the 23 countries of the Mediterranean Action Plan – one of the world regions with the highest water stakes – it was estimated that 25% of water is lost in urban areas and 20% lost in irrigation canals.

912. The image of irrigation seems poor, with only one-third of the water supplied reaching the plant roots. However, this largely ignores the fate of return flows and fails to acknowledge that in basins these flows are – by definition – increasingly tapped and used by other users somewhere else in the basin – or retain important environmental functions. The harsh reality is that there may be little water to be saved in fully developed basins and that interventions designed as conservation measures often end up amounting to sheer reallocation (Molle, et al; 2005; 2007).

913. In the industrial sector, a combination of subsidies, higher water prices and environmental regulations have encouraged industries to improve processes and reduce withdrawals. It is difficult to obtain a consolidated view of how industries manage water worldwide, but there are clear indications that the global business community is devoting growing attention to water (Online WBCSD Global Water Tool, World Economic Forum 2008). Major savings in natural and financial resources in industrial establishments can be made just by raising awareness during an environmental audit and providing relatively limited investments. In emerging and agricultural economies the scope for progress through the introduction of clean processes is even greater, since production processes are generally poor compared

with worldwide standards. Multinational companies do play a key role, but the current low levels of clean production in some countries justify massive public action in this area (subsidies and public aid for development). In the industry sector, the international competitiveness of a company and its products in the global market is enhanced by its commitment to Best Environmental Practices (BEP). This contributes to pollution reduction and improved efficiency of the water used.

914. At the national level, there are now a growing number of companies introducing clean production processes – often for pollution reduction – that result in significant water savings, with return-on-investment times seldom exceeding two years, as illustrated by some examples in the Mediterranean region (Blue Plan, 2006) and acknowledged by the Stockholm Water Awards-SWA (Box 31). These efforts are supported by different programmes of the UN (UNEP-Industry, UNIDO) through a network of cleaner production centres in 27 countries.

Box 31: Examples of clean production processes

- In Turkey, a tyre-making factory in the Izmit region reduced its water consumption by nearly three-quarters, from 900,000 litres to 250,000 litres per day, thus reducing its discharges into the community sewers. A detailed analysis made it possible to replace a cooling system with a closed-circuit system for an investment cost of US$5000 and a return time of two years.
- In Egypt, one of the largest tinned-food manufacturers (Montazah near Alexandria) underwent an eco-audit and introduced measures to reduce energy consumption: insulating steam pipes, replacing leaky parts, fitting a pressure regulator to the sterilizers, and improving the recuperation system and boiler efficiency. Water consumption was reduced by implementing water-consumption hydrometer monitors, installing sprinklers (so that water flows only when needed), and improving the water collection and recycling system. The savings made in water, steam and energy (nearly a 40% saving in fuel consumption) made it possible to reduce discharges and amortize investments in between 1 and 44 months.
- In Croatia, one of the biggest dairy companies, LURA in Zagreb-Lurat, undertook measures such as employee training programmes, a reduction in the diameter of cleaning pipes, and changes to the hot-water circuit, that resulted in a reduction of 286,000m3 per year (or 27%) in the quantity of effluents, and savings of 280,000m3 per year of drinking water. As a result of these simple measures, which involved the employees, and at a low cost (a total investment of 31,000 euros), the factory made significant savings in water and energy, equivalent to 328,000 euros per year, with an amortization of the investment in less than one month and a reduction in its effluents.
- In Tunisia, a manufacturer of car batteries discovered 19 ways of preventing identified contamination and pollution (acids, lead scoria and wastewater) and saving lead and energy. The costs of the new measures were US$522,500, but the savings amounted to US$1.5 million per year.
- In Mexico, the General Motors de Mexico Ramos Arizpe Complex (2001 Stockholm Water Award-SWA) employed a variety of physical, chemical and biological wastewater treatment processes to recover and reuse 70% of its industrial wastewater. It also promoted the efficient use of brackish well water by separating salts and increasing the useable amount withdrawn from 67% to 94%. It helped save reduce pressure on the only source of water of a population of 40,000, a small confined and brackish aquifer.
- In India, the Staple Fibre Division of Grasim Industries Ltd (2004 SWA), a producer of viscose staple fibre (VSF) used in clothing and textiles around the world, has reduced since 1980 water consumption by 85%, process steam by 51%, and electrical usage by 43%. Furthermore, the company was among the first to replace zinc – a pollutant particularly harmful for marine and aquatic life – with aluminium in its VSF production process.
- In Australia, Sydney Water (2006 SWA) is the largest water utility in Australia – the driest inhabited continent in the world – and supplies water to 4.2 million people. As part of its operating license

requirement, Sydney Water is required to reduce by 35% per capita consumption before 2011. Since the inception in 2001 of its water conservation programme (EDC Business Program), more than 310 organisations have joined the initiative and Sydney Water saved over 20 million litres a day – a daily volume equivalent to 20 Olympic swimming pools.

- In the United States, Orange County (2008 SWA) focused on ‘reuse’ in its Groundwater Replenishment (GWR) system that diverts highly treated sewer water that is currently discharged into the ocean and purifies it through a series of advanced techniques: microfiltration, reverse osmosis, ultraviolet disinfection and hydrogen peroxide. The cleaned water is returned to the groundwater basin to increase both water supply and quality. The system will provide enough water to meet the needs of an additional 500,000 people without diminishing groundwater resources for current users (2.3 million).

915. The Comprehensive Assessment of Water Management in Agriculture (CAWMA, 2007) argues for the need for reforms to enable more efficient use of water in the future. The incentives and resource constraints confronting small farmers need to be recognised by policy makers, but it would be a mistake to assume that they do not respond to market incentives (e.g. food prices have an impact on cropping patterns) and farmers will invest in inputs, irrigation technology (meaning ‘higher water costs’) if they get guarantees of higher returns. There is no reason that efficiency and equity need be out of alignment in this case.

L. The natural water cycles on earth

916. The contemporary water cycle, and hence freshwater resources, are defined by the interaction of natural and humans factors.

917. Water is an essential component of the Earth system, unifying the climate, biosphere and chemolithosphere of the planet. The importance of freshwater, which strongly limits productivity and supports critical habitat and biodiversity, is evident throughout the biosphere. These phenomena collectively define the contemporary water resource challenge, as they have for millennia, with humans struggling to stabilize and make available adequate water in light of an unforgiving climate, as well as failed governance and mismanagement, leading to depletion and pollution.

918. All human enterprise, which requires fresh water, is based on this small "slice of the pie", satisfying needs for food production, industry, and drinking water, as well as maintenance of inland water systems for transportation, waste dilution, and healthy ecosystems.

Box 32: ‘Blue’ and ‘Green’ water: Distinct yet important resources

The global renewable freshwater supply of the landmass is ultimately defined by the total amount of precipitation falling over the continents. As precipitation reaches the ground, it is partitioned into two flows of water. Blue water flow is liquid water moving above and below the ground as surface or sub-surface runoff, respectively (FAO, 1997). When blue water moves through the landscape it can be re-used until it reaches the sea. Green water flow, is the invisible flow of vapour to the atmosphere (FAO, 1997), commonly referred to as evapotranspiration. As opposed to blue water, green water flow always involves consumptive use of water, and can therefore not be re-used. Green water flow consists of a productive part (transpiration) and a non-productive part (evaporation from the soil and plant canopies). Globally, about 60% of the total water flow is attributed to green water flows (Falkenmark and Rockström, 2004) and therefore land-use decisions are also decisions about water. Abandoning agricultural land to forest results in larger green water flows and smaller blue water generation. At present, around 3 billion people are suffering from chronic blue water shortage; however, if green water is accounted for, this figure drops to about 300 million (Rockström et al., 2007), thus arguing for the consideration of green water as part of the water resource planning process.

919. It is increasingly being recognized (MEA, 2005; EPI, 2007) that for the purposes of assessment it is insufficient to view water from purely a biogeophysical perspective, as humans are deeply embedded into contemporary water systems on Earth (FC/GWSP, 2004). Some characteristics of various elements of the water system are provided in Table 22.

Table 22: Definitions of key elements of the land-based hydrologic cycle and examples of their reconfiguration by humans.

WATER SYSTEM ELEMENT	Space and Time Variability	Typical Roles in Water Resource Systems	Management Challenges, Vulnerabilities, and Opportunities
Green Water (Ga= ETa) - Precipitation as Rain and Snowfall (Pa) - Soil moisture	- Very high over both dimensions	- Direct support to rainfed cropping systems - After the process of evaporation and plant transpiration (ETa), precipitation falling on the land creates runoff (ROa) from which is derived the blue water resource (Ba)	- Highly sensitive to climate variability (both drought and flood)l; limited capacity to control - Can be augmented by rainfall harvesting techniques (many traditional / widely adopted) - Weather and climate forecasts help schedule planting, harvest, supplemental irrigation, etc. - Performance improved or compromised by character of land management - Selection of improved crop strains for climate-proofing
Blue Water (natural and altered) (Ba) - Net of loca groundwater recharge & surfac runoff,streamflow (ROa)	- High over both dimensions	- Farm ponds, check dams augment green water in rainfed cropping systems - Represents source waters and entrains constituents delivered downstream within watersheds	- Highly sensitive to climate variability (both drought and flood) and ultimately climate change - Some capacity to control - Habitat management highly localized - Many small engineering works can propagate strong cumulative downstream effects - Poor land management heightens odds of flash flooding then dry streambeds
- Inland water systems (lakes, rivers, wetlands)	- Increased stability with increased size	- Key resource over district, national, multi-national domains - Important role in transport, waste management, and to domestic, industrial, agricultural sectors	- Water losses through net evaporation occur naturally (Ciws) and through human use (Ca) - Legacy of upstream management survives downstream (e.g. irrigation losses, pollution) (Ba') - Multiple sector management objectives may be difficult to attain simultaneously - Potential upstream-downstream conflicts (human-to-human; human-to-nature), including international
- Ground Water (shallow)	- Moderate over both dimensions; links to streams	- Locally distributed shallow well systems serving drinking water and irrigation needs (Ua)	- Intimate connection to weather/climate means water yields subject to precipitation extremes - Easily polluted - Easily overused, resulting in temporary depletion; some loss to ocean of regional importance
- Fossil Ground	- Extremely	- Critical (and often sole) source	- Large repositories of water but with limited recharge potential

WATER SYSTEM ELEMENT	Space and Time Variability	Typical Roles in Water Resource Systems	Management Challenges, Vulnerabilities, and Opportunities
Water (deep)	stable	of water in arid and semi-arid regions	- Use typically non-sustainable (Uan) leading to declining water levels/pressure, increasing extraction costs - Low replenishment rates mean pollution often becomes effectively permanent
Blue Water (engineered) - Diversions (D) including reservoirs & interbasin transfers; reused waters	- Stable to very stable	- Critical (and often sole) source of water in arid and semi-arid regions - Stabilizes and/or redirects flow from water rich times/places to water poor times/places, yielding an altered blue water balace (Ba') - Serve multiple uses: hydropower; irrigation, domestic, industrial, recreational uses; flood control - Secondary reuse as effluents in irrigation	- Large quantities of water with high recharge potential - Modified flow regime, with positive and negative impacts on humans and ecosystems • fragments habitat, can destroy river fish habitat while creating lake fisheries • removes natural ecosystem "cues" for breeding, migration, etc. • stabilizes water supplies for when needed most by society - Sediment trapping, leading to downstream inland waterway, coastal zone problems - Introduction potential for exotic species - Greenhouse gas emission from stagnant water - Health problems (e.g. schistosomiasis) from stagnant water - Social instability due to forced resettlement
Virtual Water	- Stable, but linked to fluctuations in global economy	- Represents water embodied in production of goods and services, typically with crops traded on the int'l market - Not explicitly recognized as a water resource management tool until recently	- Can implicitly "off-load" water use requirements from more water-poor to more water-rich locations - Particularly important where rainfed agriculture is restricted and irrigation relies on rapidly depleting fossil groundwater sources
Desalination (DS)	- Stable	- Augmentation in water scarce areas;	- Costly, special use water supply; technologies rapidly developing for cost-effectiveness

920. Analysis of variation in flow reliability indicates sharp gradients. Projections of average annual GDP growth rates drop by as much as 38% as a consequence of this variability and even a single drought event within a 12-year period will diminish growth rates across this whole period by 10%. Flooding can also have devastating effects, particularly in areas that have high population densities and are ill-equipped in terms of early warning and emergency response systems (Figure 85). During the decade from 1992-2001, floods comprised 43% of all recorded disasters and affected more than 1.2 billion people (OFDA/CRED 2002).

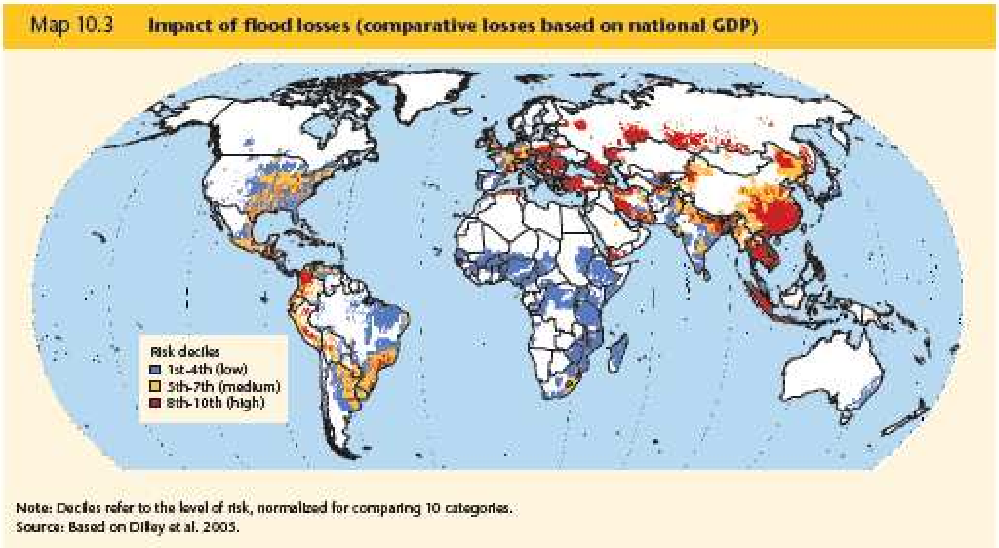


Figure 85: Impact of flood losses (comparative losses based on national GDP).

921. Such inherent seasonal and inter-annual variabilities in the water cycle are indicative of the potential impetus for, or actual investments in, engineered water stabilization facilities like reservoirs, inter-basin transfers, and/or deep groundwater pumping, which themselves can convey new patterns of hydrograph variability. Figure 86 shows an example of inherent change to the basic hydrography arising from a series of river flow regulations in the mid-western United States. The effect is pandemic and typical of those found globally. While these changes may be successful from a flow stabilization standpoint and hence optimize the availability of water to a variety of societal uses, they also are capable of creating substantial distortion in flow regimes that put stresses on downstream aquatic biota (Olden and Poff 2003).

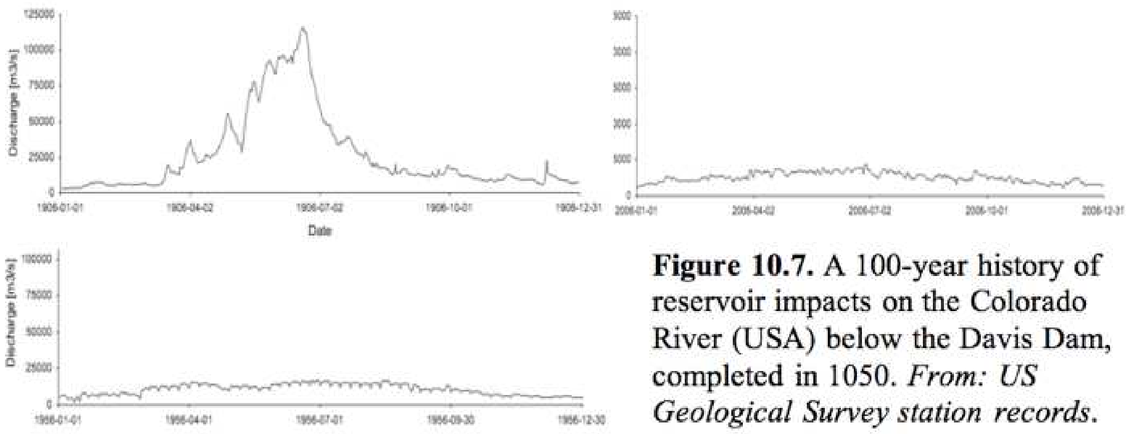


Figure 86: A 100-year history of reservoir impacts on the Colorado River (USA) below the Davis Dam

922. Large storage volumes and high storage-to-flux ratios (known also as residence time) characterize most groundwater systems. These are particularly important from a water resources perspective, rendering groundwater resources much less affected by short-term fluctuations in precipitation. Groundwater reservoirs thus add persistency and stability to the terrestrial hydrological systems and provide unique opportunities for humans, fauna and flora to bridge extended dry periods of time and survive. This underlines the potential role of groundwater in coping with increasing water scarcity due to global change. At the same time, because of strong interdependence between groundwater and surface water, the overall resource is difficult to quantify, as there is a risk of counting their respective estimation twice.

1. Relationship to global biogeochemical cycles

923. A growing body of evidence indicates that land-based human activities impart a biogeophysical signal onto river chemistry at the global scale. It has been estimated that only a minority of the world's drainage basins (~20%) have nearly pristine water quality and that the riverine transport of inorganic N and P has increased several-fold over the last 150 to 200 years (Vörösmarty and Meybeck, 2004). Appropriate monitoring and analysis tools are necessary to understand these progressive changes and to evaluate their impact on water resources, but there is a lack of observed information.

924. Water mobilizes and transports materials that are essential elements for life in terrestrial and aquatic ecosystems. For example, nitrogen, phosphorus, and silica serve as important nutrients that limit the growth of plants and algae, while organic carbon from land is an important energy source in downstream freshwater and marine systems. Water also transports natural materials that directly influence organism health (e.g. conductivity, pH) or habitat structure (e.g. sediments). Under natural conditions, these materials originate from atmospheric transport and deposition, biological activity, erosion, and/or weathering from bedrock and soils. Multiple human activities lead to additional sources of naturally occurring elements (Figure 87), as well as material not present in nature such as pesticides, endocrine disruptors, and metals. River systems have traditionally been considered as simple transporters of materials, but it is increasingly acknowledged that transformations occurring during water transit through basins have important influences on material fluxes and hence pollutant loads (Seitzinger et al., 2006; Cole et al., 2007; Battin et al., 2008). The quantity and timing of water flows play a central role in determining the mobility of potential pollutant sources and their dilution potential, which if restricted will in turn limit water supply.

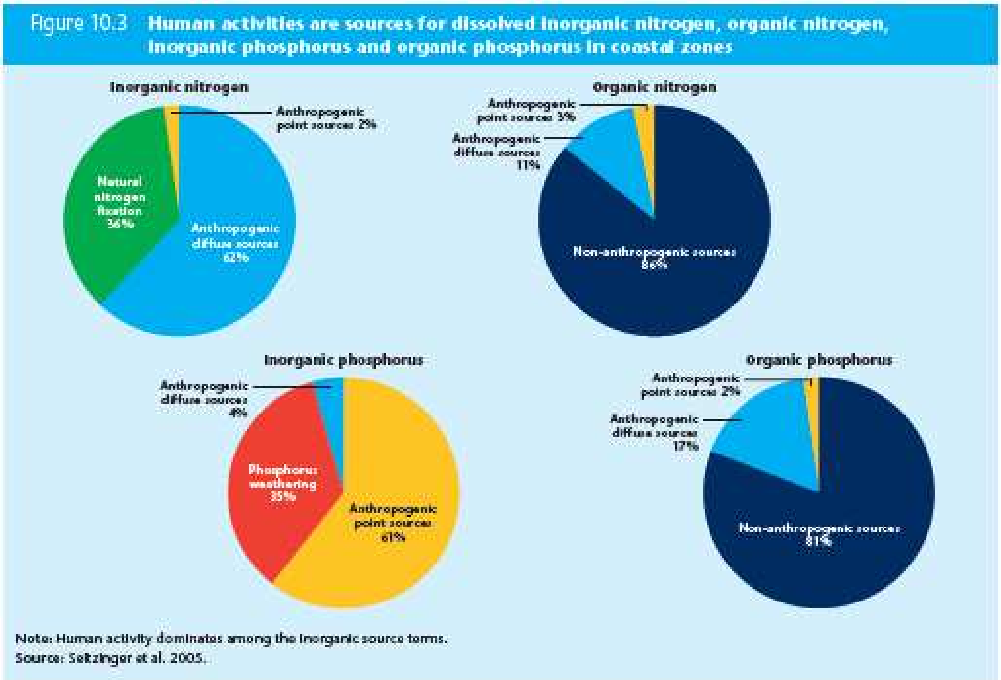


Figure 87: Different sources to the coastal zone for dissolved inorganic nitrogen (DIN), organic nitrogen (DON), inorganic phosphorus (DIP) and DOP. Note the critical role of humans in dominating the inorganic source terms, a byproduct of industrial agriculture necessary to feed a large and growing population. Source: Seitzinger et al. (2005)

925. Making broad overview statements about water quality is difficult due to the spatial and temporal richness of biogeochemical complexity, as well as incomplete monitoring and definitional problems. The numerous factors that influence material fluxes through aquatic systems (sources, hydrology, geomorphology and biology) suggest an inherent complexity in characterizing water quality at regional to global scales.

2. *Humans accelerating and decelerating the constituent cycles*

926. The behaviour of both hydrology and constituent transports have been greatly modified by human pressures, particularly over the last century and will likely remain the case well into the future (Meybeck and Vörösmarty 2005). Yet the direction of the evolution of these transports, and hence the nature of inland water quality, is a complex function of four major changes that must simultaneously be considered. We know that:

(i) human activities have greatly accelerated the biogeochemical cycles and the global transfer of materials including sediment from increased erosion associated with poor land management, construction, etc.;
(ii) fluvial system filters have been greatly modified, and in the case of artificial impoundments increased in importance;
(iii) river water discharge to oceans is already controlled and reduced by water engineering and irrigation, with irretrievable losses on the order of 200 (for reservoir evaporation) and 2000 km3/yr (for agriculture), respectively (Shiklomanov and Rodda 2003); and
(iv) new and esoteric engineered compounds, many long-lived, are appearing in our waterways.

927. Thus, we have simultaneously increased and decreased the levels of various constituents in our waterways, but the exact nature of the acceleration or deceleration is complex.

928. Human population and economic growth leads to increased demand for land and commodities for food production, housing, and fuel. The natural capacity for land to support human populations is insufficient, so humans enhance food production with fertilizer and intensive agriculture. Current estimates of global productivity appropriated by humans range between 14 and 28% (Imhoff et al., 2004; Haberl et al., 2007). Agricultural activities are also accelerating the elemental cycles of N and P in the sense that more material must be added to the landscape in mobilizable forms. Globally, N inputs to land surfaces have more than doubled, with similar increases in flux to the ocean (Green et al., 2004; Bouwman et al., 2005; Seitzinger et al., 2005). Similar results have also been documented for phosphorus (Harrison et al., 2005a; Seitzinger et al., 2005).

929. Changes in hydrological factors associated with human activity have unintentionally ameliorated other changes associated with land use. Erosion associated with land use change is elevating sediment delivery to aquatic systems, but increased reservoir capacity captures much of this material, with a small overall net change at the basin mouth (Syvitski et al., 2005). Fully one-third of sediment destined for the coastal zones no longer arrives there due to sediment trapping and water diversion (Vörösmarty et al., 2003), with concomitant increases in the net erosion of sensitive coastal settings like deltas that require a steady supply of land-derived sediment (Ericson et al., 2006). Reservoir construction is also expected to have attenuated Si, N and P fluxes, though the role of reservoirs in attenuating N and P fluxes appears to be less than for sediments (Dumont et al., 2005; Harrison et al., 2005b).

930. Net increases in nutrient loads (particularly N and P) have resulted in the eutrophication (increased primary production) of lakes, rivers, and receiving coastal waters, with subsequent degradation of ecosystems, fisheries, and human health. Anoxic dead zones in the Gulf of Mexico arise from excess nutrient inputs from agriculture in the Mississippi basin (Rabalais et al., 2007) as well as in the Yangtze plume (Wang, 2006). Alterations to inputs and "fluvial filters" of nutrients (N, P, Si) are also resulting in changed elemental ratios in freshwaters and receiving coastal waters. In addition, as different nutrient forms (e.g., DON vs. DIN) have been shown to have contrasting watershed sources and human pressures (Seitzinger et al., 2005), ratios among nutrient forms may also be changing. Changing nutrient ratios alter the composition of biological assemblages in freshwater and coastal systems, including the occurrence and recurrence of harmful algal blooms (Wang, 2006).

3. Recent progress in articulating patterns in global water quality

931. Despite existing limitations in characterizing human pressures and processes that determine the chemical characteristics of freshwater resources, syntheses of river observations and process studies have substantially advanced our ability to quantify the transformation of watershed-derived constituent inputs into river loads and exports to the coastal zone (Seitzinger et al 2006; Seitzinger et al 2005; Cole et al 2007; Green et al 2004; Boyer et al 2006; Smith et al 2003; Wollheim et al., in press). Recent models predict mean annual nutrient status based on geospatial datasets defining watershed inputs (both natural and human), hydrological and physical properties, plus biological processing potentials within rivers. They rely on global calibration of basin scale parameters with basin mouth observations to provide a consistent, spatially explicit picture of worldwide nutrient exports to the coastal zone. The models can also be used to describe subannual climatologies. Sub-models of Global-NEWS (Nutrient Export from Watersheds), organized under UNESCO's Intergovernmental Oceanic Commission, apply a consistent framework and datasets to calculate river exports of C, N, and P in multiple forms (dissolved vs. particulate and inorganic vs. organic), enabling an integrated assessment of impacts on receiving waters from a range of human pressures (see Seitzinger et al. 2005 and recent special issue of Global Biogeochemical Cycles). However, as such models have limited process representation and are not dynamic, they are not able to account for variability at event to monthly time scales, which is critical in characterizing water quality.

932. Spatially distributed, mechanistic models of nutrient fluxes through river systems are now being developed, have been applied to numerous individual basins, and are important for understanding mechansisms controlling material fluxes (Ball & Trudgill, 1995; Lunn et al 1996; Alexander et al., 2002). More recently, such efforts have been applied at the global scale to integrate spatially distributed controlling mechanisms. For example, global terrestrial nitrogen (N) models now account for within basin patterns of N loading, hydrological conditions, land surface characteristics, and ecosystem processes to predict N export fluxes (Bouwman et al 2005). Recently, a spatially distributed modeling approach was applied to global inland aquatic systems (Wollheim et al., in press) where the relative importance of small rivers, large rivers, lakes and reservoirs in the global aquatic N cycle was estimated by integrating the spatial distribution of inputs from land, discharge conditions, network geomorphology, position of various water bodies, and rates of biological activity. The relative importance of different water bodies varies with latitude due to the distribution of channel bottom surface area relative to the position of N inputs, which are increasingly being determined by human inputs in terms of fertilizers, sewage, animal wastes, and atmospheric deposition (Figure 88). These approaches now include key mechanisms that hold promise for predicting global patterns of water quality and hence water supply compromised by pollution, changes in runoff and streamflow, runoff variability, temperature and hydraulic modification.

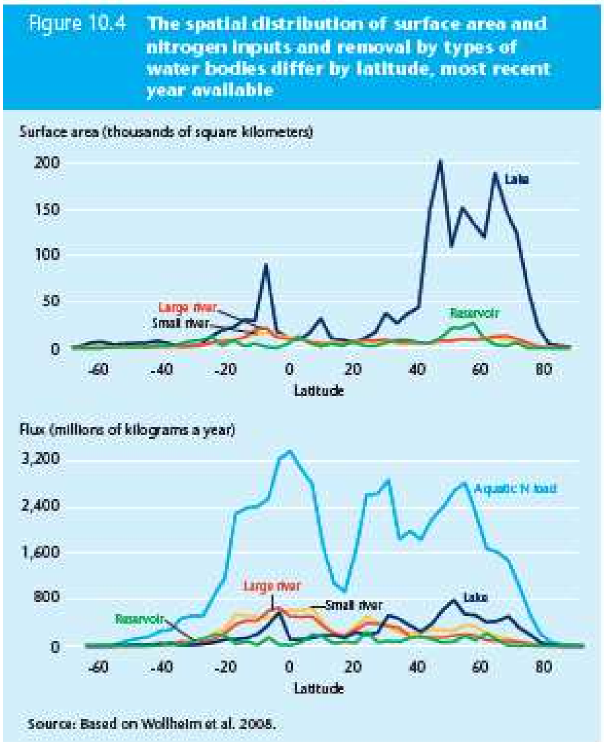


Figure 10.4 The spatial distribution of surface area and nitrogen inputs and removal by types of water bodies differ by latitude, most recent year available

Figure 88: Spatial distribution of surface area (A) and nitrogen inputs and removal (B) by different water bodies as a function of latitude. Source: Wollheim et al. (in press).

4. Water pollution as a constraint on water supply

933. Good water quality is important to the health of both aquatic ecosystems and human society and increasing development pressures inevitably lead to declines in surface and ground water quality increased human health challenges, elevated requirements for water treatment, and likelihood of deteriorating ecosystem function (Finlayson and D'Cruz, 2005). (Table 23).

934. Humans have long relied on dilution and transport by aquatic systems to manage pollution and hence the water quality of freshwater resources. In some cases, aquatic systems also permanently remove pollutants to the atmosphere, as for example denitrification of excess N. These are important ecosystem services that rely heavily on the characteristics of the water cycle. Changes in the water cycle will inevitably lead to changes in the capacity of natural systems to provide services (Hinga and Batchelor, 2005). Because aquatic systems are highly connected, local changes in aquatic ecosystem services often bear impacts far downstream.

935. Pollutants can be categorized as those directly influencing human health, and those that impact on ecosystems. Pollutants potentially affecting human health include fecal coliform contamination (Servais et al., 2007), residual pesticides (Blanchoud et al., 2007) and metals (Thevenot et al., 2007). Other examples include arsenic contamination of groundwater in Bangladesh (Mukherjee et al., 2006) and mercury in the northeastern US (Driscoll et al., 2007), as well as elevated nitrogen in drinking water supplies (Townsend et al., 2003).

936. In the developed world, many pollution issues, especially those pertaining to point sources, have been addressed and ameliorated over the last 40 years. However, in developing countries pollution issues remain among the most important water resource problems. These include lack of sewage treatment and point source controls, and pathogens combined with poor access to clean water (WHO/UNICEF 2004). In the developed world, non-point source pollution remains an important issue, in part because management requires whole landscape, multi-jurisdictional approaches that do not lend themselves to easy implementation. However, successful policies addressing acidification of surface water by atmospheric deposition in North America and Europe provide a hopeful model for landscape management that is beginning to lead to recovery of many surface waters from acidification (Driscoll et al., 2003; Warby et al., 2005).

Table 23: Principal symptoms of human-river system interactions. From: Meybeck (2003).Water uses/human pressures: a: land use change; b: mining and smelting; c: industrial transformation; d: urbanization; e: reservoir construction and operation; f: irrigation; g: other water management types. Amplitude of change: x-xxx, where + and – represent increases and decreases, respectively.

Table 10.5 Principal symptoms of human-river system interactions and human pressures on water use

Symptoms	Land use change	Mining and smelting	Industrial transformation	Urbanization	Reservoirs	Irrigation	Other water management
Organic matter	+ + –		+	+ + +	+ – –	–	+
Salts	+	+ + +	+	+	+	+ + +	
Acids							
Direct inputs		+ +	+				
Atmospheric changes		+	+ +	+ +			
Metal							
Direct inputs		+ +	+ +	+	– – –		
Atmospheric inputs changes		+ + +	+ +	+			
Historical		+ + +	+	+	– – –		
Total suspended solids	+ + +	+ +	+	+	– – –	-	-
Nutrients	+ + +		+	+ +	– –	+ –	
Water-borne diseases	+ –			+ + +	+	+	+
Persistent organic pollutants							
Direct inputs	+ +		+ +	+ +	– –		
Atmospheric inputs	+		+	+			
Historical			+ + +	+ +			
Mean runoff	+ –		–	+	–	– – –	
Flow regime	x			x	xxx	x	x
Aquatic habitat changes	x	xx		xx	xxx	x	xxx

Note: Amplitude of change ranges from + to + + + (increase) and – to – – – (decrease). The x symbols refer to magnitude of change without an indication of direction.
Source: From Meybeck 2003.

M. Changes in the global water cycle

1. Trends in reservoir, lake and wetland storage

937. Current estimates are that there are more than 50 000 large dams (>15m height and 3 million m3 storage capacity), 100 000 smaller dams (> 0.1 million m3 reservoir storage) and one million small dams (<0.1 million m3 reservoir storage) worldwide. Total reservoir storage capacity created by these dams is estimated at about 7 000 km3 and the total water surface of reservoirs is about 500 000 km2. Although there are a huge number of reservoirs, 95 % of total reservoir capacity is accounted for by about 5 000 large reservoirs (>60 m dam height) and more than 80% are used for hydropower generation (ICOLD, 2003, Aqua Media International, 2007). In the past 100 years, mainly from 1950 to 1990, many reservoirs were constructed in North America, the southeast coast of South America, Russia, China and Australia. About 350 large reservoirs are currently under construction in China, India, Southeast Asian countries, Iran and Turkey in Asia and in the Middle East (Aqua Media International, 2007). From the late 20th century, various changes related to reservoirs have occurred, such as dam removals in the U.S., conflicts on reservoir water use between upstream and downstream countries (e.g. Mekong River, Euphrates River, Syr Darya) and reservoir sedimentation. Over 25% of about 20 x 109 t y-1 of global suspended sediment discharge (Walling and Webb, 1996) is thought to be trapped by reservoirs (Vorosmarty et al., 1997). Although the construction of dams, mostly during the 20th Century, is known to have resulted in a large increase in storage of impounded water over that period, recent trends in global reservoir storage, during a period of reduced dam construction over the last 20 years, is less clear. Chao et al (2008) suggests that the change in reservoir storage has been modest over the last decade, and there have been suggestions that a prevalence of drought in key areas of the world may have actually reduced global reservoir storage over the last decade.

938. Meybeck (1995), Shiklomanov and Rodda (2003) and Lehrner and Doll (2004) have provided extensive data characterizing lakes on a global scale. Lakes store the largest volume of fresh surface water (about 90 000 km3), over forty times more than those in rivers and streams and about seven times more than in wetlands. Together with reservoirs, they are estimated to cover a total area of about 2.7 million km2, which represents about 2% of the land’s surface area outside the polar regions (Lehner and Döll, 2004). Most lakes are small, but the largest 145 lakes are estimated to contain over 95% of all lake freshwater. Lake Baikal (Russia) is the world’s largest, deepest and oldest lake and it alone contains 27% of all lake freshwater. Lake waters serve commerce, fishing, recreation and transport and supply water for much of the world’s population.

939. While changes in lake extent over the past few decades have been observed in many parts of the world, the primary factors driving these changes are specific to each region. The surface area of Lake Chad shrank from 23 000 km2 in 1963 to less than 2 000 km2 by the mid -1980s, largely due to drought. The Aral Sea also dramatically declined and the volume of water in the basin has been reduced by 75% since 1960 – changes that are attributable primarily to diversions of inflows for irrigation. The Caspian Sea level fell 3m between 1929 and 1977 but rose again by 3 m by 1995 (http://www.caspage.citg.tudelft.nl). In Siberia, changes in total lake area over the last 3 decades of the 20th century have been correlated with the state of the underlying permafrost. In the continuous permafrost zone, total lake area has increased (by 12% in western Siberia, Smith et al., 2005; and by 14.7% in eastern Siberia, Walter et al., 2006). Meanwhile, in the discontinuous, sporadic, and isolated permafrost of western Siberia, total lake area declined by 13%, 12%, and 11%, respectively (Smith et al., 2005, Figure 11.2.4). The changes in Siberian lake extent are seen as symptomatic of permafrost degradation and also have important consequences for global climate via their influence on the carbon cycle.

940. Wetlands are water-saturated environments and are commonly characterized as swamps, bogs, marshes, mires and lagoons. Although they contain only 10 percent of the water found in lakes and other surface waters , wetlands cover an area about 3-4 times greater than the world's lakes (Lehner and Döll, 2004; OECD, 1996) and play important roles in flood protection, groundwater recharge, food production, water quality, wildlife habitat, and biogeochemical cycling (Mitsch and Gosselink, 2000). During the last century, an extensive number of wetlands were destroyed or converted to other forms of land-use. Currently, extensive work is being done through the "Wise Use' campaigns sponsored principally by Ramsar, WWF and UNEP. These campaigns seek to maintain critical services in water and related livelihood and food production areas. Roughly half of the world's wetlands occur in high latitudes, and many of these owe their existence at least in part to the drainage impedance of permafrost. There is concern that permafrost degradation may cause some of these wetlands to drain and be replaced by grasslands, with important implications for the global carbon cycle and possible feedbacks to global climate change.

1. Trends in permafrost, snow and glaciers

941. Frozen ground includes soils affected by short-term freeze-thaw cycles, seasonally frozen ground and permafrost. Permafrost regions occupy approximately 22.8 x 106 km2 or 23.9% of the exposed land area of the Northern Hemisphere, while the long-term average maximum area extent, usually in January, of seasonally frozen ground (including the active layer over permafrost) is about 48.1 x 106 km2 or 50.5% of the Northern Hemisphere land area (Zhang et al., 1999; 2003). Permafrost exists mainly in high latitudes and high elevation regions. Permafrost in Eurasia occurs over the entire Arctic and boreal forest areas and includes the mountainous regions of central Asia (Tien Shan and Pamir), Tibetan Plateau and high elevated areas of Himalayas. Over North America, permafrost is mainly distributed over Alaska and the Canadian Arctic with the southern boundary of the latitudinal permafrost varying from 50oN to 57oN (Brown et al., 1997; Zhang et al., 1999). Due to the effect of the Rocky Mountains, mountain permafrost can extend as far south as 37oN.

942. Changes in the regime of ground ice in permafrost directly regulates the hydrological cycle of cold regions both in the short- and long-term. Based on information from the Circum-Arctic Map of Permafrost and Ground Ice Conditions (Brown et al., 1997), Zhang et al. (1999) estimated that the volume of excess ground ice in the Northern Hemisphere ranges from 10 800 to 35 460 km3 or about 2.7 to 8.8 m sea-level equivalent. Assuming the average porosity of permafrost soil to be about 40%, the total volume of ground ice (including both pore and excess ground ice) varies from 54 000 to 177 000 km3. Under global warming scenarios, permafrost is expected to degrade rapidly in the 21st century (Lawrence and Slater, 2005). As a result, melt-water of excess ground ice may directly participate in the hydrological cycle, while melt-water of pore ground ice may become a significant ground water resource in cold regions. Seasonal and inter-annual variations of soil water storage within the active layer and seasonally frozen layer in non-permafrost regions can be substantial and have a significant impact on the hydrological cycle in cold seasons/cold regions.

943. Over one sixth of the world's population lives in areas where surface water is dominantly derived from snowmelt, either seasonally ephemeral snowpacks, or perennial glaciers (Barnett et al., 2005). This area also accounts for over one-quarter of the global gross domestic product. Therefore, changes in the seasonal patterns of runoff, and/or permanent changes in runoff volume that result from changes in snow cover are of great concern.

944. There is a great deal of evidence that glaciers have retreated globally since the middle of the 19th century, after the "Little Ice Age" (Mayewski and Jeschke, 1979), accelerating from the mid-1970s (Yao et al., 2004; Liu et al., 2006; Aizen et al., 2006) as a response to rapid increases in air temperature, changes in precipitation amount and precipitation partition (rain/snow). Although all glaciers respond to changes in climate, tropical glaciers are more sensitive than glaciers at higher latitudes. The Andes

contain 99% of the world's tropical glaciers, most of which are undergoing considerable recession, with many having reduced their volume by 30% since 1980 (Francou et al., 2003). In the tropical Andes, runoff during the dry season (May-September) is often solely fed by glaciers, and therefore glacier retreat has major implications for water supplies seasonally (Juen et al., 2007). The available evidence from the Atacama region shows that glacier ice or permanent firn fields are rarely found below 5 200 masl. The development of glaciers is also limited by the low levels of precipitation and continuous increasing of air temperatures. In the tropical Andes, the trend in air temperatures was about 0.1°C per decade since 1939, which has tripled over the last 25 years. However, changes in air temperatures and precipitation may have different impacts in different mountain regions at macro- and meso- scales and even in small catchments. In arid regions of central and northern Chile, much of western Peru and western Argentina climate change has resulted in warming and decreasing precipitation during the twentieth century and the glaciers in South America retreated much faster than in central Asia.

945. The co-existence of high elevated cold and arid areas create unique climatic and hydrological regimes not only in the tropical Andes but also at mid- latitudes of central Asia and Tibetan Plateau. The large Aral-Caspian and Tarim closed drainage basins and the great Asian rivers, such as Ob, Yenisei, Huang He, Yangtze, Mekong and Brahmaputra, are fed by glaciers located in the Altai, Tien Shan, Pamir and Tibetan Plateaus. The central Asia glaciers cover 81 500 km2 and comprise approximately 8 000 km3 fresh water (Shi et al., 2005). Changes in global and regional air temperatures and the frequency of major atmospheric circulation processes regulating moisture flow over central Asia are the major driving forces of glacier mass balance and river discharge variability. Glaciological observations conducted on the Tibetan Plateau revealed that between the 1950s and 1960s, 50% of glaciers retreated while 30% advanced and 20% were stable. During the next decade glaciers were relatively stable but since the 1970s recessions have accelerated and in the 1990s up to 95% of 620 glaciers studied were in recession. The recession rate was 4 m yr-1 at the north Tibetan Plateau intensifying up to 65 m yr-1 to the southeast (Yao et al., 2004, 2007). The Tibetan Plateau total glacier area has shrunk by 5.5% during the last 45 years (Kang et al., 2004).

2. Links between the terrestrial carbon and water cycles

946. Among the consequences of a changing hydrologic cycle, one impact that has received particular attention is its interaction with the terrestrial carbon cycle, because interactions between various stages of the two cycles can yield positive feedbacks to climate change. The terrestrial biosphere plays an important role in the global climate system, having taken up roughly 25% of anthropogenic carbon emissions during the last century (IPCC, 2007). It is not clear how long the terrestrial biosphere can continue to absorb atmospheric carbon at this rate. Observations suggest that the rate of carbon uptake depends on hydrologic and climate conditions, as well as land use. However, in comparison with hydrological observations, long-term observations of terrestrial carbon storages and fluxes, especially over large scales, are much sparser, making it more difficult to discern the relationships of trends in global or regional carbon budgets with climate and hydrological factors. Nonetheless, in some cases, relationships between trends in the hydrologic and terrestrial carbon cycles have become apparent, while in other cases, strong relationships between shorter-term hydrologic variability and carbon fluxes have important implications for observed hydrologic trends.

947. Because water plays different roles in each stage of the terrestrial carbon cycle, it is useful to consider each stage separately. The vast majority of terrestrial carbon is stored in soils, litter, and above-ground vegetative biomass. Carbon enters these reservoirs primarily through plant photosynthetic activity, or production. Carbon may leave these reservoirs through respiration (by plants or through decomposition in the soil), export of carbon into lakes and stream networks, and disturbances such as fire (or changes in land use). Some of these stages lend themselves to large-scale monitoring more easily than others.

948. Hydrology also exerts a strong influence on the fluxes of carbon out of terrestrial ecosystems. Soil respiration is the largest efflux, approximately equal to productivity on a global, annual scale. Field studies have shown that soil respiration has a complex dependence on hydro-climatic factors such as soil temperature and moisture, as well as biogeochemical factors; in particular, soil moisture determines the proportions of carbon released to the atmosphere as carbon dioxide (CO2) and methane (CH4) (e.g. Dise et al., 1993). While attempts to find strong global correlations between trends in soil respiration and trends in hydro-climatic factors have been unsuccessful (Kirschbaum, 2006), some hydrologic trends are expected to have serious implications for soil respiration. One example is that of permafrost degradation, and the associated changes in lake extent in Siberia (sections 11.2.6 and 11.2.8). Much of the permafrost in Siberia contains tremendous reservoir (500 GtC, or roughly the carbon content of the atmosphere) of carbon-rich soil, termed yedoma, which has been protected from respiration by frozen conditions since the last Ice Age (Walter et al., 2006). In the zone of continuous permafrost, many lakes have expanded over the last few decades (Smith et al., 2005; Walter et al., 2006), actively thawing the surrounding and underlying yedoma. Because the newly thawed soil around and under the lakes is saturated with water, respiration of the carbon produces CH4, a much stronger greenhouse gas than CO2. Walter et al. (2006) observed strong methane emissions from the active margins of thaw lakes in eastern Siberia, and estimated that the recent expansion of these thaw lakes (14.7% increase in area between 1974 and 2000) may have resulted in a 58% increase in lake CH4 emissions, or 1.4 TgCH4/yr. Because the recent expansion of these thaw lakes is a result of permafrost degradation, there is concern that methane emissions from these lakes could provide a strong positive feedback to climate warming.

949. The final major efflux of carbon from terrestrial ecosystems is the export of carbon from soils to aquatic systems, as both particulate organic carbon (POC) and dissolved organic carbon (DOC). Because a large fraction of this carbon can be subsequently respired and returned to the atmosphere, either in the stream or in the ocean, this flux represents an important loss term in the terrestrial carbon budget. A substantial amount of POC consists of organic carbon absorbed onto soil sediment particles, entering streams through erosion and mass wasting. Thus trends in sediment transport would be expected to have a strong correlation with trends in POC export (although other factors such as soil carbon content and in-stream chemistry would also exert an influence on POC export). Stallard (1998) estimated that, globally, 0.4 to 1.2 PgC is transported to the oceans as POC each year. However, no global trends in POC export have yet been assessed.

950. Several studies (e.g., Worrall and Burt, 2007) have observed marked increases in the annual fluxes of DOC in many temperate and boreal streams around the world. While it has been difficult to attribute all of the observed trends to any single cause (Worrall and Burt, 2007), hydrology appears to play a role in some cases, through changes in groundwater drainage. For example, in the Arctic, several studies, including Holmes et al. (2008) and Raymond et al. (2007), have found strong correlations between daily river discharge and DOC concentrations. In this context, the increases in the annual discharge of the six major rivers of the Russian Arctic (Peterson et al., 2002) and especially the recently discovered increase in minimum flows across Northern Eurasian pan-Arctic (Smith et al., 2007) may have important consequences for the carbon cycle. Because minimum flows generally reflect the influence of groundwater, Smith et al. speculated that the cause of these trends could be a reduction in the intensity of seasonal soil freezing, allowing more connectivity in subsurface drainage networks. If this process is indeed occurring, it is conceivable that the increased flushing of the soils by groundwater, accompanied by longer growing seasons and greater microbial activity during seasons in which the soils historically have been frozen, could lead to greater mobility and loss of soil carbon. Establishing a link between these phenomena will require further research. In addition, there is some indication that the thawing of permafrost in Siberia may release large amounts of soil carbon into streams in the future (Frey and Smith, 2005), but this is based on a space-for-time substitution rather than a direct observation of a trend.

951. In summary, while hydrologic processes play important roles in all stages of the carbon cycle, trends in the carbon cycle are only sometimes strongly correlated to trends in the hydrologic cycle. Strong correlations with hydrologic processes often occur when water availability is the dominant limiting factor. For some ecosystems, water availability may become a limiting factor as other climate factors change. In many cases, while direct observations of carbon fluxes and storages may not have been made over a long enough time period or a large enough region for significant trends to be detected, strong evidence enough still exists to indicate potential impacts of hydrologic trends on the carbon cycle.

3. Acceleration of the hydrological cycle

952. There is a consensus among climate scientists that climate warming will result in an intensification, acceleration, or enhancement of the global hydrologic cycle (DelGenio et al., 1991; Loaiciga et al., 1996; Trenberth, 1999; Held and Soden, 2000, Arnell and Liu, 2001). The intensification could be evidenced and/or caused by increasing rates of evaporation, evapotranspiration (ET), precipitation, and streamflow (in some areas). Associated changes in atmospheric water content, soil moisture, ocean salinity, and in seasonal changes in glacier mass balance may also be implicated. The strength of the intensification response to future warming is hence unresolved and remains a critical question in assessing hydrologic response to climate warming.

953. The IPCC fourth assessment report indicates globally averaged increases in surface air temperatures over land for the period 1906–2005 of 0.74°C ± 0.18°C (Trenberth et al., 2007). There are fewer long-term, continuous, and quality-assured precipitation records than are available for air temperature and spatial heterogeneity is larger. Trends in precipitation have been more variable spatially and temporally compared with trends in temperature; however, regionally, increases during 1901 to 2005 have been noted in most of North America, southern South America, northern Eurasia and western Australia and decreases in western Africa and the Sahel and Chile (Trenberth et al., 2007). Current estimates of global average long-term trends in precipitation do not show significantly increasing precipitation over the period of observational record (Trenberth et al., 2007) as was reported in earlier assessments (Dai et al., 1997; New et al., 2001) possibly due to decreases in recent years and the use of different methodologies and observations. There is also some evidence that snowfall has increased in northern high latitudes (Trenberth et al., 2007) and over mountain and subpolar glaciers (Dyurgerov, 2003; see also section 11.2.9)

4. Assessing future impacts of climate change

954. Acceleration of the global water cycle that might be associated with global warming could have important consequences for the world's water resources. This section considers the consequences of such changes for water management, and impacts and adaptation strategies for coping with such changes.

955. The latest assessment of climate change by the Intergovernmental Panel on Climate Change (IPCC, 2007) reports that the vast majority of climatologists believe that warming is occurring on a global basis now. It describes water cycle effects associated with this warming that range from a warmer atmosphere that holds more water vapour to more severe regional water shortages in semiarid and arid regions. Changes are expected in the means, standard deviations and extremes of many hydrological variables and fluxes such as precipitation, soil moisture, and evapotranspiration. These possible changes in the global water cycle will be far-reaching, increasing water stress with implications for water-borne disease rates, contributing to poorer water quality and increasing the impacts of floods and droughts. Although the reliability of climate change projections are improving with time, they are subject to a number of inherent uncertainties, resulting from poorly defined initial conditions; natural and human processes and feedbacks; inadequate process representation in climate models; scale mismatches; extremes of climate; and long-term climate variability to name a few. Uncertainties are very significant

for the water cycle projections because many hydrologic processes are highly non-linear. Furthermore, projected changes in general are thought to be more accurate at very large (e.g., global and continental) scales, and much less so at regional scales, whereas it is at regional scales that mitigation and adaptation takes place.

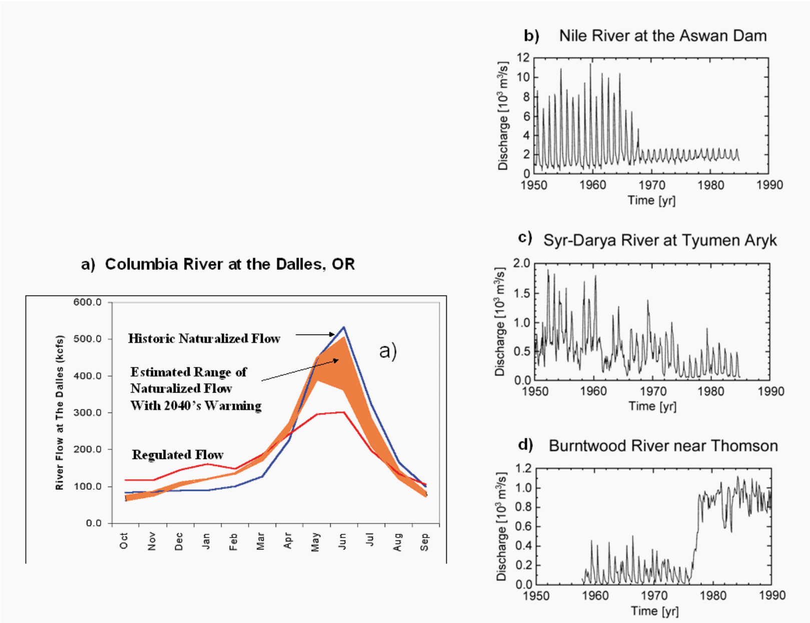
956. Exploitation of land and water resources by humans can amplify or ameliorate greenhouse gas effects on climate. Land surface change can have an important feedback effect on climate through altered surface albedo and surface energy fluxes (see e.g. Copeland et al, 1996; Strack et al, 2008). The expansion of dams and reservoirs in the 20th century has changed the variability of stream flow in many rivers and led to the retention of large quantities of water in storage leading to changes in regional evaporation and runoff patterns (Box 33). Growing populations and associated increases in water use could lead to increased aridity in some areas. Culson et al. (2004) found that irrigation enhanced the hydrological cycle on a regional scale, although the results showed a strong spatial variability. In contrast, in some areas where groundwater levels are dropping due to abstractions, growing water usage is creating situations where prolonged periods of drought could further lower levels and cause rivers that are fully dependent on groundwater input during droughts to dry up.

957. Due to the localized response of water resources to large scale forcing, global projections from climate models are of limited value for water resource applications unless they are accompanied by additional analysis.

Box 33: Changes in discharge of major global rivers (courtesy Global Water System Project; see GWSP, 2005)

Although considerable attention has been given to trends in discharge of unregulated rivers, most studies (e.g., Lins and Slack, 2005, for the U.S., and Kundzewicz et al. (2005) globally) find that the number of rivers for which statistically significant trends (that might be attributable to long-term climate variations and change) are detected is considerably less than the number for which no signicant trend is detected. For instance, Kundzewicz et al. (2005) found that at the 10 percent significance level, 70 percent of the records analyzed showed no statistically significant change. On the other hand, the discharge of many large rivers have indisputably been affected by water management, especially dam construction, but also within-basin diversions for beneficial uses such as irrigation and municipal and industrial water supply, as well as trans-basin diversions. The figure shows the observed flow of the Columbia River after construction of large reservoirs in Canada and the U.S. (totaling about 30 percent of the mean annual discharge), as well as “naturalized” discharge (the discharge that would have occurred in the absence of the dams), as well as projected effects of climate change on the naturalized flows by 2050 (the orange band reflects the range of climate model projections). Although the projected effects of climate change are substantial, they are much less than the observed effects of water management. The figure also shows other observed effects of water management globally. In the case of the Nile River after construction of the High Aswan Dam, almost all of the river’s discharge is now either diverted for irrigation, or lost to reservoir evaporation. In the case of the Syr-Darya River, flows have declined greatly due to irrigation diversions upstream (the Syr-Darya is one of the major tributaries of the Aral Sea, declining levels in which are closely related to reductions in the river’s flows. In contrast, the flow of the Burntwood River increased by a factor of almost four following an upstream diversion into the river basin in the 1970s for hydropower production purposes.

Figure: Changes in the flow of major global rivers associated with water management: a) Columbia River at the Dalles Oregon, showing effects of water management and projected climate change; b) Nile River below High Aswan Dam; c) Syr-Danya River near its mouth at the Aral Sea; d) Burntwood River near Thomson, Manitoba, showing effects of upstream trans-basin diversion for hydropower production.



958. The challenge to water managers in addressing climate change impacts is that there is evidence that some change has occurred already (albeit with considerable variability across elements of the water cycle, and regionally) and while global mitigation efforts seem increasingly likely, climate projections indicate that substantial future change may occur due to global greenhouse gas emissions that are already occurring, or have occurred. This suggests the necessity for developing strategies and tactics for adapting to the anticipated changes and monitoring the progress of their implementation. Without some modifications, current water management plans and practices are likely to have difficulty coping with the full range of future climate impacts on water supply reliability, flood risk, health, energy, and aquatic ecosystems. Society needs to build its capacity to adapt to these changes.

959. In some cases, it may be most effective to use qualitative information to inform policy makers of the implications of climate change. More dialogue is needed at the science/policy interface to ensure that the research results needed to support policy decisions are communicated to the policy community in terms they can understand and use. In Europe, where a well developed framework for water legislation exists, there are opportunities to explore within this framework how science can be used to facilitate adaptation. For example, the EU-funded SCENES initiative gives scientists and policy makers an opportunity to work together in a shared learning experience to explore the consequences of climate change for water resources.

5. Changing hazards and opportunities

960. In many places extremes have become more frequent and/or more extreme and continue to impact on both developing and developed countries. In the former, the numbers of extreme flood fatalities can be high, while in the latter, the flood material damage increases to billions of US$. More intense droughts, affecting an increasing number of people, have been observed in the 21st century. Such droughts have been linked to higher temperatures and decreased precipitation, but are also frequently a consequence of the mismanagement of available resources.

961. The water quality characteristics and the ecological functioning of many of the world's rivers are now very different to their past, partly caused by changes in flow and partly by inputs of chemical and

biological waste from man's activities. Changes in water temperature consequent on global warming are expected to have substantial effects on energy flows and matter recycling, leading to impacts such as algal blooms, increases in cyanobacteria bloom toxicity and reductions in biodiversity.

962. In areas of increasing water stress, groundwater tends to constitute a very important buffer resource, capable of responding to overall increased water demands or to compensate for decreases in available surface water. This allows groundwater to become part of the solution in coping with increasing water scarcity.

963. Direct water related hazards could be the result of too much (floods, erosion, landslides, etc.) or too little (droughts, loss of wetlands or habitat, etc.) water. However, water related hazards also include chemical and biological pollution, which can impact on water quality and in-stream ecosystems. The natural variability of water resources and changes in the hydrological regime, whatever the cause, can also provide additional opportunities. For example, the approach of Integrated Flood Management (IFM) considers the positive as well as the negative aspects of flood waters and considers the valuable resource that is represented by the flood plains that these waters, on occasions, occupy and re-invigorate.

964. While it is evident that loss of lifhttp://www.apfm.info/publications.htm - brochure022e and damage caused by floods worldwide have continued to rise steadily during recent years, the fact remains that apart from being a vital source of freshwater, small and medium sized floods can bring other benefits to the community and the natural environment (such as the recycling of nutrients and sediments). It must be recognised that any water system is at risk, but equally well can benefit from changes in the hydrological regime. Even areas where water is believed to be plentiful experience difficulties if there are even slight reductions in supplies available. This is because communities have come to expect and depend on the existing levels of supplies. For example, drought is a relative phenomenon and the magnitude and duration of drought in one area cannot be directly compared to another.

965. Huntington (2005) has recently completed a useful review of recent changes in the global water cycle from observations only, by analysing some 100+ recent references. The review shows that there are increasing global or regional trends in the second half of the 20th century in runoff, floods and droughts and some other events or variables, which in combination support the perception of intensification of the hydrological cycle. At the same time, substantial uncertainty in trends of hydroclimatic variables remains due to differences in responses of different variables and among regions as well as major spatial and temporal limitations in data.

966. The drivers associated with changes in the risks of occurrence of hydrological events and the related human and ecological hazards include:

- Climate variability and trends;
- Land use change (either intentional such as changes in farming or irrigation practices, or accidental such as wild fires);
- Excessive allocation of available resources, especially in areas where water resource systems are finely balanced;
- Increases in the risk to communities through population growth and movement; and
- Lack of adequate water allocations for the environment and a deterioration in aquatic ecosystem functioning.

6. Sensitivity of climate regions to various changes

967. Different regions of the world are experiencing different degrees of change related to both climate variations and population and development pressures. In a related way, different regions also respond differently to changes in hydrological extremes and one of the purposes of this section of the report is to

identify those areas that are likely to experience the most negative impacts on water resources as well as those that are the most sensitive to changes in extremes and hazards:

- Deserts face conflicting influences under climate change: potentially seeing more vegetation with higher CO2 levels, but overall facing increases in drought and warmer temperatures. As ecosystems in deserts are already in a fragile environment, impacts could be severe;

- Grasslands are influenced by precipitation and even when increased, changing seasonal variability is important, and declining summer rainfall could damage grassland fauna;

- Mediterranean ecosystems are diverse and vulnerable, susceptible to changes in water conditions. Even in the range of 2 degree warming, 60-80% of species may be lost in the Southern Mediterranean, while the Cape Fynbos in South Africa may lose 65% of its species;

- Tundra/arctic: with greater warming at the poles, the loss of permafrost and the potential for methane release is a major concern;

- Mountains are seeing shortened and earlier snow and ice melt and related changes in flooding. At higher altitudes, increased winter snow can lead to the opposite problem of delayed snow melt;

- Wetlands will be negatively affected where there is decreasing water volume, higher temperatures and higher-intensity rainfall; and

- The Himalayan region is highly vulnerable to anticipated climate change because the major river systems consist of substantial contributions from the melting of snow and glaciers. In the Indian context, the importance of the river systems originating from the Himalayas, namely the Indus, Ganga and Brahmaputra River systems, can be understood from the fact that they contribute more than 60% to the total annual runoff for all the rivers of India. These river systems hold immense potential as a future freshwater source and drain the major plains of the country. Some Himalayan rivers obtain more than a 50% contribution from snow and glacier melt runoff to the annual streamflow near the foothills of Himalayas. Melting of glaciers and a reduction in solid precipitation in mountain regions would have a direct impact on water resources affecting domestic supplies, irrigated agriculture, hydropower generation and other water-dependent activities.

7. Hazards associated with changes in average streamflow

968. While hazards are normally associated with hydrological extremes, there could be substantial risks to human activities caused by changes in average streamflow, especially in those areas that are already water-stressed. In 2050, the IPCC (2007) report suggests that the annual average runoff will have increased by 10-40% at high latitudes, and decreased by 10-30% over some dry regions at mid-latitudes and semi-arid low latitudes. However, in many water scarce regions, land use change and increasing levels of water resource development and use could hide the effects of climate change. At high latitudes where an increase in annual flow is predicted, the corresponding impact on low flow and drought depends on the seasonal distribution of precipitation, the storage capacity of the catchment (ability to take advantage of higher winter precipitation), changes in evapotranspiration and the length of the growing season.

969. The IPCC reports increased annual runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, indicating a regime shift for some rivers. This trend is projected to continue in response

to increasing temperatures, causing initially increased, but eventually reduced summer streamflow in downstream regions receiving melt water from major mountain ranges.

970. Extreme water-related events have both positive and negative impacts. For example, on the benefits side, they recharge natural ecosystems leading to abundant water for food production, health and sanitation. Also, for example, in the lower Mekong River delta, Cambodia applies practices to replenish rice paddies trapping water and nutrients carried down by the sediment during flood periods. Often the event itself has significant importance to the aquatic and riparian ecology which has been demonstrated during the artificial flooding of the Colorado River at Grand Canyon, USA. On the other hand, extreme water-related events destroy property and kill people. The most common extreme events are floods and drought.

971. Whatever the situation, extreme events continue to impact on both developing and developed countries. In the former, the numbers of extreme flood fatalities can be high, while in the latter, the flood material damage increases to levels of billions and tens of billions of US$. Among the recent extreme high-impact water-related events are: floods in Europe in 1997 and 2002, floods in China in 1996 (26 billion US$ in material damage) and 1998 (30 billion US$ in material damage). Destructive floods observed in the last decade all over the world have led to record high material damage. The costs of extreme weather events have exhibited a rapid upward trend and yearly economic losses from large events increased ten-fold between the 1950s and 1990s, in inflation-adjusted dollars (IPCC, 2001) (Table 24: Examples of Major Floods and Flooding World Wide. However, the question remains as to whether or not the frequency and/or magnitude of flooding is also increasing and, if so, whether it is in response to climate variability and change. Disaster losses, mostly weather and water related have grown much more rapidly than population or economic growth suggesting a climate change factor.

Table 24: Examples of Major Floods and Flooding World Wide

Date of event	Location	Meteorological conditions	Peak discharge (m3/s)	Impact (Mill $)	Impact (human losses)
Jan 2008	Zambezi River/Mozambique	Heavy torrential precipitation in Mozambique and neighboring countries	3 800	2	20 dead, 113 000 displaced
May 2006	Lower Yukon/USA	Snowmelt, ice-jam break - up			
April – May 2003	Santa Fe/ Argentina	Saturated soil due to important precipitation in summer 2002 and heavy rainfall in April 2003	4 100		22 dead, 161 500 displaced
Feb 2000	Limpopo River/Mozambique	Extreme precipitation in tropical depression enforced with torrential rain of 3 cyclones	10 000		700 dead, 1 500 000 displaced
Jul 1997	Czech Republic	Saturated ground after extreme long-lasting precipitation and extreme precipitation	3 000	1.8	114 dead, 40 000 displaced
Jun 1997	Bangladesh Bramaphutra River	Torrential monsoon rains during monsoon season	10 200	400	40 dead, 100 000 displaced
Mar – Apr 1997	Red River, North Dakota/USA	Heavy rains and snowmelt	3 905	16 000	100 000 homes flooded, 50 000 displaced
Nov 1996	Subglacial Lake Grimsvotn/Iceland	Jokulhlaup flood	50 000	12	0 dead
Feb 1996	West Oregon/USA	Extreme spring snowmelt and heavy spring precipitation			9 dead, 25 000 displaced
Jul 1995	Athens/Greece	Storm with a short duration and extreme intensity	650		50 000 displaced
Nov 1994	Po River/Italy	Cold front associated with cyclonic circulation gave heavy rainfall	11 300		60 dead, 16 000 displaced
Feb 1994	Meuse River/Europe	Heavy rain due to low pressure system	3 100		No exceptional damage
Sep 1993	Mississippi River/USA	Heavy precipitation in June and July. Saturated soil due to extremely high precipitation		15 000	50 dead, 75 000 displaced
Nov 1988	Hat Yai City/Thailand	Brief torrential monsoon rain		172	664 dead, 301 000 displaced
Jan 1983	Northern Peru	El Nino situation with heavy rains	3 500		380 dead, 700 000 displaced
Aug 1979	Machu River/India	Exceptional heavy rainfall, swollen river. Resulting with the collapse of the Matchu dam	16 307	100	1500 dead, 400 000 displaced
Jun - Sep 1954	Yangtze River/China	Intensive rainfall over several months	66 800		30 000 dead, 18 000 displaced
Jan 1953	North Sea/Netherlands	High spring tide and a severe European windstorm		504	1835 dead, 100 000 displaced
Jan 1910	River Seine/France	Very wet period for six months	460		No dead, 200 000

		followed by heavy rains in January			displaced
May 1889	Johnstown/USA	Extremely heavy rainfall due to storm followed by breach of dyke		17	2200 dead
Jul 1860	East Norway	Frost and heavy snowfall followed by snowmelt heavy precipitation	3 200		12 dead

Box 34: Urban Stormwater management in association with land use and land cover planning: A resource, not merely a nuisance. (Uri Shamir and Naomi Carmon).

Urban areas cause substantial changes in stormwater hydrology, increasing runoff volumes and peak discharges and changing water quality. The traditional view is that urban runoff is a nuisance and should be removed as quickly and effectively as possible. An expanding number of studies, policies and implementation in several countries and cities around the world have shown convincingly that this attitude should be replaced by the paradigm that stormwater is a resource, not merely a nuisance. Optimal management of runoff is determined by local conditions, and can include recharge of aquifers, retention and detention to improve water quality, to reduce downstream flood impacts and the cost of drainage systems, as well as on-site use of the water ("Rainwater Harvesting") or to irrigate and enhance the urban environment. Stormwater management can be exercised at all spatial scales: from the household level to the entire built area of a city.

The broad context of this paradigm is termed Water Sensitive Planning (WSP). It dictates that water considerations must be incorporated in land use and land cover planning from the very outset. Traditional practice has it that planners locate land uses and design land cover and then hand over to engineers the task of designing drainage systems to remove the runoff. Instead, water considerations should be incorporated in determining the location of land uses, their layout and topography, the distribution of pervious and impervious land cover, and the use of Best Management Practices (BMPs), a term used for land cover practices as well as constructed facilities for capturing, detaining, storing and infiltrating runoff while ***improving its quality through settlement of sediments and passing through wetlands.*** In fact, efficient water use and conservation, recycling of grey waters and possible use of treated wastewater in the urban area should be part of planning from the outset. Water sensitive designs can also be implemented in existing urban areas, albeit with greater difficulty and expense than in newly constructed ones. Connecting roof drains to pervious spaces, constructing a low wall around properties to make them into mini-detention basins that store and infiltrate runoff, and directing the excess water to playgrounds, open public spaces and parks can all be effective in making better use of stormwater runoff and reducing flooding damages.

For the Coastal Plain of Israel, with an annual rainfall of 500 mm, it has been estimated that the aquifer recharge can be increased by about 25,000-77,000 m^3 km^{-2} of urban area by connecting roof drains to a 15% pervious area on the property and surrounding the property with a low (~20 cm) wall (Carmon and Shamir, 1997). The actual reduction in runoff loss will depend on local rainfall patterns, topographic and soil conditions, and on the means employed for managing and using the runoff.

In conclusion: land use should be counted among the drivers of change, either alone or in connection with "urbanization". Land use and land cover should be planned to maximize the beneficial use of potable water and stormwater, while reducing the hazards associated with runoff.

972. It is becoming increasingly apparent that, in the light of climate change and other global trends, we must become more risk assessment orientated in the management of our vulnerable water resources, adopting practices that enable us to manage and maintain a sustainable water supply system, balancing social, environmental and economic requirements.

973. Despite its importance for river baseflow and wetlands, groundwater is frequently ignored in water balance calculations. As long as groundwater levels are rather stable, or the annual variations of groundwater levels lie within certain intervals, groundwater is regarded as constant. However, for longer

term evaluations such as associated with global changes, groundwater resources are of utmost importance, since groundwater has a buffer function for short term climatic variations and is at the base of important adaptation strategies.

974. Groundwater flow processes are usually much slower than atmospheric or surface water processes, often by 2 or 3 orders of magnitude. In large aquifer systems containing most of their groundwater in stock, more than 90 percent of the groundwater resources are made up by “dead” storage that was formed in previous times when rainfall conditions were conducive for higher recharge. While not part of the present day water cycle, it forms an extremely valuable asset, chiefly in regions that are known for their aridity, e.g. the deserts of North Africa, the Arabian Peninsula, Central Asia and Australia. These so-called fossil groundwater resources are increasingly used for agricultural, industrial and domestic water supplies, although they are almost never recharged and will be depleted one day. There are many cases in the world, where such groundwater mining forms the only reliable water resource.

975. There are even more locations where groundwater is pumped, in the absence of an understanding of its source and how much is annually recharged and therefore may be used sustainably. This causes dropping water levels, dry wetlands, dewatered rock sequences and land subsidence. It is therefore very important to collect more groundwater data and to quantify the groundwater resources worldwide, as a basis for improved groundwater management.

976. The groundwater portion of the water cycle has been subjected to massive changes, particularly during the past hundred years since humans have learned to dig or drill wells and abstract groundwater by pumps. In the past fifty years it has become very popular to pump groundwater for irrigated agricultural production. Some 70 percent of the global groundwater abstraction is thought to be used for irrigation, where enormous amounts of water are lost by evaporation and plant growth. Particularly in areas associated with the so-called green revolution, the consequences of heavy groundwater pumping are disastrous: falling water levels, degradation of groundwater bodies and increased salinisation.

977. Changing land use and water infrastructures have also greatly modified the groundwater regimes. Pumping groundwater from deep aquifers and dewatering adjacent aquitards is now a worldwide phenomenon. It probably accumulates to several thousands of km3 over the past century and is presently at about 40 km3 annually (about 4 % of the total annual groundwater abstraction). In contrast, there are many good examples of sustainable groundwater management practices, e.g. in European countries, where groundwater has been used for decades as a safe, high quality source for drinking water supply, without any degradation. These highly valued and well-protected groundwater resources are key factors for social and economic development.

978. From a global perspective recent increases in soil loss are likely to have been at least partially offset by reduced erosion in other regions, as a result of the implementation of soil conservation programmes and improved land management during the 20th century. For example, Uri and Lewis (1999) estimate that in recent years soil conservation and related measures promoted by the Food Security Act of 1985 have reduced the total annual erosion from US cropland by about 40%, from 3.4 Gt/y to 2.0 Gt/y. Likewise the successful implementation of erosion control measures in the loess region of the Middle Yellow River Basin in China after 1978 (Hu et al., 2008) played a major role in reducing the annual sediment load of the Middle Yellow River from ca. 1.6 Gt/y in mid 20thcentury to ca. 0.7 Gt/y at the end of the 20th century. Elsewhere in the world, the progressive introduction of no-till and minimum till practices will also have reduced erosion rates on cultivated land. Montgomery (2007) indicates that such measures typically reduce erosion rates by more than an order of magnitude and Lal et al. (2004) estimate that, to date, no-till and minimum till practices have been implemented on about 5% of the world’s cropland.

979. There is now increasing recognition that future climate change is likely to cause further changes in soil erosion rates, with the increased variability of rainfall and an increase in the frequency of high magnitude storm events resulting in increased erosion rates in many areas of the world.

980. The sediment load of a river is sensitive to a range of environmental controls, related to both supply of sediment to the river and its ability to transport that sediment. The lack of long-term sediment measurements for most of the world's rivers precludes detailed analysis of global trends, but available data emphasize that important changes are occurring (Walling, 2006). Many rivers around the world provide evidence of reduced sediment loads in recent years (Walling and Fang, 2003), primarily as a response to the construction of dams along their courses, which trap a large proportion of the sediment load previously transported by the river. Vorosmarty et al. (2003) estimate that more than 40% of the global river discharge is currently intercepted by large dams (i.e. dams with a maximum water storage capacity ≥0.5 km3). The Nile and the Colorado Rivers provide examples of where sediment trapping by dams has reduced the sediment load of those rivers to near zero.

981. From a more local perspective, increased sediment loads frequently cause degradation of water quality and aquatic habitats, as well as increased siltation of reservoirs, river channels, canal systems and harbours. In many contexts, reduced sediment loads bring benefits, but reduced sediment inputs to deltas and coastal areas can remove important nutrient sources and change the sediment balance leading to shoreline recession.

982. Climate change will affect water quality and ecosystem health through increased water temperatures, decreased water levels, increased flooding, and changes in lake stratification patterns. The major drivers for aquatic ecosystems dynamics are temperature and availability of water; together they determine primary production, composition, structure and biological diversity of ecosystems, energy flow and the range of global biomass, pattern of ecosystem succession and the type of climax biome in the globe.

983. Increased water temperatures promote algal blooms and raise the cyanobacteria bloom toxicity. Experiments performed by Sivonen (1990) and Lehtimaki (1994) showed that production of cyanobacterial toxins reaches the highest rate at temperatures of 15-25°C. A toxin produced by microcistis - Microcistina-LR - is ten times more toxic than strychnine and its toxicity may be enhanced by the presence of other toxins. Toxic cyanobacteral blooms, already present in all the continents, may intensify posing restrictions on water resources use for humans.

984. Relatively small increases in temperature also accelerate energy flow and matter cycling; a 1°C warming enhances ecosystem productivity by 10-20% at all trophic levels. An intensification of food consumption may reduce the densities of zooplankton, resulting in a decrease in the fish food base, inhibit growth and favour small species over large ones. Overlapping of changing abiotic conditions, e.g., increasing temperature and decreasing dissolved oxygen content, may be an additional stressor, contributing to lowering of biodiversity and ecosystems function and specifically shifts in dominant species, destabilisation of the ecosystem equilibrium and a shift to another steady state. Rising water temperatures and related changes in ice cover, salinity, oxygen levels and water circulation have already contributed to global shifts in the range and abundance of algae, zooplankton and fish in high-latitude oceans and high-latitude and high-altitude lakes, as well as to earlier migrations of fish in rivers. It must also be recognized that the affect of increased temperatures and the acceleration of biological processes will differ depending on hydrological type and the characteristics and complexity of aquatic ecosystems. For example, rising water temperatures can improve water quality during winter and spring in colder regions where earlier ice-breakup increases oxygen levels and reduces winter fish-kills (IPCC, 2007).

985. The response of the river ecosystems to climate change will depend on their location within the river basin. Longitudinal linkages play an important role in the river functioning as an ecosystem. Upper sections of rivers are usually driven by abiotic factors and the biotic structures are better adapted to high abiotic (hydrological) variability, resistant to rapid and unexpected changes, and have a better ability to recover from stress. Down the river course, with stabilizing abiotic characteristics, biotic processes determine ecosystem dynamics, thus the ecosystems will be more vulnerable to global warming.

986. Modification of precipitation patterns due to climate changes will directly influence runoff and the timing and intensity of nutrient and pollutant supply to the rivers and lakes. Changes are expected to be intensified in catchments with degraded vegetation cover, landscape drainage and wetland loss. Open nutrient cycles in the terrestrial ecosystems due to reduced retentiveness in biomass and mineralization of organic matter in soils, will intensify their loss to freshwater. The more intense rainfall events will also lead to greater fluvial erosion and increases in suspended solids loads (turbidity) in lakes and reservoirs (IPCC, 2007). Extending of the growing season due to global warming may increase the duration of agricultural activities during a year, which may cause more nutrient leaching from agricultural areas (Hillbricht-Ilkowska, 1993). The above processes will contribute to an intensification of eutrophication, a common problem in lakes and rivers all over the world and a serious hazard for both human activities (drinking water, aquaculture, recreation), as well as ecosystem functioning.

987. The expected overall lowering of water levels in rivers and lakes will lead to decreases in water quality. Water reserves will become more turbid through the re-suspension of bottom sediments (Atkinson et al., 1999) and the decrease in water supply will decrease the dilution of pollutants in water resources. A key indictor of biological water quality is the level of oxygen in the water; oxygenation of river water is enhanced under high flow conditions that encourage surface aeration. Mimikou et al (2000) simulated stream conditions under several climate change scenarios and found that decreased streamflows resulted in reductions in oxygen levels and decreased water quality. Salinity levels will increase with decreasing streamflow in semi-arid and arid areas; salt concentrations are predicted to increase by 13-19% by 2050 in the upper Murray-Darling Basin in Australia. Salinisation of water resources is also predicted to be a major hazard for island nations where coastal seawater intrusion is expected with rising sea levels (IPCC, 2007).

988. The higher temperature, change in precipitation patterns and shift in regional wind regimes associated with climate change are likely to alter the thermal stratification of lakes and reservoirs. Increases in temperature are likely to increase thermal stability and alter mixing patterns in lakes, this can result in reduced oxygen concentrations and an increase in the release of phosphorous from sediments (IPCC, 2008). Simulations for hypothetical lakes show that lakes in subtropical zones (about latitude 30 to 45°) and in subpolar zones (latitude 65 to 80°) are subject to greater relative changes in thermal stratification patterns than mid-latitude or equatorial lakes and that deep lakes are more sensitive than shallow lakes in the subtropic zones (Meyer et al., 1999). Fang and Stefan (1997) show by simulation that winter stratification in cold regions would be weakened and the anoxic zone would disappear. The greatest increases in water temperatures are foreseen in lakes were the duration of ice cover will substantially reduce. In addition the simulated boundary of ice-free conditions shifted northward by 10° of latitude or more in the northern hemisphere (Hostetler and Small, 1999). Observations during droughts in the boreal region of northwestern Ontario show that lower inflows and higher temperatures produce a deepening of the thermocline (Schindler and Stainton, 1996). Changes in wind speed and direction contributing to patterns of lake and reservoir mixing and thermal stratification may alter the biomass cycling in lakes.

989. The loss of aquatic biodiversity by global warming will be mostly caused by shifts of the physical characteristics of ecosystems and shrinking of suitable habitats. Other species will not be able to reach the suitable habitats due to increasing disconnections and disintegration of climate and landscape. New

analyses show that 15–37% of a sample of 1,103 land plants and animals might eventually become extinct as a result of climate changes expected by 2050 (Thomas et al., 2004).

990. Progressive modification in catchments due to the impacts of other, powerful, non-climatic agents of global change, may both enhance or mitigate the expected effects of climate change. The socio-economic drivers superimposed upon the ecological and hydrological processes include changing demography, technology development, dynamics of economic markets and resource demands, political and social institutions, culture, knowledge and information exchange (Redman et al, 2004). They stand at the beginning of a chain of causal links transformed though ‘pressures’ (emissions, waste, resource use and land use) creating pressure on nature and the environment, including climate change, to ‘states’ (physical, chemical and biological) and to ‘impacts’ on ecosystems, human health and functions. These eventually may lead to political ‘responses’ such as prioritisation, target setting and indicators, policies, regulations or possibly socio-economic constraints and losses.

991. Ensuring ecosystem integrity while meeting the demands of a growing and increasingly affluent population has emerged as one of the world’s primary resource issues. Human utilization and control of water resources enables managers to convert natural riverine flows into dependable ecological services (e.g., water supply, hydropower generation, flood control, recreation, and navigation), yet this also results in considerable ecological damage and the loss of important ecosystem services that are valued by society. In response to the intensifying competition for water, scientists are becoming increasingly engaged in the development of environmental flow recommendations needed to sustain river ecosystems. Environmental flows are typically discussed in the context of water releases from dams, where there is general agreement that managed flows need to exhibit patterns of natural variability necessary to support a functioning riverine ecosystem.

8. Impacts on transboundary water resources

992. Countries that share water resources may face additional challenges under conditions of changing hazards. In areas where there is already experience of hazards, nations are used to such crisis management. However, if the severity of hazards is increased (in terms of intensity and magnitude) these countries will face additional challenges. Consequently, hazard mitigating efforts would require new and additional cooperation with the other concerned states (Romm, 2007). In new hazard exposed areas, there will be great variations in how nations mitigate the hazards that affect international waters. In broad terms, OECD-member countries in Europe, North America and South East Asia, would be able to mobilise their institutional and financial resources to invent new cooperative efforts, while developing nations that have limited resources and hazard mitigating experience would be the most exposed. Examples include the Mekong basin and some of the major basins in West and Central Africa (International Crisis Group, 2007). Changes in transboundary water resources (either through engineered developments or climate change) represent opportunities for future cooperation, given that there is the political will to engage in such cooperation. However, it is important to recognise that cooperation must be based on a common understanding of the nature of the resource as well as its value to the countries who share it. This further emphasises the need for the collection and sharing of reliable data (with which to quantify the resource availability and use), as well as the use of compatible data analysis methods.

9. Hazards versus opportunities

993. Based on identified trends, the future will see increased pressure on water resources together with changes in the patterns and magnitudes of resource availability related to changing climate patterns. While it is no embellishment to say that climate change represents a huge challenge for the next generation, it could also represent an opportunity. Most of the talk about the economic impact of climate change refers to the potential threat, while it is important not to ignore the opportunities – for new growth,

innovation in the management of water resources and for a modern economy. Because the human race has adapted to and modified its life style to fit in with its existing climate and the inherent variability, climate change is expected to impact on most aspects of human life and notably on the hazardous aspects of water-related events. However, there are opportunities for gain as well as for loss. Some areas may gain in access to water through increased precipitation while other may have less or more variable water resources.

994. There are many examples of countries that have managed their scarce resources efficiently and effectively, despite low rainfalls and stream flows. For example, Spain, a traditionally dry climate country (in general) historically has succeeded in managing its water resources through adaptation.

995. Another example is that of South Africa. The actual evapotranspiration of five commonly grown crops-maize, millet, sorghum, groundnuts, and beans-in two selected districts were analyzed by six country teams. In addition, two country teams also analyzed other crops grown in the districts. The regional analysis shows that the actual yield of the different crops-specifically of maize and groundnuts-improves with an increase in actual evapotranspiration, although the gap remains wide between actual and potential yield and actual and maximum evapotranspiration, especially for the rainfed crops. The results of the analysis also show that a 2°C increase in the temperature and a doubling of carbon dioxide concentration in the atmosphere will shorten the growing period of maize, which will result in decreased crop water requirement and use (World Bank, 2007).

996. The increased exposure of potential climate change hazards has led to an increasing awareness of a number of issues related to the management of water resources that require solutions in the future regardless of the impacts of climate change. The revision of management strategies in response to potential climate change threats therefore represents an opportunity to implement policies and practice that will lead to more sustainable use of available resources into the future. Over many generations, the human race has shown an amazing ability to adapt and adjust to meet climate variability and increasing pressure on resources. Therefore, there will be significant opportunities for the development and implementation of both mitigation and adaptation strategies as we move forward. These strategies could include, but would not be limited to, improved observation networks, increased integration in the use of groundwater and surface water supplies (including artificial recharge), improved early warning and forecasting systems for hazardous events, improved risk-based approaches to management and the raising of community awareness of sustainable water resource use and individual responses to water related hazards.

997. There are many specific examples of turning potential hazards into opportunities. For example, the use of increased runoff due to the melting of glaciers for the development of more reliable water supplies for larger areas, the use of flood storage for increasing the reliability of water supplies and improved floodplain management and planning.

Table 25: Key findings relative to trends in land surface water cycle components

Table 11.2 Summary of key findings relative to trends in land surface water cycle components

Hydrologic variable	Key findings
Precipitation	The mode of precipitation may be more important than the average precipitation in determining hydrologic impacts. Widespread increases in heavy precipitation events have been observed in some places where total precipitation has decreased. At the same time the length, frequency and intensity of heat waves have widely increased. In addition, more precipitation now falls as rain rather than snow in northern regions. All these changes are consistent with a warmer atmosphere with a greater water-holding capacity.
Evaporation and evapotranspiration	Several studies provide evidence that on average for large areas of Asia and North America, actual evapotranspiration is increasing, even though pan evaporation is decreasing.
Soil moisture	In-situ soil moisture measurements are too sparse to draw conclusions about multidecadal soil moisture trends at the global scale, and current satellite sensors are suboptimal in terms of microwave frequency and have record lengths that are too short to provide meaningful information about trends. Studies using physically based model reconstructions with precipitation and temperature to estimate soil wetness are not comprehensive enough to fully understand the uncertainties and generate unambiguous results.
Runoff and streamflow	Two recent studies that assess high and low flow trends on a worldwide basis concluded that their results do not support the hypothesis that global warming has, to date, caused an increase in hydrologic extremes, such as more floods and (hydrologic) droughts. Where long streamflow records support century-scale trend analysis, there is evidence of increases in low flows and mean annual flows, but not floods. These changes appear to be generally consistent with observed precipitation increases over the same period.
Groundwater	A recent US Climate Change Science Program report states that '. . . the ability to predict the effects of climate and climate change on groundwater systems is nowhere near as advanced as for surface water systems.' Much more work is needed to understand the sensitivity of this critical resource to climate change globally.
Reservoir, lake and wetland storage	Changes in lake extent have been observed in many parts of the world over the past few decades, but the primary factors behind these changes are regionally specific. Decadal scale variations in lake, wetland and reservoir storage are natural characteristics of the dynamics of these water bodies and cannot necessarily be ascribed to climate, land cover or other anthropogenic causes.
Permafrost	Changes in the physical climate at high latitudes, primarily increasing air temperature, are forcing changes in permafrost conditions and permafrost degradation. These include increased permafrost temperatures, thickening of the active layer, and thermokarst and talik development (including changes in the extent of thaw lakes) over the Northern Hemisphere permafrost regions. Ground-based measurements indicate that the magnitude of permafrost temperature increase is greatest in continuous permafrost regions and transitions to no change in discontinuous and sporadic permafrost regions.
Snow	Most studies suggest that over the Northern Hemisphere the length of the snow cover season has decreased and spring melt has occurred earlier, over the last 50-100 years. Some studies suggest that these changes may have accelerated in the last several decades; however inconsistencies in data sources complicate such a conclusion.
Glaciers	There is strong evidence that glaciers have retreated globally since the middle of the 19th century, after the 'little ice age', and this retreat has accelerated from the mid-1970s as a response to rapid increases in air temperature, and changes in precipitation amount and rain and snow partitioning. Although there is evidence of glacier retreat globally, tropical glaciers are more sensitive than those at higher latitudes, and have shown the most rapid changes.

N. Water Governance Reform: Strengthening Policy, Planning and Institutions

1. Integrated Approaches to Water Planning and Reform

998. Reforms in water resource planning, policy and institutions are ongoing in developed and developing countries. European Union members, for example, are currently implementing the Water Framework Directive. Water reforms also are ongoing in many middle-income and least-developed countries in Africa, Asia and Latin America, many focusing on principles of Integrated Water Resources Management (IWRM). The second edition of the United Nations World Water Development Report (WWAP, 2006) concluded that, while some countries had IWRM plans and policies in place, their effective implementation remained disappointing. A recent United Nations water report (Box 14.1) made a similar conclusion, noting that, although many countries have progressed in formulating plans and policies, their actual implementation often was lacking, especially in regard to water use efficiency (UN-Water, 2008) (Box 35.

Box 35: UN-Water Survey on progress toward IWRM/WE 2005 Targets

The increasingly stressed water resources present managers with increasingly difficult decisions on water allocation and protection. IWRM is an approach that assists such decisions by drawing attention to efficient, equitable and environmentally-sound water management. A global target was agreed at the World Summit on Sustainable Development (WSSD) in 2002 to "Develop integrated water resources management and water efficiency plans by 2005, with support to developing countries through actions at all levels."

A survey, prepared and implemented by UN-Water in 2007/08, aimed to highlight progress toward illustrate progress towards the targets, based on responses to questionnaires from government agencies in 104 countries, with 77 of the countries being developing countries, or countries with economies in transition. Informal surveys were made earlier by the Global Water Partnership and the African Development Bank. The questionnaires were prepared by UN-DESA and UNEP (through UNEP's Collaborating Centre, DHI, Copenhagen). The survey included questions in the following categories:

- Main national instruments and strategies that promote IWRM (e.g., policies, laws and IWRM plans);
- Water resources development, represented by such items as assessments, regulatory guidelines and basin studies;
- Water resources management, as reflected in programs for watershed management, flood control and efficient allocation;
- Water use, represented by water demand surveys and programs for managing agricultural, industrial and municipal water uses;
- Monitoring, information management and dissemination, as reflected in monitoring and data collection networks;
- Institutional capacity building, represented by items such as institutional reforms, river basin management institutions, and technical capacity-building programs;
- Stakeholder participation, illustrated for example by decentralized structures, partnerships and gender mainstreaming; and
- Financing, represented by such items as investment plans, cost recovery mechanisms and subsidies.

The questionnaire responses were quality-checked, and a database of answers populated. A regional analysis divided the responses into summaries for Africa, the Americas and Asia. For the developed countries, it was found that, out of 27 questionnaires, only 6 have fully implemented national IWRM plans. A further 10 countries have plans in place and partially implemented. Particular areas of improvement are public awareness campaigns and gender mainstreaming.

The results for developing countries indicated the proportion of completed plans was 38 per cent, with the Americas at 43 per cent, Africa at 38 per cent, and Asia at 33 per cent. Africa lags behind Asia and the Americas on most issues, although it is more advanced in stakeholder participation, subsidies and micro-credit programs. Asia appears to be leading in institutional reform. Another additional survey finding was that indicators and monitoring could provide countries with a better assessment of their needs to advance in implemented IWRM (UN-Water, 2008).

999. Although development and application of this approach is proving more difficult than originally envisioned, this approach was meant to facilitate the mainstreaming of water priorities and related environmental issues within the context of national economic development activities, a goal often considered only after considerable development activities have already been undertaken (Box 36). The utility of IWRM as a framework and essential tool for effectively managing water resources and water resource issues also was endorsed at the 16th Session of the Commission on Sustainable Development, noting also that the Commission's review on progress in the water and sanitation sector should go beyond mere stocktaking of IWRM efforts.

Box 36: Impacts of Non-integrated Approaches to Water Resources Management

The transboundary Rio Grande (USA and Mexico) illustrates the negative impacts of a non-integrated water resources management. This region is one of the fastest growing areas in both countries, benefiting from the enhanced economic activities associated with the North American Free Trade Agreement (NAFTA) between the USA, Mexico and Canada. One result of NAFTA has been a proliferation of product assembly plants (maquiladoras) on the Mexican side of the border, making it a magnet for job seekers in Mexico. This has been accompanied by a proliferation of informal settlements (colonias) on both sides of the border. Further, there is extensive agriculture on both sides of the border in the lower Rio Grande Valley, making agriculture an important economic sector for Mexico and Texas. Finally, there are 7 major paired urban areas along the international portion of the Rio Grande. Because of the associated water demands, approximately 96 per cent of the average flow of the river is allocated for municipal, agricultural and industrial uses. Although water allocations are governed by several treaties, the most noteworthy being the 1944 Treaty ("Treaty Regarding the Utilization of Waters of the Colorado Tijuana and Rio Grande Rivers"), the river also is subjected to the jurisdictional concerns of federal and state agencies in 3 states in the USA and 5 states in Mexico. With responsibility for its quantity, quality and/or allocations residing in several international, national and state organizations with differing mandates in both the United States and Mexico, the result is that the river is over-allocated and degraded throughout much of its length (Moore et al., 2002).

It is noted that an analysis of 67 EU projects related to IWRM, spanning the period 1994-2006 (Gyawali, Allan et al., 2006), provides insight into current challenges facing practical application of IWRM. These various analyses suggest that, although it has not yet provided unequivocal guidance regarding the application and implementation of national water planning and reforms, IWRM can provide a useful reform and planning framework. The analyses also indicate that, in order to be most effective, IWRM must consider policy formulation and implementation as a primarily political process involving government officials, the private sector and civil society.

Box 37: Water Resources Development in Tunisia

Water resources management in Tunisia began with development of the supply side, addressing the water demands of various sectors. The country has since established a system of interlinked water sources, making it possible to provide water for multiple purposes, including mixing waters of low and higher salinities to make even less usable water more productive. The country developed a national water-savings strategy for both urban and agricultural needs at an early stage of water planning, confirming a cultural 'oasis' tradition of frugal and patrimonial management of water resources, being a rare commodity in Tunisia. Because of this tradition, irrigation water demands have been stable for the past 6 years, despite increasing agricultural development, seasonal peaks in water demands, and unfavourable climatic conditions (including droughts). The current water demands of tourism (a source of foreign currency) and urban areas (a source of social stability) are being addressed.

Underlying principles of the Tunisian water strategy include: (1) shifting from isolated technical measures to a more integrated water management approach, an example being a participatory approach giving more responsibility to water users (e.g., 960 water user associations were created, encompassing 60 per cent of the irrigated public areas); (2) gradual introduction of water reforms and adaptation to local situations; (3) financial incentives to promote water-efficient equipment and technologies (including a 60 per cent subsidy for equipment purchases); (4) supporting farmer incomes to allow them to plan for, and secure, agricultural investment and labour; and (5) A transparent and flexible water pricing system, aligned with national goals of food security, thereby leading to gradual recovery of costs.

Wastewaters from urban centres are treated and made available for agricultural use. Further, using a targeted pricing policy, the costs of operating water services are completely recovered, with tourists paying the highest water prices and household users the lowest. Water system monitoring also is extensive, including real time information on all irrigation flows. One result is improved groundwater storage, and vegetation recovery in sensitive natural areas, (UNEP, 2008). The current plan ends in 2010.

In spite of the success to date, however, Tunisia's water resources are still under considerable stress. A combination of increasing population growth and water use in all sectors signals major future threats, being an impetus for considering scenarios to address fundamental future water allocation choices (Plan Bleu, M. Hamdanne, Fiuggi, 2002; Treyer, S., 2004).

1000. Scenario-based planning tools also are currently being developed in some countries. As an example of evolving water planning and reforms, the Netherlands used scenario-based planning to help make decisions on water management options. Its first plan during the late-1960s only addressed water quantity issues, but has since evolved into a multi-facetted water management process, with a main pillar being stakeholder (other ministries, local authorities, private sector, public, etc.) involvement (Box 38).

Box 38: Integrated Water Planning in the Netherlands

The Netherlands is preparing its fifth integrated water management plan, with the potential consequences of climate change high on its management agenda. Its first plan, made in 1968 was essentially supply-driven, addressing only water quantity issues. Because of a subsequently deteriorating water quality situation, and a very dry summer in 1976, the government fundamentally change its approach to water management, with its second plan completely different in content and approach. A study, "Policy Analysis of Water Management for the Netherlands," was carried out, with the cooperation of other ministries and external expertise, to develop its second water management plan, with the project objectives being to (i) develop and apply a methodology for generating alternative water policies for The Netherlands; (ii) assess and compare the results; and (iii) create a Dutch capability to conduct further similar analyses. Project results included: (i) better operational understanding of Dutch water systems; and (ii) cost-benefit analyses of promising options for improving water management, resulting in definition of implementable local-level projects, thereby forestalling large, expensive infrastructure projects. One important conclusion was that water quality problems could not be solved at national level (e.g., redistributing water at the local level would inflict large losses on other sectors). Tight control of groundwater abstractions also was needed to meet environmental standards, accepting large losses to various water users.

Subsequent water management plans continued the development of IWRM. The third plan (1989) added in-depth analyses of the role of ecology in water management, while the fourth plan (1998) focused on specific water systems and themes facilitating implementation of needed actions, and clarified institutional roles in the process.

The evolution of these five water plans, each building on its predecessor, facilitated significant shifts in thinking and engendered new approaches to water management. With its origins in a technical, supply-oriented, model-based decision process, the planning process is now multi-faceted, with a main pillar being stakeholder involvement (including other ministries, local authorities, public, etc.) and a focus on sustainability and climate proofing related to anticipated future developments. It also has demonstrated that IWRM takes time to develop and implement (more than 30 years in the Netherlands), and that consideration of external expertise and inputs can facilitate the implementation of new concepts in some cases.

1001. Many developing countries and economies in transition are working to transform their water management systems into IWRM approaches, incorporating a number of relevant elements, including (i) decentralization (subsidiarity); (ii) stakeholder participation and transparency; (iii) increased commercialization/privatization; (iv) partnerships (public-private, public-public, public-civil society); (v) integration/coordination; and (vi) developing new administrative systems based on river basins/catchments. Such reform processes also are taking place in other development sectors as well.

1002. An important rationale behind river basin management units is to improve coordination in water decision-making, having been done in many countries (Kenya, Kazakhstan, South Africa, Australia, Brazil, European Union member countries) (e.g., Box 39). The European Union Water Framework Directive is a stringent program for establishing sustainable water resources management, with a major impact in countries newly joining the EU, since it mobilizes funding for improved water resources management. The Government of Quebec has deposited a draft water law that identifies river basins as the fundamental water management unit. In fact, utilization of organisations and catchment bodies smaller than the river basin scale may be ineffective. Evidence from countries such as South Africa suggest that some may simply be too complex to implement, with it being difficult to clearly determine what benefits may be obtained. Several river basin organisations have concluded that implementation of river basin organisations is challenging, with considerably uncertainty about their roles and functions when it comes to implementing integrated approaches to water resources management. The quality of stakeholder participation also can vary considerably.

Box 39: Integrated Management of Land-Based Activities in São Francisco Basin, Brazil

The United Nations Environment Programme (UNEP), in cooperation with the National Water Agency (ANA) of Brazil and the Organization of American States (OAS), and with funding from the Global Environment Facility (GEF), undertook a river basin-scale project during 1999-2002 to develop a watershed management program for the Rio São Francisco Basin. The basin traverses 5 states in northeastern Brazil before discharging into the Atlantic Ocean. It is of strategic importance to the economic development of a vast region of Brazil, thereby subjecting its natural resources to increasing demands on the part of the local and regional society. Mining, agricultural, urban, and industrial activities contribute significant contaminant loads to the system, including organic chemicals, heavy metals and sediments. Environmentally-sensitive estuarine wetlands at the river mouth were threatened by unsustainable hydrological management and land use practices within the basin. The basin's economic development has also historically been haphazard with little planning and within a relatively weak institutional framework, resulting in less optimal use, and degradation, of its water resources. Large stretches of regulated flows also have altered natural flows, causing changes in the freshwater, estuarine, and marine flora and fauna.

The initial project objective was to conduct planning and feasibility studies necessary to formulate an integrated watershed management plan as the basis for environmentally-sustainable economic development of the basin. Major project components included: (1) river basin and coastal zone environmental analyses; (2) public and stakeholder participation; (3) organizational structure development; and (4) watershed management program formulation activities. Concluded in 2002, the environmental analysis provided a sound scientific/technical basis for strategic remedial actions to protect the coastal zone from land-based activities. Stakeholder participation efforts involved communities in identifying and field testing remedial measures, including establishing a dialogue process among stakeholders and agencies with economic interests in the basin. Basin institutions are being equipped and trained to implement new laws, regulations and procedures for addressing the basin's environmental problems. Finally, program formulation efforts, involving agencies and individuals both inside and outside the government structure, synthesized data and experiences, feasibility assessments, and cost analyses developed in the other three components, as the basis for development of a long-term basin management program. During the course of the project, 217 public events were held, including seminars, workshops, work meetings and plenary sessions. More than 12,000 stakeholders, including more than 400 organizations, including federal, state, and municipal governmental organizations, universities, NGOs, unions and associations, participated in the events. A subsequent comprehensive Diagnostic Analysis and Strategic Action Program for the Integrated Management of the San Francisco Basin was completed in 2003, and is currently ongoing (ANA, 2004).

1003. Coordination with related sectors (i.e., land, agriculture, energy, etc.) is a fundamental requirement for improved water resources use and allocation. Sectoral approaches to water resources management inevitably lead to fragmented, uncoordinated development and management. Fragmentation of the institutional framework and overly complex coordination mechanisms are common characteristics of the water sector in many countries (Rast 1996). In the absence of appropriate inter- and intra-linkages, different ministries and agencies deal with many water sub-sectors. Weak water governance systems exacerbate competition for this finite resource.

1004. Institutions, law and policy are inter-connected, with practical implementation of law often being a "trial and error" effort requiring constant feed-back, and establishment of practices and practical cases on how to interpret certain aspects of water law

Box 40: Legal Frameworks for Managing Water in Selected Countries

Although they can be difficult to establish, effectively managing competing water uses requires clear, widely-accepted rules to allocate water resources, especially under water scarcity conditions. Water allocation systems should work to balance equity and economic efficiency, with tradable water rights favouring the latter over the former, therefore being regulated to varying degrees, although there are tendencies to ignore environmental concerns from both perspectives. In Chile, for example, the environment is not granted any water licenses. In contrast, decisions-makers in South Africa are determining how to operationalize water law on environmental protection.

One means of avoiding conflicts of interests in water legislature is separation of policy, regulation and implementation functions, as illustrated with the Kenyan example. The Ministry of Water and Irrigation focuses on policy formulation and guidance, while the Water Services Regulatory Board and Water Resources Management Authority address both national and regional regulatory functions. Water service providers (community groups; NGOs; autonomous entities established by local authorities; private sector under contract with regional water services boards; etc.) implement water supply and sanitation services.

The Mexican Congress passed the Law on National Waters in November 1992, with the Executive adopting Implementation Regulations in January 1994. These laws were supplemented in 2004, inaugurating a package of regulatory, economic and participatory approaches to water resources allocation and pollution control, including (i) river basin planning; (ii) licensing of water abstractions and uses; (iii) permitting wastewater dischargers; (iv) charging for water abstractions and wastewater disposal; (v) recording relevant legal instrument in a Public Water Right Registry; (vi) providing opportunities for water user participation through formation of water users' organizations or membership in Basin Councils in numbers equal to the governmental members; and (vii) articulation of federal government administration at the river basin/aquifer level. Implementation and enforcement of this new regulatory structure began in 1993 under a programme of survey and registration of ongoing abstractions and disposals, requiring ten years, and a series of intermediate regulatory adjustments and massive information campaigns, to complete the process (Velasco, 2003).

1005. Climate change is highlighted in WWDR3 as an issue with many potential impacts locally and globally. It is clearly cross-cutting in that it can be related to virtually all other drivers, either as a causative factor or as an impact of human activities. Water resources are strongly affected by climate change and variability. The responses to challenges posed by climate change will likely be specific for each country, or even at the sub-national level.

1006. There are a growing number of countries and cities where water-related adaptations to climate change are being incorporated into planning and policy efforts, as are institutional and technological adaptation measures to mitigate such predicted impacts as sea-level rise, more frequent droughts and increased precipitation (Box 41).

Box 41: Water-related Responses to Climate Change

The examples discussed herein illustrate policy, institutional and technological/infrastructure development responses to climate change and variability.

London and Venice are redesigning their urban stormwater drainage system to accommodate predicted changes in precipitation frequency and intensity. Tokyo is designing urban holding ponds under roads and parks to temporarily store storm runoff water to avoid flash floods. Jakarta has recently initiated a program to construct a major stormwater drainage canal system ("East Canal") to provide adequate drainage to its eastern half. Viet Nam has developed an extensive system of dikes, including 5,000 km (3,107 mi) of river dikes and 3,000 km (1,864 mi) of sea dikes as physical protection from typhoons and rising sea water levels.

Floodplain restoration was used to restore thousands of hectares of aquatic habitat in the lower Danube River Basin in Eastern Europe. The restoration of tanks in Andhra Pradesh, India, by removal of silt allows the capture of more monsoon runoff, resulting in less groundwater pumping, restoration of some dry wells, allowing an extra 900 ha of land to be irrigated. Reconnecting lakes in the Hubei Province in China to the Yangtze River, by opening sluice gates and initiating sustainable management techniques, increased wetland areas, and wildlife diversity and population, while make them more resilient to flood flows. Government agencies in China subsequently adopted the new lake management regimes into their standard operating procedures, allocating funds for ongoing implementation efforts. There are potential scaling-up possibilities with this approach, as there are literally hundreds of sluice gates along the Yangtze River that disconnect it from nearby lakes.

1007. The participation requirements of Article 14 of the EU Water Framework Directive (WFD) are an example of launching a broader discussion about participatory approaches, as illustrated in Box 42.

Box 42: Public Participation in Water Resources Management

The RhineNet Project highlights the value of public participation, one of its conclusions being that, "when you seat everyone at one table from the start, you can save yourself a lot of trouble afterwards." Although the projects ranged from reactivating flood plains, constructing fish ladders, flood protection and recreational enhancement, and the state of knowledge of the public participants (ranging from farmers, fishermen and simply interested citizens) varied, public involvement in virtually all the projects enhanced their public acceptance, even those that might otherwise be considered 'losers' in the process. As a specific example, the project plans for reactivating the Saar River floodplains in Hostenback, Germany, were presented to the mayor of Wadgassen, the municipal facilities and the general public. The project received widespread support, with the citizens exhibiting considerable flexibility regarding details of the required construction, one important agreement being utilization of a much less used alternative path for the estimated 8,000 trucks to be involved in the project's earth removal activities. Meetings and discussions also were held regularly during the project, including opportunities for citizen complaints, and the media reported on the events in local bulletins, newspapers and electronic media. One other important conclusion was not to underestimate the amount of time needed for such efforts, noting that neither the media nor professionally-organized press conferences could replace the individual interviews and discussions with the interested and critical-minded people being affected by the project (Lange, 2008).

1008. Corruption can have enormous social, economic and environmental impacts, particularly for poor people. Water-related constructions (e.g., aqueducts; basic sanitation and wastewater treatment plants; sewer systems) have become a major source of corruption in developing countries, particularly in view of limited oversight capacity on efficient use of public resources. The Global Corruption Report (2008) estimates corruption in the water sector can increase the investment costs of achieving the water and sanitation MDGs by almost US $50 billion. Some progress has been made in recent years, with prevention of corruption gaining visibility in the development agenda of governments and their bureaucracies, private firms, civil society organisations and multi– and bilateral donors, with the SADC region providing some positive examples. As part of its water sector reform, Zambia established Water Watch Groups in some cities to monitor the relation between water regulators and service providers. South Africa established 'telephone hotlines' for consumer redress and complaints. Some districts in Malawi developed 'Water Board Anti-Corruption Policies,' aimed at improving water sector efficiency by preventing malpractice and/or addressing water consumer/user problems (WGF, WaterNet and Cap-Net, 2008; Mapping of integrity and accountability in water activities and relevant capacities in the SADC-region).

1009. Examples of selected Internet-accessible initiatives on community and civil society capacity development, focusing on sanitation, include: (1) an online comprehensive collection of capacity-building materials previously provided in the form of a CD-ROM at the 2006 World Water Forum in Mexico (http://www2.gtz.de/dokumente/bib/06-1322.pdf): (2) an online link to gender, water and capacity building (http://www.genderandwater.org/page/4208); (3) a thematic overview paper [Visscherand et al. (2006)] guidelines to improve knowledge management at the personal and organisational level (http://www.irc.nl/page/29472); and (4) a conceptual introduction [Smits et al. (2007)] to learning water sector alliances, case studies and lessons learned (http://www.irc.nl/page/35887).

1010. The water sector often requires sophisticated understanding of the hydrological cycle and its variability, the relationship between water uses and sustainable economic development, and decision-maker needs. Such knowledge can be generated or obtained through studies and research, and through the traditional knowledge of local communities. However, that knowledge often is available in a fragmented form from a growing number of water stakeholders, each holding part of "the solution." Thus, communication is a critical instrument in building the knowledge base and institutional and human capacities; in acquiring and disseminating knowledge from across the water sector; and in forging political consensus.

1011. Water management possibilities can be used in innovative ways to address other issues (Box 43 and Box 44).

Box 43: Using Water Management to Preserve Biodiversity and Economic Livelihoods

Although part of the infrastructure for collecting, storing and distributing water, large dams can disrupt the natural water cycles and the ecosystems relying on them. Kafue Flats (Zambia) illustrates how technological innovation and cooperation can be used to alleviate such disruptions. Kafue Flats is a rich wildlife habitat occupying a 6,500 km2 (2,510 mi2) area along the Kafue River, a major tributary of the Zambezi River. It sustains the livelihoods of local peoples through hunting, fishing, and cropping as floods receded on the Flats at the end of the wet season. The Itezhi-tezhi Dam was built in 1978 upstream of the Kafue Gorge hydro-electric dam, the latter being downstream of the Flats, in order to store wet season peak flows to maximize hydropower production at the downstream hydro-electric dam. Although it is Zambia's primary power supply, operation of the Itezhi-tezhi Dam interrupted the beneficial wet season flooding of Kafue Flats, impacting the 300,000 people relying directly on it for their livelihoods. In 1999, in cooperation with the World Wildlife Fund, and local peoples and commercial farmers, the Zambian Government, and Zambia Electric Supply Corporation (ZESCO) initiated a project to restore a more natural flow pattern to water releases from the Itezhi-tezhi Dam. An integrated water resources management study was undertaken in 2002, under the supervision of ZESCO and the Zambian Ministry of Energy and Water Development, including development of the KAFRIBA (Kafue River Basin) hydrology model. The model was linked with real time data from rainfall and river gauging stations in the catchment to predict water flows and reservoir levels. Based on this modeling exercise, agreement was reached among all partners in 2004 to implement new dam operating rules associated with the KAFRIBA model. A major water flow mimicking the natural wet season flooding pattern was released for the first time in early-2007, and concurrent modules have been launched for wetlands rehabilitation, focusing on infrastructure development, tourism enhancement and community-based natural resource management. The long-term results are expected to include an improved environmental health for the Kafue Falls and improved livehoods for the local peoples (particularly increased fish and pasture productivity), development of a wildlife-based tourism industry, and sustained irrigation capacity. The hydro-electricity production potential also is expected to be maintained or increased. Based on this experience, there are ongoing discussions on up-scaling the environmental flows model to other dams in the watershed (Kafue Gorge; Cahorra Bassa; Kariba) to extend benefits to the entire course of the rivers in Zambia and Mozambique. Preparations also are underway to develop a conjoint operation and management strategy for the three dams, involving the Zambezi River Authority, the Joint Operational Technical Committee for Cahorra Bassa and Kariba Dams, and the SADC agreement for an IWRM strategy for the Zambezi under the auspices of its shared water protocol (World Wildlife Fund, 2008).

Box 44: Agricultural Irrigation Technology to Increase Water Use Efficiency

In a California study water use efficiency ranged from 60-85 per cent for flood irrigation, 70-90 per cent for sprinkler irrigation, and 88-90 per cent for drip irrigation. Shifting a fraction of the crops grown from flood irrigation to sprinkler and drip irrigation systems resulted in an average annual water savings of approximately 740 million m3 (0.6 million acre-ft), with potential water savings even higher if combined with more precise irrigation scheduling and shifting a portion of lower-value, water-intensive crops to higher-value, more water-efficient crops (Cooley, 2008).

Chinese agriculture also has utilized water conservation and increased its agricultural water use efficiency since undertaking water-saving measures and irrigation system modernization since the 1990s. China has approximately 402 large irrigation systems (i.e., irrigation district with an irrigated area of more than 20,000 ha [77 mi2]), comprising about 25 per cent of the total irrigated area of 56 million ha (216,200 mi2). The modernization activities included application of new materials and technologies to upgrade irrigation system structures, as well as application of modern irrigation concepts and institutions to improve irrigation management. Because of these activities, the duration of water conveyance and irrigation intervals was decreased, and irrigation water losses reduced. Total agricultural output in the program area also increased by 46 per cent, even though irrigation water withdrawals as a proportion of China's total water use decreased from about 80 per cent in 1980 to 60 per cent today, representing a dramatic reduction in irrigation water needs (ICID, 2008).

1012. Increasing a demand-driven research capacity in developing countries is essential because a critical mass of individuals in research and development is needed to facilitate economic development (Human Development Report, 2006; Van der Zaag 2007). The Paris Declaration also stressed that developing countries must become more capable of solving their own problems, therefore requiring research capacities which also will facilitate their ability to absorb and utilize existing knowledge from other sources and countries (Box 45).

Box 45: Examples of Research Linkages in Developing Countries

The Water Law and Indigenous Rights (WALIR) program (2001-2007) began as an international action-research alliance to critically inform the debates on peasant, indigenous and customary rights in the Andean Region (Peru; Bolivia; Ecuador), and to facilitate action on local, national and international platforms. A major program objective was to better understand local water rights and water management forms. The strategy was to focus on research and action, together with local, regional and international networks (both indigenous and non-indigenous) hand-in-hand with training of policymakers, water professionals and grassroots leaders. The program has subsequently deepened water policy debates on the politics of water rights recognition, thereby providing concrete entrances for better legislation and more democratic water governance and management policies. Network participants also have extended their activities into new policy research and action networks, further embellishing the focus on water rights plurality, multi-scale water user organization, and ways to strengthen and recognize such processes through training, policies and user-oriented intervention strategies.

Concertación (2006-2011) is an interdisciplinary research and capacity building network, concentrating on empowerment of peasant and indigenous water management, with a focus on the Andean Region. The

Water Research Fund for Southern Africa (WARFSA), established in 1999, is available to any researcher or institution resident in any SADC-member country. A thorough peer review system ensures high quality research proposals are selected for funding, with a board consisting of researchers of differing professional backgrounds and countries formulating the Fund's research policy and defining priority areas. Although the Fund is mainly contributed by donors, rather than the end users of the research results, the WARFSA is currently exploring ways to better link societal demands to the research community, as well as reviewing its own role in promoting this connection, primarily to ensure that the Fund-enabled research is responsive to the regions' needs.

1013. Reliable and accurate water resources information and data provides a means by which decision-makers can attempt to convert uncertainty regarding water resources into more reliable assessments of water risks (the latter being more manageable from a political perspective). Proper information facilitates better choices of needed infrastructure and makes public institutions more accountable for the impacts of their actions. The Ugandan government, for example, used local knowledge to identify and protect important fish breeding areas on the eastern shore of Lake Albert on the Uganda-Democratic Republic of Congo border (ILEC, 2003). Further examples are given in Box 46.

Box 46: Using Monitoring Information in Water Resources Management

Monitoring information can be used to: (i) show the limits of water resources; (ii) enlighten hard-to-see connections; and/or (iii) help develop innovative solutions to water resources problems. An example of monitoring information used to illustrate water resources limits involved collection of data on fishing intensity and gears. These data ultimately led to temporary fishing moratoriums for Lakes Baringo and Naivasha in Africa, and restrictions on the allowable fishing technologies for Lake Victoria (ILEC, 2005), subsequently resulting in either recovery or significant improvements in these fisheries.

Biophysical processes in water systems are complex, often being expressed in small incremental changes not readily observable. Detailed measures and investigations at Lake Biwa (Japan), for example, showed that decreasing snowfall over several decades, along with a weakening water profile in the lake, combined to decrease the dissolved oxygen levels in its bottom waters, increasing lake eutrophication.

Field monitoring in the Lake Chad Basin (Africa) illustrated that wet-season conditions could be simulated by water releases from the Tiga and Challawa Dams, and demonstrated that artificial flooding of wetlands could be undertaken with the existing infrastructure (ILEC, 2005).

Monitoring data from Lake Ohrid (Macedonia) collected over several years suggested both the phytoplankton and zooplankton communities in the lake were changing, consistent with its increasing eutrophication, and making the need for nutrient control unequivocally clear (ILEC, 2005).

Such long-term monitoring also can have serendipitous effects. Long-term snow records from the above-noted Lake Biwa (Japan) monitoring programme, combined with lake water temperature and dissolved oxygen concentrations, provided indications of the potential effects of global warming on the lake.
Monitoring data collected from Lake Dianchi (China) provided information indicating that policies implemented to reduce the external nutrient load from individual enterprises was successful. Such post-project monitoring can be extremely useful to justify the often-considerable expenditures required for water resources management programmes and activities.

2. Financing

1014. One of the most persistent problem in the water resources decision-making arena (as with other sectors) is the availability (or lack) of sustainable financing. Ultimately, the main sources of financing are tariffs, support from the national budget and external aid. Decision-makers within the water sector may not control all of the factors influencing these financing sources, but can contribute to creating the right investment climate, and ensure good management of the financial resources at their disposal. Several key initiatives have arisen over the past five years to help shape the agenda of water financing. These initiatives include the Camdessus Panel, Gurria Task Force, and UN Secretary General's Advisory Board on Water and Sanitation (UNSGAB). But there are examples of how some countries are tackling the identified problems and implementing the recommendations in these reports.

1015. An increasingly recognized approach for financing environmental protection and conservation is "payment for environmental services" (PES), being based on the concept that natural environments, such as wetlands and watersheds, provide a range of life-supporting goods and services, including potable water supply, irrigation water, flood control benefits, aesthetic benefits, etc. Under normal conditions, there is a direct link between the service provider and service beneficiary, the basis of any market economy, meaning increasing scarcity for a commodity is usually reflected in an increased price for it. This is more difficult in regard to environmental goods and services, however, because they are traditionally thought of as being provided "free" by nature. Environmental goods and services also can take many forms. Further, there often is no direct link between the service provider and the consumer because of the spatial separation between the upstream provider (e.g., land owner; resource manager) and the downstream user (e.g., public water supply; agriculture; industry). With the market for these services often poorly developed or nonexistent, ecosystem managers with little economic incentive to improve their management efforts. The PES concept attempts to address this problem by creating markets for environmental services, in the same manner as for other commodities. Money is collected from water users, and payments directly made to those providing the resource, encouraging efficient and sustainable delivery of watershed services.

1016. There is a growing experience with PES systems in several countries. New York City (USA), for example obtains it drinking water supply from watersheds in the Catskill Mountains north of the city. Water quality was traditionally very good, with little or no treatment required for its use. By the end of the 1980s, however, agricultural and other developments in the Catskills threatened the water quality. In response, New York City planners chose to work with upstream land owners in the Catskill watersheds to eliminate potential water quality problems, in contrast to constructing a water treatment system costing US $4-6 billion to build and US $250 million per year to operate. The resultant plan included payments for both on-farm capital costs and pollution reducing agricultural measures, being implemented at a cost estimated to be only 20 per cent of the water treatment system approach. This PES approach also protected the watersheds and the other environmental goods and services they provided (e.g., recreation; biodiversity conservation), with the payments to water providers coming directly from the revenues collected from water users in New York City (Pagiola and Platais, 2002; 2007). Because better quality raw water is thus ensured, the cost of water treatment to the city is lower. A similar approach was utilized in Heredia, Costa Rica, which established a PES system that taxed its approximately 50,000 connected water users to pay farmers in the watershed to undertake improved conservation measures.

1017. Examples from China and Madagascar (Muñoz Piña et al. 2007) suggest that the development of infrastructure for PES systems may be necessary, as a means of creating the enabling environment for their successful implementation, although this also may increase the costs of implementing such systems (Pagiola and Platais 2007; World Bank 2007).

O. Solutions from beyond the water arena

1018. External drivers and policies have more impact on water management than many policies championed and implemented by water-related ministries. Trade-offs between water and other policy sectors should be identified at an early stage to enhance policy impact in all sectors, as well as to reduce potential adverse effects on water.

1019. Governments, civil society, and individual business leaders make decisions every day that have a potential consequence for water; hence it is important to identify what can create win-win conditions, where such decisions can also lead to improvements in services of the water sector.

1020. Examples of win-win situations abound - whether created by governments, communities, or businesses - that further point to the need to promote deliberate cooperation between water and non-water actors, and for the integration of water issues into external decisions.

1021. Water governance - the institutions and frameworks that govern the use of water - is ultimately determined by the broader patterns of policy and decision-making that prevail in a country or organization. The rule of law, a culture of public accountability, as well as to a certain extent a set of stable economic policies all form part of this underlying context.

1022. Transparency in the operations of public utilities is paramount and where, according to some data, 20% to 70% of resources invested could be saved from curbing corruption[52] (Box 47).

Box 47: Combating corruption

Efforts to curb corruption in the public or private sector are now part and parcel of development efforts. Transparency and accountability in government, along with clear rules and procedures will go a long way to ensuring stability that is much needed in order to promote social and economic development. Donors are also increasingly implementing anti-corruption measures in their development assistance programming, in order to promote an aid effectiveness agenda. Efforts to promote integrity, transparency and accountability in any and all sectors can also pave the way for similar reforms in the water and sanitation domains. Similarly, efforts to combat corruption in the water sector can also benefit from successes and lessons learned in other sectors.

Key elements of a successful anti-corruption strategy include: citizen participation and access to information, the creation of independent checks and balances and oversight mechanisms, public sector codes of conduct as well as addressing incentives to corruption in public administration, to name but a few.

Anti-corruption strategies can be incorporated at all levels of project development and implementation (from procurement to monitoring and evaluation). For example, The Kecamatan Development Program (KDP) in Indonesia, a project implemented by the Indonesian Ministry of Home Affairs (Community Development Office) and supported in part by the World Bank, promoted the participation of village communities in a water infrastructure project, using inter-village competition to single out bad construction proposals and to strengthen social control in measuring quality throughout the project cycle.[53]

As seen in
Box 48, the potential benefits of decentralization to water management depend on the extent to which the overall process provides adequate authority and resources to local governments.

Box 48: Decentralization – making room for better environmental governance at the local level[54]

The devolution of decision-making powers over natural resources to publicly accountable local authorities is frequently advocated as a means of achieving social development and enhancing environmental

[52] From http://www.adb.org/Documents/Conference/Fight_Corruption/part3.pdf

[53] From: http://www.waterintegritynetwork.net/content/download/2038/34265/file/3_The%20Role%20of%20donors.pdf also see http://siteresources.worldbank.org/INTEAPREGTOPSOCDEV/Resources/Monitoring-Corruption.pdf

[54] Excerpted from “Decentralization, politics and environment in Uganda”, by Nyangabyaki Bazaara, World Resources Institute, January 2003.

management. The experience of Uganda's current decentralization reforms, however, suggests that the extent to which such benefits occur depends on the character of the decentralization. In order to pave the way for better water governance and services, the decentralization process has to offer the following elements: The first is that decentralization has to provide adequate legislative and regulatory powers to local authorities; the second condition is the devolution of executive and enforcement authority and finally, the provision of adequate resources.

Under the Uganda Local Government Act of 1997, district councils (DCs) and city councils are empowered to make bylaws without reference to, or seeking permission from, the center, provided those bylaws do not conflict with the national constitution or other laws. They should, therefore, be able to make bylaws on environmental matters. District councils are responsible for vector control, environmental sanitation, entomological services and vermin control, and forests and wetlands. However, according to the same schedule, forests and game policy remain the preserve of the central government. Despite this transfer of authority, evidence shows that with regard to environmental matters, there has been no effective devolution of executive powers. Instead, another kind of administrative decentralization, a kind of de-concentration within line ministries in charge of particular resources, has been attempted. With regards to enforcement authority, local governments are, as already indicated, required to assist in the enforcement of various environment-related rules and laws. Local councils below the sub-county have powers to deal with those who break rules decide on the penalty. However, the lack of clarity regarding the powers of sanction or arbitration has undermined good environmental practices. In many cases, the transfer of responsibility has not been accompanied by a transfer of resources, which has effectively hindered their effectiveness in promoting better environmental management. Despite these constraints, some positive achievements have been noted. In many areas, resources have been mobilized from external aid sources that – at least temporarily – can supplement local resources; in another area, the local government made significant progress in fulfilling its legal responsibility of protecting wetlands and river banks by negotiating land and water use with the local community.

1023. Examples of application of the ecosystem approach abound – including many reflecting innovative approaches (Box 49).

Box 49: The ecohealth approach: combating malaria through agricultural practices in Kenya

In Kenya, a project supported by the International Development Research Centre and bringing together experts from the International Centre for Insect Physiology and Ecology (ICIPE) and the International Water Management Institute (IWMI) as well as the local community, is examining the linkages between agriculture and malaria through the ecosystem approach. The goal is to reduce the incidence of malaria. Through research and capacity-building, communities can adopt numerous agricultural practices to reduce and prevent malaria, improve nutrition, and benefit their economic outlook. These practices include the following:

Using cattle as "bait" to divert mosquitoes away from humans. Research has shown that certain species of malaria-bearing mosquitoes prefer the blood of cattle to that of humans.

Reduce mosquito-breeding habitats by limiting the amount of water used for rice cultivation. Reduce the amount of time that paddies are wet, either by changing flooding schedules or alternating rice cultivation with dryland crops such as soya.

In addition to limiting the mosquitoes' habitat, planting soya could boost income and improve nutrition.

Introduce naturally occurring bacteria into stagnant water to kill mosquito larvae during the peak breeding season.

1024. The heart of the ecosystem approach is to include active participation of community members in the research process, and therefore help researchers understand people's perceptions of the health and development problems in the area. The ecosystem approach also seeks interventions and solutions that are transdisciplinary[55].

1025. In Djibouti, where water scarcity is severe, the 2004 Poverty Reduction Strategy Paper recognizes that "the absence of a natural resources base, weak human capital, high costs of labour and production factors (energy, telecommunications and water), inadequate financial intermediation, and administrative constraints of all kinds are the key obstacles to economic growth and to the development of private initiative." (Box 50).

Box 50: Measuring the water limits to growth in Ethiopia

Up until now, most policy and macro-economic decisions have been based on growth models that assume rainfall is consistently at historical average levels. These models do not take into account shocks to the economy caused by extreme water events, such as floods and droughts. A World Bank study on Ethiopia (World Bank 2006) estimated the magnitude of the impacts of high water variability on growth and poverty so that the government can better manage water and manage other parts of the economy (trade, transport) to reduce the impacts of water shocks. The study found that considering the effects of water variability reduced projected rates of economic growth by 38% per year and increased projected poverty rates by 25% over a twelve year period. Furthermore, the variability of rainfall increased value added water investments, such as irrigation, that reduce vulnerability to rainfall. The study also found that transport infrastructure played a major role in the inability of local economies to adjust to localized crop failures, as it allows areas with food surpluses to sell to areas in food deficit. This analysis, undertaken in cooperation with the Ethiopian government, helped to make the issue of water resource management a central focus of the government's national poverty reduction strategy.[56]

1026. There are many examples from the private sector illustrating how production can be increased whilst reducing environmental footprints. (Box 51)

Box 51: Sustainable expansion

Mondi South Africa is a wholly owned subsidiary of Anglo American plc. Its operations are focused on the production of pulp, paper, board, mining support systems and corrugated containers. Activities range from forestry operations to highly technical manufacturing and converting processes. The increasingly competitive and demanding international pulp market has given rise to Mondi's R2.3 billion Rand (approximately US$ 24 million) expansion project, which raises the mill's production capacity by 25% to 720,000 tonnes per annum, and accommodates a 40% increase in timber supply from over 2,800 small growers who form part of Mondi's Khulanathi timber growers scheme.

The project began in 2001 with an engineering study followed by a detailed Environmental Impact Assessment in 2002. Through a series of improvements in energy supply infrastructure, as well as targeted equipment and technology upgrades, the company achieved its expansion objectives, while realising the following benefits:

SO2 – 2,177 tons representing a 50% reduction;
NOx – 509 tons representing a 35% reduction;
CO2 – 297,121 tons representing a 50% reduction;
Total sulfur (TRS) emissions were reduced by approximately 60%.
Total energy and water cost-savings of R 38,678,843 (approximately 4.9 million US$)
A reduction of water use by some 13,000 cubic meters per day
Wastewater volumes were reduced by more than 25%.

[55] As quoted in Population, Health and Environment, PEP, 2008 – more at http://www.idrc.ca/en/ev-29117-201-1-DO_TOPIC.html
[56] From Claudia Sadoff, Can Water Undermine Growth : Evidence from Ethiopia, ARD Notes,World Bank, 2006

1027. Private-sector awareness of the centrality of sustainable water management is clearly increasing, as demonstrated by the adoption of the CEO Water Mandate by the members of the UN Global Compact, as a strategic voluntary platform for addressing sustainability in business operations and supply chains[57].

1028. There is also evidence of national policies moving away from being over-focused on food independence (Box 52).

Box 52: Water-sensitive agricultural policy

Beginning in the early 1980s, Saudi Arabia invested heavily to mobilize significant volumes of water from mainly non-renewable aquifers in an effort to achieve food self-sufficiency. Having almost no expertise in settled farming, Saudi investors were induced by the government subsidies to import the technology, equipment, seeds, fertilizers, engineers and the farm workers required by these projects.

Within 12 years, between 1980 and 1992, wheat production grew 29-fold. The overall irrigated surface increased during the same period by almost a million hectare. Between 1980 and 1999, 300 million cubic meters of water were used.

For the 5 years between 1997 and 2001, the volume of Saudi water used to produce exported foodstuffs averaged 2.5 billion cubic meters annually. For the 5 years between 2002 and 2006, the value of Saudi foodstuff exports doubled in comparison to the previous 5 years. If the composition of the exported produce did not change, it would be safe to estimate that Saudi virtual water exports between 2002 and 2006 averaged 5 million cubic meters per annum.

However, this policy proved both environmentally and economically unsustainable, since production continued to rely heavily on government subsidies, and water quality and quantity was seen to decline rapidly.

On January 8, 2008, realizing that this strategy was unsustainable from an economic standpoint as well as from a water perspective, the Saudi Government abandoned its food independence strategy and decided instead to import the country's entire wheat needs by 2016.[58]

1029. While a first step in moving towards water benefits should be the avoidance of negative impacts, the urgency of the situation with regards to water around the world also points to the need to cultivate conscious win-win choices in all aspects of social life. A growing number of examples of such win-win scenarios can now be found in all policy areas: from traditional water-using sectors to security policies, and implemented at various scales and levels.

1030. Consultation and cooperative management is also increasing (e.g. Box 53).

Box 53: The BAPE consultation on water resources management

In 1998, the Minister of the Environment entrusted the BAPE with a mandate of holding a public consultation on water management in Québec. The consultations, to be conducted through written comments, public hearings and discussions, were designed to help develop recommendations towards better water management.

From March 15, 1999 to May 1, 2000 the commission held 142 public meetings in the 17 administrative regions of Québec, and heard 379 briefs. The BAPE report entitled Water: a resource to be protected, shared and enhanced was submitted to the Minister of the Environment on May 1, 2000. The report placed special emphasis on three main aspects:

- Improved governance through water management at the river basin level;
- The preparation of the portrait of each region with the public's expectations concerning the management of water and aquatic ecosystems; and

57 http://www.unglobalcompact.org/Issues/Environment/Water_sustainability/index.html

58 Saudi Arabia's Agricultural Project: From Dust to Dust, by Eli El Hadj, in the Middle East Review of International Affairs; June 2008

-A reform of the legislation and institutions is necessary to implement an integrated water and aquatic ecosystem policy;

Specifically, the report addresses 16 themes, among them agricultural pollution abatement, hydroelectricity, the integrated management of water and aquatic ecosystems at the watershed level, exporting water and the special case of the St. Lawrence River.

The commission made 13 main recommendations broken down over the short, medium and long terms. In addition, the commission identified numerous findings and observations that guided the government's reflection. The process and report of the BAPE respected all of the principles proposed by the COMEST Sub-Commission on the Ethics of Freshwater Use to which earlier reference was made (UNESCO, 2004).

In 2002, the Government of Québec released the Québec Water Policy entitled Water: Our Life, Our Future. This policy seeks to:

- Ensure the protection of water resources as a unique heritage;
- Manage water in an integrated manner, in a sustainable development perspective;
- Better protect public health and the health of ecosystems.

Most of the recommendations of the BAPE commission are adopted in the Policy. It reaffirms that water is an essential element of the collective heritage of Quebecers and presents the measures intended to:

- Implement integrated river basin management;
- Implement this form of management in the St. Lawrence River, by granting it a special status;
- Protect water quality and aquatic ecosystems;
- Continue water clean-up efforts and improve the management of water services; and
- Promote water-related recreation and ecotourism activities.

1031. Technical investigations can also pave the way to collaborative learning processes among and between scientists and decision makers, as seen in the example from Arizona in Box 54.

Box 54: Collaborative learning processes through adoption of an adaptive management framework

The Upper San Pedro Partnership (Arizona, USA) represents a diverse consortium of interests – including municipal, state and federal government institutions – who, from an initial goal of developing one definitive regional groundwater management plan in 1998, later evolved into a more complex, yet flexible, ongoing adaptive management planning process that still continues ten years later.

A primary strength of an adaptive management approach is that it allows actions that have low risk or uncertainty to be taken early on. Partnership member agencies realized that the implementation of certain water management strategies required substantial information through monitoring, research and modelling efforts as well as political assessments, while other projects represented relatively low risk strategies whose implementation could be more immediate. By 2003, the Partnership had identified more than 100 projects for implementation, ranging from the repair of leaky infrastructure, car-wash water recycling, voluntary retirement of agricultural pumping through conservation easements, recharge of treated effluent, and reintroduction of beavers. In their 2004 Water Management and Conservation Plan the Partnership prioritized additional projects for implementation, including the development of model codes and ordinances, the establishment of water-conservation surcharges for excessive use, exploration of a transfer-of- development-rights (TDR) program, and other measures. Other projects with greater uncertainty, higher political risks and/or significant costs were targeted for additional feasibility studies and/or evaluation through use of a decision-support system (DSS) model. With the DSS the Partnership evaluates different combinations of management options (scenarios) such as the possible relocation of municipal wells, construction of additional recharge facilities, and various water-augmentation strategies. Such a tool allows for the consideration of spatial and temporal groundwater-management concerns, as opposed to a simple annual "bottom line" water-budget approach. The former approach is essential for maintenance of the hydrologic context needed to sustain the ecological values of the San Pedro Riparian National Conservation Area.

In the case of the San Pedro, complex and controversial strategies such as water importation, the transfer of development rights, and surcharges for excessive water use all have the capacity to divide the

community, as did “toilet to tap.” These particular issues must be carefully managed by direct engagement of the community early on in planning processes. Toward that end, the Partnership conducted a series of community meetings to provide citizens with an opportunity to thoughtfully consider issues, help shape their own destiny, and provide meaningful input.
The combination of a complex regulatory framework, coupled with a myriad of interacting environmental, social, and economic factors present tremendous challenges related to groundwater management within the Sierra Vista Sub watershed for local decision-makers, elected officials, and the general public. The need to apply strong science and the best analytical tools is apparent. But in addition, the role that collaborative learning processes play in effectively transforming this science into informed decisions will continue to be one of the most essential factors that determine the future of this river, and the fate of the waters that sustain it.[59]

1032. Experience shows that lasting win-win benefits for water and agriculture are often the result of trade-offs being explicitly recognized, analysed and factored into decision-making. (E.g.

Box 55: The Integrated Watershed Development Programme, Jhabua District, Madhya Pradesh, India

By the 1960s, severe deforestation had created serious effects on the ecosystem, climate and populations of Madhya Pradesh in India: widespread soil erosion, overgrazing and inappropriate land use resulting in barren landscapes and also seasonal migration of men in search of employment. Multiple interventions were attempted which aimed at the natural resources rejuvenation and socio-economic improvement of people. The project promoted an integrated approach, based on community needs. Activities included:

- Protected afforestation on community land;
- Distribution of seedlings to encourage planting on private land;
- Soil and water conservation;
- Pasture improvement through planting pasture grasses;
- Water harvesting;
- Distribution of subsidised fuel and energy saving devices;
- Integration of land-use innovations with measures to improve community livelihoods;
- Promotion of alternative income generating activities to reduce poverty and discourage seasonal migration;

In addition to immediate land productivity benefits, ecosystem-wide benefits were very positive. A marked increase in groundwater recharge was noted, as well as increased water supply from harvesting, and better livelihoods. The model was subsequently adapted to neighbouring states. This project was implemented by the National Centre for Human Settlements and Environment (NCHSE) and the local communities with funds from the Government of India[60].

1033. Eco-efficiency, a microeconomic objective, is about reducing the amount of water, energy, chemicals, and raw materials used per unit output. Eco-efficiency is motivated not only by environmental concerns but by the prospects of significant financial savings in the form of reduced energy and water bills, less money spent on raw materials, and fewer regulatory hurdles. For example, Swiss-based ST Microelectronics cut electricity use by 28 percent and water use by 45 percent in 2003 and reported saving $133 million. DuPont committed to a policy of keeping energy use flat no matter how much production increased, which reportedly saved over $2 billion in the past decade. The company Advanced

[59] From Holly Richter, Udall Center for Studies in Public Policy, 2008.

[60] . http://nird.ap.nic.in/clic/water_madhya.html Integrated watershed development Madhya Pradesh; http://www.mprlp.in/projectdoc.htm or http://www.nchse.org/projects.htm

Micro Devices tracks "kilowatt hours per manufacturing index" and reports a 60-percent reduction from 2.17 in 1999 to 0.86 in 2005.[61]

1034. With 898 million of travellers in 2007 and 1.6 billion forecast in 2020, tourism is a growing sector of the economy, and one to which many developing countries are turning for diversification.62 In addition to direct employment and investment, tourism generates jobs and revenues in surrounding communities, stimulates infrastructure investment. In the case of sustainable tourism, or eco-tourism, it can also provide impetus to conservation efforts. Tourism depends on the availability of natural resources, landscapes, and ecosystem services, chief among them water and biological diversity. In reverse, tourism installations and infrastructures can also generate significant adverse impact on ecosystems through pollution, deforestation or over-exploitation. Tourism also requires increased water supply and sanitation, which may in some cases create diversions from other uses of water. Antigua and Barbuda, whose economy is dependent on tourism, has to purchase freshwater from neighbouring island Dominica in order to satisfy demand.

1035. There is increasing evidence that win-win scenarios between tourism and water are possible, as well as between tourism and community development. With the recent rise in consumer awareness, tourism enterprises everywhere are increasingly making efforts to demonstrate corporate social and environmental responsibility. From a government perspective, much is being done to promote more integrated tourism investment planning, sustainable use of protected areas, impact assessment and certification programs. Ecotourism, provided it is more than a simple marketing strategy, can help promote conservation, poverty reduction and sustainable water management, when adequate enforcement and benefit sharing mechanisms are in place.

1036. In many cases, multiple objectives can be achieved through regional economic development facilitated by regional institutions (e.g. Box 56).

Box 56: The Tennessee Valley Authority – Economic and social transformation in a river basin and beyond

At the time of the Great Depression of the 1930s, the United States Tennessee River Valley, which stretches through parts of seven Southern states and drains a basin of 105,930 km2, was a land of despair. More than 90% of the Valley residents had no electricity and nearly 40% had no toilets or outhouses. Only a few had home radios and less than half read newspapers. The majority of the horsepower required for agriculture was from horses, and most of the residents of the valley were subsistence farmers working on either ruined soil or in Valley areas subject to serious and repetitive flooding.

President Franklin Roosevelt, as part of his efforts to bring the nation out of depression, launched many programs designed to bring the country back to its feet, and to improve the lot of those portions of the nation that were mired in poverty. Coming into office with a strong interest in basin planning and in developing system-level solutions, he asked the Congress to create "a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise." In 1933, the Congress authorized the Tennessee Valley Authority (TVA) to serve as this corporation.
Given a broad charter, the TVA focused on carrying out its mission on integrated, watershed basis, dealing concurrently with development of hydropower production, navigation on the Tennessee River, and elimination of flooding, while at the same time addressing health problems such as malaria prevention and dealing with resource challenges that included reforestation, erosion control and restoration of fisheries. If the concept had existed in 1933, it would have been labelled as integrated water resource management.

[61] From State of the World Report, 2008
[62] World Tourism Organization www.unwto.org

By 1945, TVA had completed more than a dozen large dams and built a 1050 km navigation channel. It also had become the largest supplier of electricity in the United States. Reviewers of its program noted that, "in its program for flood and navigation control, for land reclamation, and for cheap electric light and power the TVA is substituting order and design for haphazard, unplanned, and unintegrated development. Through its social and educational activities it is bringing to this region a consciousness of its own rich natural and human resources." The electricity generated was a major driver for rural electrification in the USA.

By the 1960s, the residents the TVA Valley were sharing in unprecedented economic growth and attainment of a quality-of-life that brought electricity, clean water and sanitation to most all homes in the Valley.

Today, TVA provides economical electrical power, recreation, improved water quality, and a reliable supply of water to cool power plants and meet municipal and industrial needs. It generates more electricity than any other public utility, operates a system of 49 dams and reservoirs on Tennessee River and its tributaries and manages 118,572 hectares of public land. It operates the river system as an integrated whole to provide year-round navigation. Barges on the Tennessee River carry some 50 million tons of goods annually. Reduced flooding through both structural and non-structural approaches annually prevents an estimated $230 million in flood damages. In one decade, through the development of its water resources, the Tennessee Valley lifted itself out of poverty; in seven decades it has become a powerful economic and social force in the United States.

1037. Win-win scenarios are also being promoted through Security and Crisis Prevention. Regardless of the lens through which security is considered, water is emerging as a strategic resource in that it underpins many of the other dimensions of security. Therefore, many interventions at local, regional or global level that are designed as direct responses to insecurity can have benefits for water – and potentially generate multiplied human security benefits in the long term (Box 57).

Box 57: Nepal: a community-led initiative to mitigating water-induced disasters[63]

The Himalaya range is among the rich fresh water bodies on the Earth and home to some 1.3 billion people. This however is also among the most fragile eco-systems on the planet, which is attributed primarily to the existence of rugged mountain systems of youngest geological formation prone to mass-wasting, seasonal monsoon precipitation fraught with extreme events, and ever increasing population pressure in a region otherwise already densely populated. Being located in the mid of the Himalaya range, Nepal has been subject to the risks associated with mass-wasting and flooding each year, affecting lives and livelihood of its population, which account for more than half of the deaths due to different types of disasters in the country. The situation has further aggravated with the observed intensification and frequent occurrence of extreme climatic events in recent decades such as torrential rains resulting from global climate change.

The community of Madhumalla in Morang district, south-eastern part of Nepal, is located on the right bank of Mawa river, a small rain-fed river with a upper watershed of just about 20 sq. km. This 25 km long river has an average gradient of 4% in the upper reaches and 2% in the lower reaches, and width varying between 200 to 700m. As with majority of the rivers originating in the southern belt of Nepal, Mawa river is facing unpredictable flooding mainly caused by monsoon rain with sudden cloud-burst in the upper watershed generating torrent laden with debris, boulders and sediments. This results in rapid changes in river morphology with a cycle of aggradation and degradation of river bed, under-cutting,

63 Dinesh L. Shrestha, Snr. Water and Sanitation Officer, UNHCR Geneva, Switzerland and Tako Ganai, Consultant Engineer, UNHCR Jhapa, Nepal

erosion and overflowing of river banks, and shifting of entire river course. Consequently, the population living in the vicinity is under a constant threat of being washed away, and their habitats and the crops being damaged.

The Madhumalla community, led by its then Chairman, Mr. Kashi Nath Paudyal, embarked on a remarkable mission some 14 years ago to address the threats posed by unpredictable and devastating floods they had witnessed in the area. The community employed bioengineering technique, which relies on planting series of stratified green belt along the river bank using native trees, shrubs and grasses in that order towards the river in conjunction with reinforcing materials, to defend undercutting and erosion of the banks and degradation of floodplains. Structural measures such as embankments and spurs made of gabion boxes were placed intermittently at selected locations to protect green belt from being damaged during the initial years. This approach turned out to be a huge success, has become a role model and replicated in several other communities in the region, including in the refugee camps nearby. The project area is currently serving as a training center in-situ on bioengineering technology.

Under this project, the community planted some 5.5 km stretch of 30 to 80 m wide greenbelt along the river bank with different plants most suited for this particular situation and having root depths ranging from 2 to 7 m and strategically placed short gabion spurs of 5 to 30 m long. Altogether some 65,000 tree and shrub varieties (locally known as Khair, Kadam, Sisir, Sisso etc. and having a good commercial value) and 5000 bamboos along with large amount of grass varieties including Vetiver were planted. The project was designed and implemented on the basis of the community's indigenous knowledge and experiences on the characteristics of locally available plant varieties vis-à-vis their relative strengths to withstand against forces of river water as well as understanding of the local physical environment and the river morphology. The project mobilized a substantial amount of resources internally in the form of cash, labor and material assistance, besides receiving grants from several national and international donors totaling about US$ 40,000. The project is currently in the threshold of reaping benefit from sale of forestry products from the plantation area and expected to generate annually over hundreds of thousand of US dollars in a couple of years.

This project is a perfect example of a success story at grass-root level towards managing and adapting to flood disasters. A community-led initiative employing bioengineering technique has been found to be most appropriate and effective in mitigating not only the annually recurring flood havocs, but also turning such "risks into rewards".

1038. Rehabilitation of wetlands can also be a powerful force in recovery from socio-political crises (Box 58).

<u>Box 58: Rehabilitating the Iraqi marshlands for integration and stability</u>

The Iraqi Marshlands constitute the largest wetland ecosystem in the Middle East and Western Eurasia. They are a crucial part of intercontinental flyways for migratory birds, support endangered species, and sustain freshwater fisheries, as well as the marine ecosystem of the Persian Gulf. In addition to their ecological importance, these Marshlands are unique from the global perspective of human heritage. They have been home to indigenous communities for millennia. The destruction of the Iraqi Marshlands, and the consequent displacement of its indigenous Marsh Arab population, is one of the major humanitarian and environmental challenges facing Iraq. The role of the Marshlands as a transboundary water resource and the presence of petroleum reserves have placed the future of the Marshland region among the priorities for Iraq's reconstruction agenda, creating, at the same time, trade-offs for the decision-makers.
Assessments carried out in 2003 and 2004 have reported that between 85,000 to 100,000 Marsh Arabs currently reside within and near the remaining Marshlands, with less than 10% leading a traditional subsistence existence. An estimated 100,000 to 200,000 Marsh Arabs still remain displaced internally within Iraq, and approximately 100,000 are thought to be living as refugees outside Iraq, primarily in Iran.

Non-Marsh Arab communities also reside within the Marshland region. With the collapse of the former regime in mid 2003, local residents opened floodgates and breached embankments to reintroduce water back into the Marshlands. Satellite images analyzed by UNEP in 2003 revealed that some of the formerly dried out areas have been re-inundated, helped by the wetter climatic conditions than usual. By April 2004, approximately 20% of the original Marshland area was re-inundated, compared with 5-7% in 2003.

With Phase III commenced in 2007, the following benefits of the UNEP Iraqi Marshlands Project can be identified:

- ESTs (Environmental Sound Technologies) on drinking water provision, sanitation provision and wetland restoration are being introduced and implemented, making use of Iraqi expertise.
- Access to safe drinking water provision has been made available for the benefit of up to 22,000 people in six pilot communities (Al-Kirmashiya, Badir Al-Rumaidh, Al-Masahab, Al-Jeweber, Al-Hadam, and Al-Sewelmat).
- Water treatment facilities with a total capacity of 750 cubic meters per day and water distribution facilities consisting of 23 kilometers of water distribution pipes and 127 common distribution taps had been newly installed.
- Some displaced residents are returning to pilot site areas, partly because drinking water has been made available through this project. As stability returns, possibilities for rebuilding life in the Marshes are increasing.
- A sanitation system pilot project has been implemented in the community of Al-Chibayish. The EST, constructed wetlands, aims to serve approximately 170 inhabitants, who face health hazards from discharges of untreated wastewater to a nearby canal.

Wetland rehabilitation and reconstruction initiatives are being implemented in cooperation with the Centre for the Restoration of Iraqi Marshlands (CRIM) of the Ministry of Water Resources (MOWR).

1039. In addition to promoting human security at the local level, inter-regional cooperation around shared waters can help promote peace-building and trust among countries, as seen in the cases of the Nile Basin and the Senegal River (Box 59). Although the causal pathways between water scarcity and conflict are still the object of much academic debate, there is no doubt that international cooperation on shared waterways is occurring, in many cases in areas where tensions existed even outside of the water issues (e.g. Central Asia). The creation of solid international water institutions at the very least demonstrates that cooperation is possible, and can be successful provided the rules of cooperation are transparent, and consensual.

Box 59: Sustainable water institutions promote regional cooperation and stability – the case of the Senegal River[64]

Created in 1972 through an agreement among the three riparian states (Mali, Mauritania and Senegal), the "Organisation de Mise en Valeur du Fleuve Sénégal" (OMVS) established the Senegal River as an international waterway whose rational exploitation and management was to be pursued. In 2002, member states adopted a Charter on the use of the river that aims to adopt principles and modalities of distribution of water resources among different sectors, defines project approval criteria and environmental rules as well as participation modalities for broader public engagement.
The OMVS functions as a key institution where country parties agree on future projects (e.g. dams, electricity, agricultural investments), provides usage guarantees, such as navigation, and agree on sectoral priorities. Because of the central role of the River in many activities in all countries, cooperation has gradually extended to tripartite discussions at the central and local levels in other sectors, such as agriculture and local enterprises. The OMVS also has at its disposal an Environmental Observation organ

[64] www.omvs.org

that provides information on the state of the resource and its associated ecosystem, in order to guarantee sustainability.

This long history of cooperation around a central waterway has been recognized as a key contribution to regional stability and integration. It is known as an example of a solid water-based institution for the promotion of collaboration on the multiple uses of water and the promotion of integrated water management.

1040. The consequences of climate change are primarily manifested through water resources in glacial melt, floods, droughts and sea level rise. Planners can no longer rely solely on past hydrologic conditions to conceptualize future risks. These risks are compounded by demographic, economic and other changes. Climate change increases the risk of failure or underperformance of structures and institutions. Developing countries are considered amongst the most vulnerable to climate change, due to high dependence upon climate-sensitive sectors, poverty and low capacity to adapt. In fact, current climate variability and weather extremes already severely affect economic performance in developing countries (World Bank, 2004).

1041. One way to cope with the uncertainty of climate change is to adopt management measures which are flexible and robust to uncertainty. The use of adaptive management principles, which involves a systematic process for improving management policies and practices by learning from the outcomes of implemented management strategies, is particularly relevant in the context of climate change by explicitly recognizing that management strategies and even goals may have to be adapted over time (Pahl-Wostl, 2007; Pahl-Wostl et al, 2007).

1042. Examples of successes in creating social marketing campaigns around water issues can be found in almost all countries. In the countries riparian to the Danube, the campaign involved educational institutions and the private sector, in the creation of the Danube Educational Toolkit, the “Danube Box”. The "Green Danube Partnership" is an alliance between the Coca-Cola Company, Coca-Cola Hellenic and the International Commission for the Protection of the Danube River (ICPDR). In national workshops taking place in several Danube countries, problems and needs of the countries were discussed and collected, and it was decided to produce a prototype of a transboundary educational kit, taking into account the needs for awareness raising materials. In at least five Danube countries the implementation of the Danube Box is under way: the kit has been translated, is in production and will be promoted in various projects and activities in Austria, Germany, Hungary, Romania and Serbia. All this is happening in close cooperation with the respective ministries for environment and water or water management and the ministries for education, pedagogical institutes and school authorities.

1043. There is increasing realisation of the critical need for Integrating water resource management in development planning. The importance of water for development makes it essential to integrate IWRM, water sector reforms and National Development Plans. This enables national development strategies to contribute to meeting the MDG’s by securing water for all MDG targets (E.g. Box 60).

Box 60: Zambian experiences on linking Integrated Water Resources Management (IWRM) to National Development Plans[65]

Zambia is an African country with sufficient water resources, but with increasing water stress due to declining rainfall patterns and increased water use. Water is used by households and for production such as mining and industries, as well as for hydropower production, which earns Zambia on average over US $10 million per year on exports. Agriculture is also a key sector for development depending on water for irrigation, livestock watering and other uses.

[65] This case is based on material from: “Zambia – National Water Resources Report for WWDR3”, prepared by Prof. Imasiku A. Nyambe, University of Zambia and Miriam Feilberg, DHI Water Policy for Ministry of Energy and Water Development, Zambia

During the past 10 years economic and administrative reforms have put the country on the road to significant economic growth. Increasing pressure on the water resource to secure access to water for further economic growth, has led the Government of Zambia to undertake broad water sector reforms. The reforms started with the National Water Policy in 1994, followed by first reforms of Water Supply and Sanitation and then Water Resources Management. The latter were planned through the Water Resources Action Programme (WRAP) established in 2001 with 7 components such as institutional and legal framework and water resources demand, supply and infrastructure. The reform would include a new policy, legislation and a new institution to manage and develop the water resources.

The government of Zambia through its Fifth National Development Plan 2006 – 2010 expressed concern with ensuring that the benefits of a healthier economy reach the rural and urban poor. As the government realised the importance of water for development it was natural to integrate IWRM, the water sector reforms and the NDP. Linking the 5th NDP and the IWRM plan was seen to be fundamental to poverty reduction and achieving the MDG's. The IWRM/WE plan became the 8th component of WRAP.

When formulating the 5th National Development Plan, the government used a participatory approach by involving 17 Sector Advisory Groups such as the Water SAG, a Government led high level forum, which helps to improve sector coordination as well as advise government on water sector reform and sector performance as well as monitoring and evaluation. It comprises representatives from key institutions and stakeholders in and outside the water sector. The IWRM plan programmes were integrated through this process.

This process secured political support for IWRM. It was decided by Government that Zambia's IWRM/WE Plan should be the instrument to implement the water related programmes the 5th NDP. The recognition of the importance of water for development in all sectors demonstrated the need for a new water policy as the 1994 policy dealt mainly with reforms within the sector. The new policy is centred on integration of management of water throughout all sectors in Zambia.

Linking IWRM to national development strategies contribute to meeting the MDG's by securing water for all MDG targets. As a result of this integration, many donors have incorporated water-related investment in their assistance packages to the Government of Zambia.

1044. Innovative mechanisms for mobilizing and channeling resources to the water sector are also increasingly being devised. Public-private partnerships, payments for ecosystem services and other similar schemes are increasingly explored as a promising avenue to generate financing for the water sector and environmental enhancement (e.g. Box 61.

<u>Box 61: Payments for ecosystem services help curb climate change, protect biodiversity, while protecting water resources</u>

The highland forests and paramos of the Andes mountain chain provide a variety of ecosystem services for human and natural communities in northern South America. In the center of the Colombian Andes, the Chingaza and Sumapaz national parks together represent over 225,000 hectares of these fragile ecosystems which provide habitat for a variety of threatened biodiversity and are crucial for the provision of water for downstream human populations. The area is the watershed for the Colombian capital, Bogota, which has over seven million residents. The water supply, distributed by the Bogota water services company EAAB, has significantly declined in recent years due to human activities such as agriculture and cattle grazing, which has led to degradation of the high Andes ecosystems. EAAB has estimated that the water demand will increase significantly by 2020, which means that immediate measures are necessary to protect the watershed in order to be able to meet that anticipated demand.

Recently EAAB, together with the Colombian government and with the help of Conservation International (CI), implemented a unique pilot project to help finance the protection of these critical watersheds. The project, conceived to provide climate change mitigation benefits as well as reliable freshwater supplies, provides clean, renewable energy while protecting the watershed and providing funding both to EAAB and the Colombian national parks. In this case, EAAB's Santa Ana small-scale hydroelectric power plant generates electricity without the greenhouse gas emissions associated with traditional plants using fossil fuels; the dam project is now officially recognized as a Clean Development Mechanism (CDM) project by the United Nations Framework Climate Change Convention. As such, it generates about 23,000 Certified Emission Reduction (CER) units with an approximate value of $450,000 each year. EAAB has committed to give provide half of this revenue to the Colombian Park Service, which uses the resources to consolidate and expand Chingaza National Park. Increased funds for park management have the effect of reducing deforestation and ecosystem degradation, thereby reducing another source of greenhouse gases while improving water supplies. The project thereby enhances the very watershed on which the hydro plant and the city of Bogota depend, while providing multiple benefits through climate change mitigation and biodiversity conservation.

In the next phase of the project, CI and partners are supporting an initiative to consolidate a regional biological corridor to connect Chingaza with Sumapaz national park, eastern Andean mountain slopes and the San Rafael water basin. The partners involved in this initiative are planning a variety of financing mechanisms to generate income based on the water and climate mitigation services the area provides. Through a large-scale reforestation effort on degraded lands in the corridor, the project would enhance carbon sequestration and water provision on a wider area, providing benefits to other communities which depend on the water produced by threatened high Andean ecosystems.[66]

1045. These examples provide useful insight into the pursuit of win-win government policy, business decisions and civic initiatives that will benefit water services and achieve multiple benefits. Because water issues are so central to every aspect of development, actors within and outside the water sector should intensify their collaboration to create and promote appropriate information, financing and institutions. The breadth and variety of pathways to promote linkages between interventions in and outside the water box shows that better, more sustainable development is possible. Increased political will to address water issues worldwide will continue to remain crucial, along with a willingness to consider innovative ways to approach local, regional and international cooperation.

1. The Way Forward

1046. All planning and management decisions must recognise the role of water.

1047. Managing water is a critical component of sustainable development: proper management seeks to ensure the survival, health and well-being, security, as well as the intra- and inter-generational equity for families, businesses and communities through water supplies and sanitation, the provision of water for food and for energy, and by responses to the hazards and damages of droughts, floods and other disasters. The achievement of each and all of the MDGs in some way requires recognition and incorporation of the role of water.

1048. The uneven distribution in time and space of water resources, as well as the extent to which they are being modified, are fundamental sources of the water crisis. There is a consensus among most climate scientists that climate warming will result in changes in the trend and a simultaneous intensification of the variability of the global and local hydrologic cycles, thus making the situation worse. There is some evidence that this is already happening. Even if mitigation measures that are recommended are executed,

[66] Conservation International, 2008

the climate will continue to change for decades, requiring adaptation to its impact on water resources and their use.

1049. External drivers and policies - those that deal with sectors and issues such as agriculture, trade, energy, housing and real-estate, disaster preparedness, security, finance and social protection, and those that affect overall economic diversification - have more impact on water management than many policies championed and implemented by water-related ministries, the private sector and civil society leaders of the water domain. These leaders acting alone and in isolation may end up making uninformed and sub-optimal development decisions. They also run the risk of being overlooked or even ignored in the broader decision-making frameworks.

1050. The most valuable evolution of IWRM could be the extension into dialogue and partnerships with water-using sectors, whose policies and strategies are governed by many other factors beyond water alone.

1051. Different drivers, different demands and what can be reasonably achieved given limited resources means that trade-offs are needed. Where water is abundant, trade-offs may be made with little detriment to concerned parties. As water becomes increasingly scarce, the role of leadership and the need for arbitrage grows and the significance of trade-offs becomes more important.

1052. Tested approaches available to water managers that show promise lie within the fields of:

- Water policy and planning processes that are currently not fully developed, and where incremental change that secures alignment with the real-world outcomes in the use of water will be most effective;
- Institutional development, through continuing reforms which create institutions that are better attuned to today's current and future challenges, considering decentralization, stakeholder participation and transparency, increased corporatisation wherever feasible and implementable in fairness, partnerships and coordination (public-private, public-public, public-civil society), and new administrative systems based on shared benefits of water, especially when water crosses statutory boundaries or political borders;
- Water law, both formal and customary, including regulations within other sectors that bear influence upon the management of the water resource;
- Consultation with stakeholders and developing accountability in planning, implementation and management; building trust, as effective management relies more and more upon pluralistic governance and interactions among parties with different vested interests.
- Developing appropriate solutions through innovation and research; and
- Institutional and human capacity development.

1053. Interest groups come to the fore in negotiating trade-offs. Industry and civic leaders may advocate Government to pursue certain directions. By and large, industry lobbies for self-regulation rather than control, while Governments enforce existing legislation, laws, regulations and by-laws. International regulators and local market pressures may be brought to bear to prevent manipulation of prices. International movements advocate for global goods and services. Following the 2008 Davos meeting, there are calls for a minimum water impact alongside a minimum carbon footprint.

1054. UN bodies and intergovernmental organisations provide summaries and counsel based on their experience in various locations and circumstances. The Chief Executives of the United Nations Agencies, following the example they have set by discussing jointly their combined response to climate change, should meet to examine the role of water and water management in development and give direction to the Agencies and advice to Member Countries.

1055. Options will be different in different situations, because social, economic and environmental conditions, as well as water availability and its spatial and temporal variability, are very different across the world. Equally important are the importance of extreme conditions – droughts and/or floods - in the area under consideration.

1056. The world faces major choices in the way that it meets the challenge of climate change. Public policy has so far been dominated by mitigation, but could choose a path that better balances action on mitigation and adaptation. Carbon is the measure of the anthropogenic cause – water is the measure of the impact. The international community has also to balance investing for tomorrow's probable problems of wider climate variability and global warming with investing to tackle today's real problems of climate variability to avoid the losses caused by droughts and floods. While both are necessary, with the latter option they also can create resilience to deal with the problems of to-morrow.

1057. Failure to recognise the essential role of water in the provision of food, energy, water supplies and sanitation, the management of responses to droughts, floods and other disasters and environmental sustainability has led to a lack of investment in infrastructure, the capacity to build and maintain it, and its renewal. Lagging investment in many countries leaves hundreds of millions of people without these benefits, suffering from poverty and ill health, exposed to the risks of water-related disasters, and potentially creating political instability.

IV. SYNTHESIS OF INFORMATION CONTAINED IN CBD NATIONAL REPORTS

A. Third National Reports

1 Introduction

1058. Information contained in the third national report was summarised for the second meeting of the Ad-Hoc Open-Ended Working Group on Review of Implementation (2007) in documents: UNEP/CBD/WG-RI/2/INF/1 (synthesis); UNEP/CBD/WG-RI/2/INF/1/Add.1 (priorities, challenges and progress towards targets; UNEP/CBD/WG-RI/2/INF/1/Add.2 (implementation of Articles and Provisions of the Convention); and UNEP/CBD/WG-RI/2/INF/1/Add.3 (implementation of the thematic work programmes).

1059. The following updated synthesis is prepared on the basis of the information contained in all 128 Parties which submitted a third national report (as of May 2009). Not all Parties answered all the relevant sections. Hence the total number of responses does not always sum to 128.

2. Information contained in the Third National Reports (3NR)

General

1060. Among the thematic programmes of work forest biodiversity is ranked as a high priority by the largest number of countries. Close to 70% of reporting countries give a high priority to its implementation. The second and third in ranking are the programmes of work on marine and coastal and agricultural biodiversity. The programme of work on dry and subhumid lands biodiversity is accorded high priority by the lowest number of countries. If we combine the data of high and medium priorities, we find that almost all the work programmes are covered by most countries (over 90% for forest and agricultural biodiversity, more than 75% for marine and coastal and inland waters biodiversity and close to 75% for mountain ecosystems and dry and sub-humid lands biodiversity).

1061. The most common avenue for the integration of biodiversity considerations within climate change mitigation and adaptation is through National Adaptation Programmes of Action or national/regional climate change policies. Other projects are being implemented through forestry plans or policies or inland waters and marine and coastal management plans.

1062. Regarding protected areas, 41 countries reported undertaking significant actions while 46 countries reported taking limited actions to increase representation of marine and inland ecosystems in protected areas. Many countries have plans to increase the extent of Marine and Coastal Protected Areas (MCPAs) covering the habitat of rare and endangered marine species, as well as to include marine territories of importance as wintering, nesting and resting sites of migratory species in existing terrestrial protected areas. Many of these would be inland but coastal areas. Some reporting coastal countries have already declared and gazetted some MCPAs.

Incorporation of the objectives and relevant activities of the programme of work into NBSAPs, wetland policies and strategies, and other relevant plans

1063. A summary of responses to question 148 regarding whether Parties have incorporated the objectives and relevant activities of the programme of work into various activities and implemented them is provided in Figure 89.

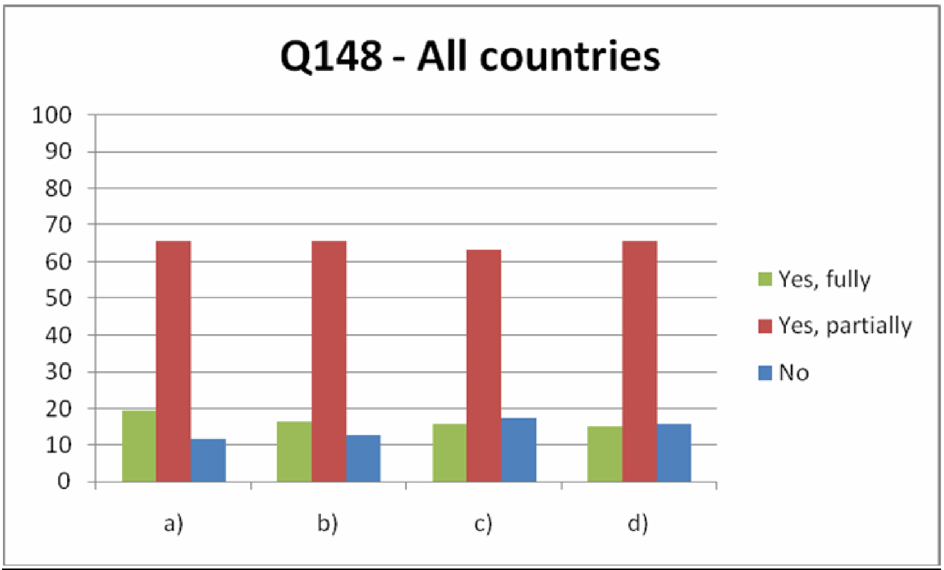


Figure 89: Responses of Parties to question 149 regarding incorporation of relevant activities etc. into: a- r biodiversity strategies and action plans; b- Wetland policies and strategies; c- Integrated water resources management and water efficiency plans being developed in line with paragraph 25 of the Plan of Implementation of the World Summit on Sustainable Development; d - Enhanced coordination and cooperation between national actors responsible for inland water ecosystems and biological diversity.

1064. The responses by country category are disaggregated in Table 26.

Table 26: Responses to question 149 disaggregated by country category

Question	All Parties	Developed countries	Developing Countries	Countries with economies in transition	Least developed countries	Small islands developing States
148.a – "yes" partially or fully integrated into NBSAPs	85.2%	96.2%	84.1%	76.9%	92.3%	66.7%
148.b – "yes" partially or fully integrated into wetland policies and strategies	82.3%	96.2%	86.3%	84.6%	76.9%	55.6%
148.c – "yes" partially or fully integrated into IWRM plans	78.9%	76.9%	88.6%	69.2%	76.9%	66.7%
148.d – "yes" partially of fully enhanced cooperation between	80.5%	76.9%	81.8%	84.6%	88.4%	66.7%

national actors etc.						

1065. Most Parties (97) report that they have incorporated objectives and relevant activities into their NBSAPs. However, most of them (77) have done so partially and not all objectives and activities are implemented. Some Parties (20) have integrated objectives and activities fully and implemented these fully. Only a few Parties provided further relevant details and comments on the objectives and activities incorporated into their NBSAPs.

1066. Most Parties (91) report that they have integrated objectives and relevant activities of the work programme in wetland policies and strategies. Only some Parties (31) have referred to specific water policy, strategy, or plan in which objectives and relevant activities related to the work programme were integrated. Among these 31 Parties, some (20) commented on policies, strategies, and plans that are specific to wetlands.

1067. Some Parties (20) have mentioned other national environmental policies, strategies, and plans in which the biodiversity of inland waters has been considered. Among these 20 Parties, a few (6) (Bangladesh, Canada, China, El Salvador, Romania and Turkmenistan) have considered inland water biodiversity in policies, strategies, and plans related to fisheries, and a few Parties (3) (Belarus, Colombia, India) have done so in policies, strategies, and plans related to development (e.g., Colombia's National Plan of Development 2002 - 2006 "Towards a Communitarian State").

1068. Canada is the only Party to mention activities in urban areas through the New Deal for Cities and Communities 2005 which targets new funding at environmentally sustainable municipal infrastructure, including water and wastewater systems, and through the Green Municipal Fund that offers grants and low-interest loans for sustainable infrastructure initiatives that generate measurable environmental, economic and social benefits.

1069. Many Parties (87) report that they have integrated objectives and relevant activities of the work programme into integrated water resources management (IWRM) and water efficiency plans. Many Parties (70) have done so partially and a few (17) fully. However, only a few Parties (8) (Belgium, Brazil, Canada, Lebanon, Malawi, Chile, France and Portugal) explicitly mentioned their IWRM strategies or plans or refer to application of IWRM in projects. It is noteworthy to mention Canada which has been involved in IWRM for many years and which mentioned the implementation of IWRM at several levels (provincial board, river basin level) and in many projects (e.g. Great Lakes Action Plan 2001-2006, Georgia Basin Action Plan, St. Lawrence Action Plan and Vision 2000, Lake Erie Lakewide Management Plan, Fraser Basin Council, Integrated Watershed Modelling of the South Saskatchewan River Basin).

1070. Responses regarding the extent to which the programme of work has been integrated into IWRM and water efficiency plans differs significantly from other sources of information on this subject. At the Johannesburg Summit in 2002 an objective was set that all countries should develop IWRM plans by 2005. A survey, prepared and implemented by UN-Water in 2007/08 (after the CBD third national reports were submitted), aimed to highlight progress towards the targets, based on responses to questionnaires from government agencies in 104 countries, with 77 of the countries being developing countries, or countries with economies in transition. For the developed countries, it was found that, out of 27 questionnaires, only 6 have fully implemented national IWRM plans. A further 10 countries have plans in place and partially implemented (which means that less than 60% of those developed countries had actual completed plans when the third national reports were submitted). The results for developing countries indicated the proportion of completed plans was 38 per cent, with the Americas at 43 per cent, Africa at 38 per cent, and Asia at 33 per cent. A report by the UNU[67] points to even slower uptake of the Johannesburg Summit objective stating "Possibly not a single country on earth produced their national plan by the end of 2005. At best, a number of countries started their planning in 2005". Detailed analysis of this discrepancy would depend on whether CBD national report respondents were referring to plans being developed or those in place. But it is clear that the response that 78.9% of CBD Parties have "partially or fully integrated into IWRM plans" is not consistent with evidence that at the time most Parties very likely did not have such plans. Much of course depends on the wording of the questions and their interpretations by respondents. Different constituencies may also provide different perspectives – in this case the information on take-up of IWRM by UN-Water being provided most likely by national water sector specialists or agencies and that for the programme of work by environment agencies. Whatever the interpretation, it can be concluded that it is not possible to confidently gauge the extent to which this programme of work has been incorporated into IWRM and water efficiency plans. And this is an important gap in knowledge in assessing progress in implementation of the programme of work.

1071. Most Parties (92) report that they have incorporated the objectives and relevant activities of the programme of work into enhanced coordination and cooperation between national actors. However, only a few Parties (12) mentioned activities related to the enhancement of coordination and cooperation between national actors. Among them, a few Parties (7) mentioned a committee, board, or council responsible for coordination. A few Parties mentioned coordination at the local level (county, district, or watershed committee) and in other settings. For example, Ethiopia has conducted an institutional and legal review through the involvement of key national stakeholders of wetland and inland water ecosystems in order to produce a workable institutional set-up for efficient conservation and wise use of inland water ecosystems. Lebanon mentioned the MedWetCoast Project which developed many local, national and international partnerships and collaborations. A few Parties also mentioned cooperation with the private sector.

1072. Some Parties (29) have referred to a legislative framework, whether a water law, act, or code. Among these, a number of EU member states mentioned the Water Framework Directive as incorporating objectives and activities of the Inland Water programme of work. Noteworthy examples include the following two cases: i) Israel amended its Water Law in 2004 to include the allocation of water for nature and landscapes assets, i.e., for the conservation and rehabilitation of natural assets and landscapes including rivers, springs, and wetlands; and ii) China implemented in 2003 a spring fishing ban in the Yangtze River in order to maintain and use reasonably the aquatic biological resources of the Yangtze River and ensure the sustainable fishery development in that river.

Identification of priorities for each activity in the programme of work, including timescales, in relation to outcome- oriented targets

1073. The percentage of Parties that have established national targets for the programme of work (PoW), and for each sub-target, is shown in Figure 90.

[67] Water and Ecosystems: Managing Water in Diverse Ecosystems to Ensure Human Well-being (2007). United Nations University International Network on Water, Environment and Health (UNU-INWEH), Hamilton, Canada

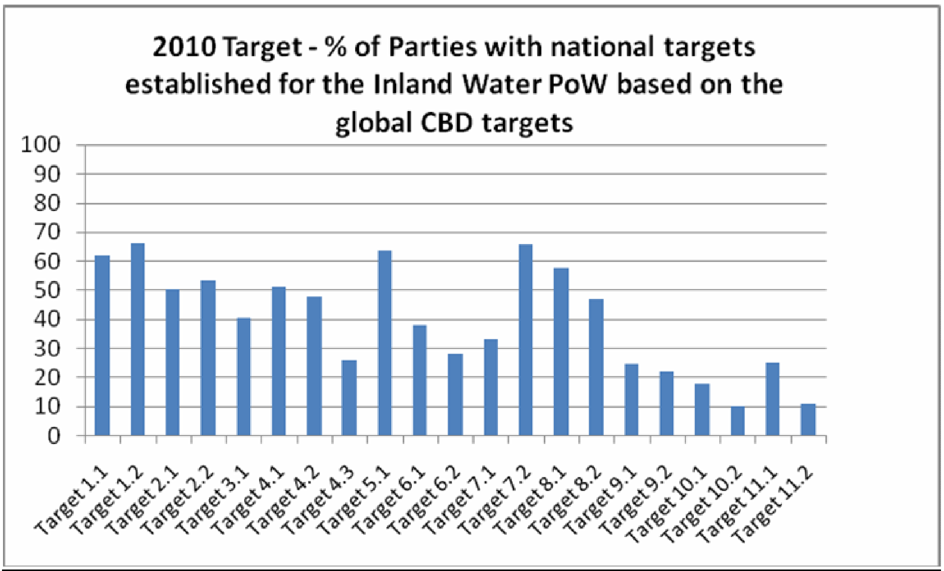


Figure 90: Establishment of national targets for the PoW

1074. For ease of reference the relevant targets are shown in Table 27.

Table 27: Descriptions of the relevant targets for the data in the above figure.

Goal/Target	Description
Goal I: Promote the conservation of the biological diversity of ecosystems, habitats and biomes	
Target 1.1: (Box III – II of the 3NR)	At least ten percent of each of the world's ecological regions effectively conserved
Target 1.2: (Box IV – II)	Areas of particular importance to biodiversity protected.
Goal 2: Promote the conservation of species diversity	
Target 2.1: (Box V – II)	Restore, maintain, or reduce the decline of populations of species of selected taxonomic groups
Target 2.2: (Box VI – II)	Status of threatened species improved
Goal 3 : Promote the conservation of genetic diversity	
Target 3.1: (Box VII – II)	Genetic diversity of crops, livestock, and of harvested species of trees, fish and wildlife and other valuable species conserved, and associated indigenous and local knowledge maintained
Goal 4 : Promote sustainable use and consumption	
Target 4.1: (Box VIII – II)	Biodiversity-based products derived from sources that are sustainably managed, and production areas managed consistent with the conservation of biodiversity

Goal/Target	Description
Target 4.2 (Box IX – II)	Unsustainable consumption, of biological resources, or that impacts upon biodiversity, reduced
Target 4.3 (Box X – II)	No species of wild flora or fauna endangered by international trade
Goal 5: Pressures from habitat loss, land use change and degradation, and unsustainable water use, reduced	
Target 5.1: (Box XI – II)	Rate of loss and degradation of natural habitats decreased.
Goal 6: Control threats from invasive alien species	
Target 6.1: (Box XII – II)	Pathways for major potential alien invasive species controlled
Target 6.2: (Box XIII – II)	Management plans in place for major alien species that threaten ecosystems, habitats or species
Goal 7: Address challenges to biodiversity from climate change, and pollution	
Target 7.1: (Box XIV – II)	Maintain and enhance resilience of the components of biodiversity to adapt to climate change.
Target 7.2: (Box XV – II)	Reduce pollution and its impacts on biodiversity
Goal 8: Maintain capacity of ecosystems to deliver goods and services and support livelihoods	
Target 8.1: (Box XVI – II)	Capacity of ecosystems to deliver goods and services maintained
Target 8.2: (Box XVII – II)	Biological resources that support sustainable livelihoods, local food security and health care, especially of poor people maintained
Goal 9: Maintain socio-cultural diversity of indigenous and local communities	
Target 9.1: (Box XVIII – II)	Protect traditional knowledge, innovations and practices
Target 9.2: (Box XIX – II)	Protect the rights of indigenous and local communities over their traditional knowledge, innovations and practices, including their rights to benefit sharing
Goal 10: Ensure the fair and equitable sharing of benefits arising out of the use of genetic resources	
Target 10.1: (Box XX – II)	All transfers of genetic resources are in line with the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture and other applicable agreements
Target 10.2: (Box XXI – II)	Benefits arising from the commercial and other utilization of genetic resources shared with the countries providing such

Goal/Target	**Description**
	resources
Goal 11: Parties have improved financial, human, scientific, technical and technological capacity to implement the Convention	
Target 11.1: (Box XXII – II)	New and additional financial resources are transferred to developing country Parties, to allow for the effective implementation of their commitments under the Convention, in accordance with Article 20
Target 11.2 (Box XXIII – II)	Technology is transferred to developing country Parties, to allow for the effective implementation of their commitments under the Convention, in accordance with its Article 20, paragraph 4

1075. The results for question 149 regarding priority setting are shown in Figure 91.

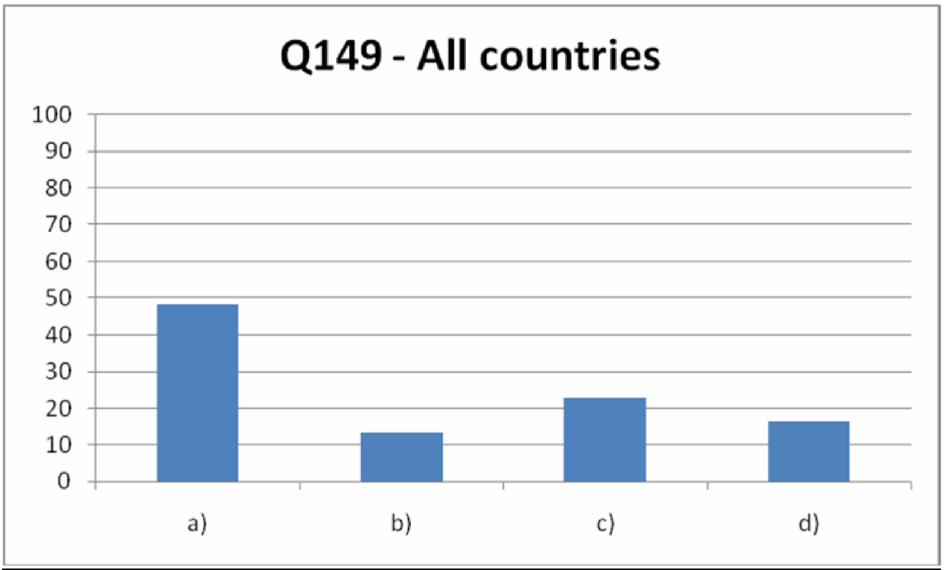


Figure 91: Responses to question 149 regarding identified priorities (a - No; b - Outcome oriented targets developed but priority activities not developed; c - Priority activities developed but not outcome oriented targets; d - Yes, comprehensive outcome oriented targets and priority activities developed).

1076. These responses are disaggregated by country category in Table 28.

Table 28: identified priorities disaggregated by country category

Question	**All Parties**	**Developed countries**	**Developing Countries**	**Countries with economies in transition**	**Least developed countries**	**Small islands developing States**
149.a – priorities not identified	48.4%	38.5%	45.5%	38.5%	50.0%	77.8%
149.b – outcome oriented targets	13.3%	11.5%	15.9%	23.1%	7.7%	11.1%

developed but priority activities not developed						
149.c - priority activities developed but not outcome oriented targets	22.7%	38.5%	22.7%	30.8%	11.5%	11.1%
149.d - have comprehensive outcome oriented targets and priority activities developed	16.4%	11.5%	15.9%	7.7%	30.8%	5.6%

1077. Some Parties (20) said that they had both identified priority activities and developed outcome-oriented targets. Among these parties, 7 mentioned that they had done so through a specific water and/or wetland policy or plan (e.g., the Water Framework Directive for the European Community, or the Wetland Sector Strategic Plan of Uganda), whereas 2 said they had done so through other policies or plans not specifically related to inland waters (e.g., the poverty reduction strategy of Benin). Two Parties have both identified outcome-oriented targets and priority activities through their NBSAPs.

1078. India was the only Party which mentioned the organization of consultative workshops in different regions of the country to identify key issues of wetlands which would be addressed through integrated conservation and development plans.

1079. Some Parties (16) said that outcome-oriented targets had been developed but priority activities were not developed. Among these Parties, 4 (Canada, Mauritania, Sweden, Viet Nam) mentioned water policies or plans to refer to the targets (e.g., the action plan on protection and sustainable development of wetlands 2004-2010 in Viet Nam), and 2 Parties (Japan and Belarus) mentioned the outcome-oriented targets in relation to the Ramsar Convention.

1080. Some Parties (25) have developed priority activities but not outcome-oriented targets. Among these Parties, 2 Parties (Brazil and Denmark) referred to water policies/plans whereas 5 Parties mentioned more general policies or plans (e.g., Hungary's National Nature Conservation Master Plan; the Medium Term Philippine Development Plan). A few Parties (4) (Czech Republic, Indonesia, Poland and Republic of Moldova) have identified priorities for each activity in the programme of work through their NBSAPs. A few countries mentioned that their NBSAPs help to set general priorities.

1081. Regarding targets for protected areas, in the case of inland water biodiversity, only a few countries reported that such a target is in place. For example, Thailand has aimed to conserve and restore 35% of its wetlands by 2010.

1082. Overall, targets are seldom clearly defined for implementing all the thematic work programmes and many countries listed measures currently in place rather than targets *per se*. For inland waters, examples include keeping lakes and watercourses ecologically sustainable with habitats maintained and protected, promoting local participation in wetland management and fishery development, protecting aquatic species from toxic substances, and monitoring and control of invasive alien species. Most countries either listed legislative measures in place or described the protection and recovery measures being implemented. In fact, some countries listed conservation measures rather than targets, particularly when asked whether they had specific targets for the different thematic programmes of work, though more than a half of countries stated that targets had been incorporated into the thematic work programmes on forest, marine and coastal and inland waters biodiversity.

1083. For example, for agricultural biodiversity, measures taken include: reducing pollution from agricultural chemicals, use of organic fertilizers, promoting good agricultural practices, monitoring of hydrological change, conservation of pastoral systems, reducing persistent organic pollutants and nitrogen surplus, promoting organic agriculture. All of these are activities relevant to the inland waters programme of work. To protect inland waters ecosystems, some countries are taking measures, such as a ban on disposal of pollutants in water bodies, ban of poisonous substances in fishing, reducing agricultural runoffs, recycling plastics and other wastes in water bodies, minimizing use of pesticides and other chemicals, reducing eutrophication of water bodies, and chemical control of waterweed.

1084. Regarding target 8.2 - Capacity of ecosystems to deliver G & S maintained: To protect inland waters ecosystems, some countries are taking measures, such as a ban on disposal of pollutants in water bodies, ban of poisonous substances in fishing, reducing agricultural runoffs, recycling plastics and other wastes in water bodies, minimizing use of pesticides and other chemicals, reducing eutrophication of water bodies, and chemical control of waterweed.

1085. The responses to question 149 (regarding priority setting) and questions relating to the 2010 target (as above) are conflicting. According to the responses on the 2010 target, overall more than 60% of Parties report that they have established targets for this programme of work (although the figures vary between sub-targets). However, according to question 149, only 29.7% of Parties have established outcome oriented targets for this programme of work (that is, summing Parties giving a positive answer to question 149b plus 149d). This is a significant discrepancy, difficult to interpret. Possibly this may be due to some Parties referring more to "activities" regarding the programme of work as opposed to targets *per se*.

Promoting synergies between this programme of work and related activities under the Ramsar Convention as well as the implementation of the Joint Work Plan (CBD-Ramsar) at the national level

1086. A summary of responses regarding synergies with the Ramsar Convention (Question 150) is provided in Figure 92.

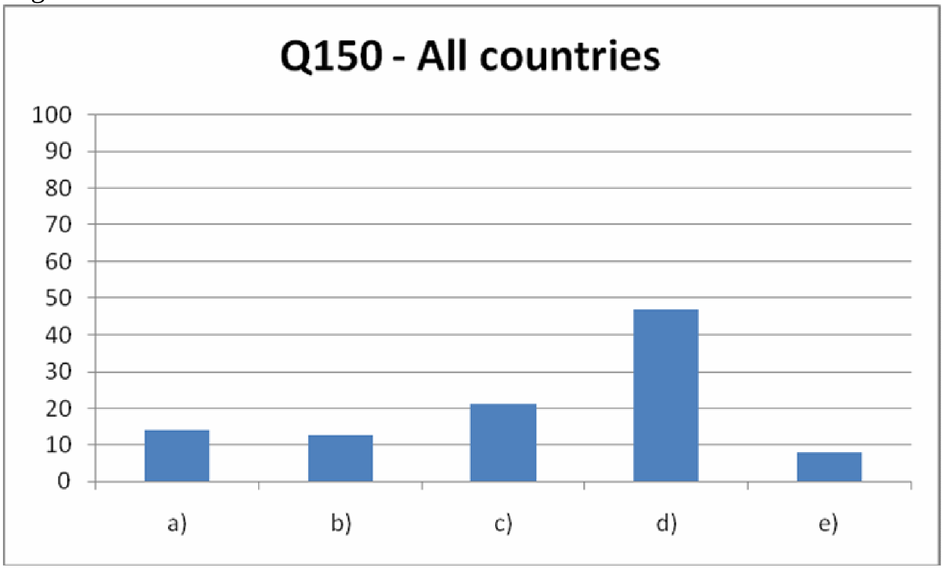


Figure 92: Responses to question 150 regarding synergies with the Ramsar Convention. (a - Not applicable (not Party to Ramsar Convention); b - No; c - No, but potential measures were identified for synergy and joint implementation; d - Yes, some measures taken for joint implementation; e - Yes, comprehensive measures taken for joint implementation).

1087. These responses are disaggregated by country category in Table 29.

Table 29: Responses of Parties to question 150 disaggregated by country category

Question	All Parties	Developed countries	Developing Countries	Countries with economies in transition	Least developed countries	Small islands developing States
150.a – not a Party to the Ramsar Convention	14.1%	N/A (all are Parties)	11.4%	7.7%	11.5%	44.4%
150.b – not promoting synergies	12.5%	11.5%	9.1%	7.7%	15.4%	22.2%
150.c – not promoting but potential measures identified	21.1%	19.2%	18.2%	38.5%	26.9%	11.1%
150.d and e - some or comprehensive measures	68.0%	73.1%	61.4%	53.8%	46.2%	27.8%

1088. Some Parties (25) responded that potential measures were identified for synergy and joint implementation. Despite being a non-Party of the Ramsar Convention, Turkmenistan mentioned that its NBSAP provides for a range of targets and activities compatible with the principles of the Ramsar Convention and highlights the possible synergies between Ramsar and CBD. Among these 25 Parties, 6 Parties identified synergies and joint implementation in relation to the management of their Ramsar sites, 3 Parties mentioned specific bodies, committees, or ministries to promote the synergies (e.g., Brazil's National Wetlands Committee or Turkey's Ministry of Environment and Forestry) and 2 Parties identified synergies and joint implementation in specific programmes, strategies or plans (e.g., the National Wetlands Diagnosis of Brazil).

1089. Many Parties (52) said that some measures were taken for joint implementation. Among these 52 Parties, 14 Parties mentioned a specific body, committee, or ministry in charge of promoting synergies (e.g., National Wetland Committee in Chile, the "Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification" part of the National biodiversity Committee in Morocco, and the Danish Forest and Nature Agency). 11 Parties mentioned synergies through the management of Ramsar sites, and 9 Parties mentioned specific strategies or plans in which synergies and a joint work plan were included.

1090. A few Parties (9) have taken comprehensive measures for joint implementation. Three countries mentioned specific projects in relation to comprehensive joint implementation (e.g., habitat restoration including water retention in bog meadows, bog meadow habitat restoration and bog meadow vegetation control in Hungary and the sustainable use, management and rehabilitation of flood plain in the Middle Tisza District in Hungary which started in 2004).

Steps to improve national data on goods and services provided by inland water ecosystems, related socioeconomic variables, basic hydrological aspects of water supply, species at all taxonomic levels, and threats to inland waters ecosystem

1091. A summary of responses of Parties regarding improving national data is provided in Figure 93.

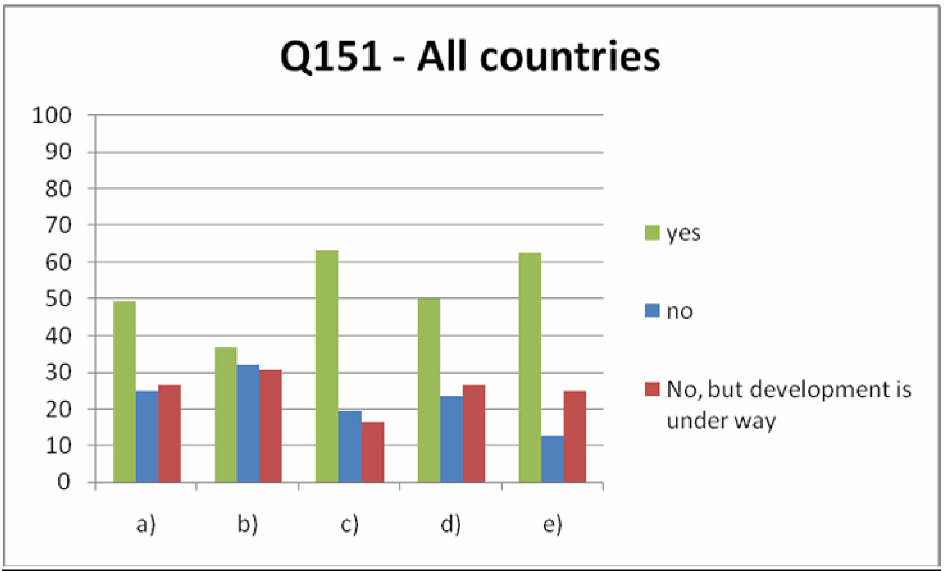


Figure 93: Summary of responses to question 151 on improving national data on various aspects (a) Goods and services provided by inland water ecosystems?; b) The uses and related socioeconomic variables of such goods and services?; c) Basic hydrological aspects of water supply as they relate to maintaining ecosystem function?; d) Species and all taxonomic levels?; e) On threats to which inland water ecosystems are subjected? (Possible Answers: Yes; No; No, but development is under way)

1092. The responses disaggregated by country category are shown in Table 30.

Table 30: Responses to question 151 disaggregated by country category.

Question	**All Parties**	**Developed countries**	**Developing Countries**	**Countries with economies in transition**	**Least developed countries**	**Small islands developing States**
151.a - Goods and	49.2%	57.7%	65.9%	30.8%	42.3%	16.7%

services provided by inland water ecosystems ("have", "have not but dev. underway", "have not" – listed from top to bottom)	26.6% 25.0%	30.8% 11.5%	25.0% 9.1%	23.1% 46.2%	23.1% 38.5%	33.3% 50.0%
151.b - The uses and related socioeconomic variables of such goods and services ("have", "have not but dev. underway", "have not" – listed from top to bottom)	37.7% 30.5% 32.0%	50.0% 30.8% 19.2%	52.3% 36.4% 11.4%	7.7% 15.4% 69.2%	26.9% 34.6% 38.5%	11.1% 22.2% 66.7%
151.c - Basic hydrological aspects of water supply as they relate to maintaining ecosystem function ("have", "have not but dev. underway", "have not" – listed from top to bottom)	63.3% 16.4% 19.5%	84.6% 7.7% 7.7%	68.2% 25.0% 6.8%	69.2% 7.7% 23.1%	53.8% 26.9% 19.2%	27.8% 0 66.7%
151.d - Species and all taxonomic levels ("have", "have not but dev. underway", "have not" – listed from top to bottom)	50.0% 26.6% 23.4%	80.8% 15.4% 3.8%	65.9% 25.0% 9.1%	30.8% 30.8% 38.5%	26.9% 34.6% 42.3%	27.8% 11.1% 55.6%
151.e - On threats to which inland water ecosystems are subjected ("have", "have not but dev. underway", "have not" – listed from top to bottom)	62.5% 25.0% 12.5%	84.6% 11.5% 3.8%	70.5% 29.5% 0	53.8% 30.8% 15.4%	50.0% 26.9% 26.9%	33.3% 27.8% 33.3%

1093. Many reporting countries (49%) indicated that they had taken steps to improve national data on goods and services provided by inland water ecosystems, while some (29%) are taking steps towards this direction and some (22%) are yet to take any steps.

1094. Of all the responding countries, many countries (60 to 65%) indicated that they had taken steps to improve data on the basic hydrological aspects of water supply, on species and all taxonomic levels, and on threats to inland water ecosystems. However, only some countries (38%) indicated that they had taken steps to improve national data on the uses and related socioeconomic variables of goods and services provided by inland water ecosystems.

1095. Some Parties (35%) countries provided specific lists of named data sets on inland waters while some Parties (40%) listed general inventories. Some Parties (17%) mentioned work done to explore socio-economic or valuation questions to their inventories and some Parties (15%) elaborated on the state of water quality monitoring schemes.

1096. Some Parties (16%) elaborated on threats such as those from urban, industrial and agricultural wastes, and development projects, with a view to addressing them. A few Parties (10%) showed through their descriptions a move towards using an integrated approach at some level within the management of data on inland waters.

Taxonomy

1097. Question 31 requests specific information regarding whether the country developed taxonomic support for the implementation of the programmes of work under the Convention as called upon in decision VI/8?

1098. Responses to this question are summarised in Figure 94.

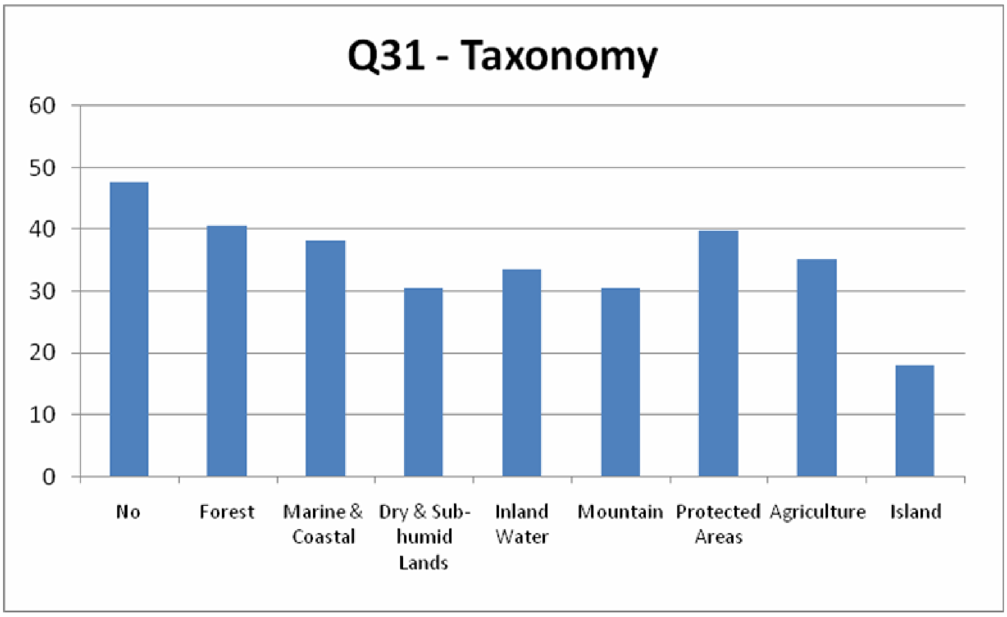


Figure 94: Summary of responses (% yes) of Parties stating that they have developed taxonomic support in the various programmes of work. (Possible answers are: a - No; b to i - Yes, for each programme of work).

Promoting the application of the guidelines on the rapid assessment of the biological diversity of inland water ecosystems

1099. Responses to question 152 regarding this subject The responses to this question are disaggregated by country category in Table 31.

Table 31: responses of Parties regarding their promotion of the guidelines (question 152)

Question	All Parties	Developed countries	Developing Countries	Countries with economies in transition	Least developed countries	Small islands developing States

152.a – have not promoted	73.4%	84.6%	70.5%	69.2%	69.2%	77.8%
152.b – have reviewed and found the guidelines inappropriate	3.1%	0	2.3%	7.7%	3.8%	0
152.c – have reviewed and promotion is pending	15.6%	11.5%	18.2%	15.4%	19.2%	11.1%
152.c – have promoted and applied the guidelines	6.3%	7.7%	4.5%	7.7%	11.5%	0

1100. Most (83) countries reported that the guidelines have not been reviewed. Only some countries (17) said that the guidelines had been reviewed and their application and/or promotion is pending. A few (7) had promoted and applied the guidelines.

1101. Three countries reported improvements to their databases (Belgium, Malaysia, Mauritania). Three countries (Estonia and Finland and Rwanda) reported on the improvement of laws or the creation of new legislation to apply the guidelines. Some (16) countries emphasized positive aspects of their rapid response programmes.

1102. The European Community reports that the assessment system developed for the Water Framework Directive provides a more comprehensive assessment than that proposed under the CBD rapid assessment guidelines.

1103. A few (7) countries reported improvements to their monitoring systems. Chile reported that they are using biodiversity as a secondary norm of quality of inland waters, and Lebanon reports research on the use of macrophytes as bioindicators. In Lesotho, the South African Scoring Standard has been adopted for assessment of rivers. Portugal reports that the valuation of cultural heritage and the use of ecological indicators are being developed (see http://medwetnet.icn.pt). Uganda reports that rapid assessment of inland water ecosystems has been done using selected indicator species such as higher plants, fish, dragonflies and water birds and that the national data is available in the database of its national wetlands programme.

1104. Malaysia emphasizes the importance of multi-sectoral participation in remediation and mitigation measures. Finland notes the need to promote sustainable use in water management, and Colombia is beginning to apply the Ecosystem Approach to the implementation of the guidelines.

1105. Six countries mentioned some of the problems they encountered in the implementation of the guidelines. Colombia reported that monitoring the status of the biological diversity of continental water ecosystems in the country is done but in a fragmented way and through small sub-regional projects, which affects the general interpretation of the ecosystem status. Three countries mentioned lack of some capacities for applying the guidelines.

Differences between country economic groupings

1106. The responses of Parties sub-divided by economic grouping is a fruitful area for analysis. The rankings of the five country groupings (developed, developing, economies in transition, least developed and small island developing States) are shown in Table 32.

<u>Table 32: Rankings of responses to the various sections of the third national report by country economic grouping (groups were ranked according to the percentage of Parties responding to the particular question on the basis of what the positive or desirable response would be, which varies according to the question. A high rank (1) means a high level of engagement/progress and the lowest rank (5) indicates the lowest engagement/progress. Groups with the highest ranks are therefore doing "better". For example a rank 1 on "have not" means a lower percentage of countries in that group "have not" done it – which is better than a higher percentage of countries having not done it).</u>

Question		**Developed**	**Developing**	**Countries EiT**	**LDCs**	**SIDS**
148.a – "yes" partially or fully integrated into NBSAPs		1.00	3.00	4.00	2.00	5.00
148.b – "yes" partially or fully integrated into wetland policies and strategies		1.00	2.00	3.00	4.00	5.00
148.c – "yes" partially or fully integrated into IWRM plans		2.50	1.00	4.00	2.50	5.00
148.d – "yes" partially of fully enhanced cooperation between national actors etc.		4.00	2.00	2.00	1.00	5.00
149.a – priorities not identified		1.00	3.00	2.00	4.00	5.00
149.b – outcome oriented targets developed but priority activities not developed		3.00	2.00	1.00	5.00	4.00
149.c - priority activities developed but not outcome oriented targets		1.00	3.00	2.00	4.00	5.00
149.d - have comprehensive outcome oriented targets and priority activities developed		3.00	2.00	4.00	1.00	5.00
150.a – not a Party to the Ramsar Convention		1.00	3.00	2.00	4.00	5.00
150.b – not promoting synergies		3.00	2.00	1.00	4.00	5.00
150.c – not promoting but potential measures identified		3.00	4.00	1.00	2.00	5.00
150.d and e - some or comprehensive measures		1.00	2.00	3.00	4.00	5.00
151.a - Goods and services provided by inland water ecosystems	"have"	2.00	1.00	4.00	3.00	5.00
	"have not"	2.00	1.00	3.00	4.00	5.00
151.b - The uses and related socioeconomic variables of such goods and services	"have"	2.00	1.00	5.00	3.00	4.00
	"have not"	2.00	1.00	5.00	3.00	4.00

151.c - Basic hydrological aspects of water supply as they relate to maintaining ecosystem function	"have"	1.00	3.00	2.00	4.00	5.00
	"have not"	2.00	1.00	4.00	3.00	5.00
151.d - Species and all taxonomic levels	"have"	1.00	2.00	3.00	5.00	4.00
	"have not"	2.00	1.00	4.00	3.00	5.00
151.e - On threats to which inland water ecosystems are subjected	"have"	1.00	2.00	3.00	4.00	5.00
	"have not"	2.00	1.00	3.00	4.00	5.00
Total – all sections (sum of ranks)		41.50	43.00	65.00	73.50	106.00

1107. Across most (but not all) areas reviewed in the national reports, as might be expected, developed countries show a high level of engagement (meaning more positive responses in terms of progress etc.) in the programme of work. But not always, and developing countries often "outperform" them and the total scores (sum of ranks) are only marginally different between these two groupings (41.5 *versus* 43). That developing countries often engage well in the programme of work perhaps reflects the more pressing nature of water-biodiversity related issues to the poor, the need to manage natural resources more wisely under more harsh economic conditions and the fact that direct dependency on biodiversity is higher amongst them. The same would apply to least developed countries but their performance is perhaps more constrained by capacity than for developing countries. Overall, least developed countries perform in fourth position out of the five groupings.

1108. Interestingly, countries with economies in transition are ranked third overall (and their total score is more aligned to least developed countries than either developed or developing countries). This supports the long held paradigm that countries experiencing more rapid economic growth (in transition) tend to give less attention to the environment, particularly freshwater related resources, despite the increasing capacity to do so.

1109. Engagement in the programme of work is consistently by far the lowest amongst Small Island Developing States (SIDS) – which is a grouping of both developing and least developed States. Some might argue that it is due to capacity considerations – although there has been no rigorous assessment of whether this is the case (they have numerically fewer human resources, but fewer resources to manage, and smaller areas can be easier to manage than larger ones). But very likely a factor is that islands may focus on marine and coastal areas, climate change, and for many also forests. If correct, this is not logical. There are no grounds to assume that inland waters are less important on islands. In fact, there are strong arguments that they can be more important. Freshwater resources availability is a critical issue in most SIDS (if not all). The smaller the island – the more important freshwater becomes. Some SIDS are currently even importing freshwater from neighbouring States. Even from the perspective of species conservation – islands are characterised by high degrees of freshwater species endemicity (probably more so than for terrestrial biota, and certainly compared to marine). Neither could a case be made that freshwater needs and issues are lower in countries with economies in transition.

1110. These overall observations show that implementation of the programme of work is not linked linearly with economic status. Whatever the reasons, it is at least clear that there are differences amongst economic groupings and that these are not easily explained by economic status or capacity constraints.

1111. Differences between country groupings within subject areas also give some interesting insights. Regarding targets, Question 149 (answer d) is the ideal combination of having comprehensive outcome oriented targets and priority activities in place for them. Least developed countries (LDCs) rank highest in this (Table 32). Based on the actual numerical percentages of Parties within groupings (Table 26) they are approaching three times better on this point than developed countries. Even developing countries "out perform" developed countries in this area (also on 149b – which refers to having targets but no priorities set). In the area of targets/priority activities (question 149), developed countries rank highest only where priorities have been identified but no targets established. Interpretation of such information is difficult. But it is clear that least developed and developing countries are ahead regarding the importance of target setting and identifying priority actions to achieve them (even if they have perhaps more limited capacity to implement).

1112. LDCs are second highest (after developed) in integrating the programme of work into NBSAPs. Better progress is reported by all groups (except SIDS) than developed in enhancing cooperation between national actors (suggesting this is a continued area of weakness in developed countries). Developed countries rank highest in those areas which clearly require a high degree of technical capacity (for example, taxonomy, identifying threats and hydrological aspects of water supply as they relate to maintaining ecosystem function).

1113. Developing countries are doing "better" than developed in areas relating to attention to goods and services provided by inland water ecosystems and the uses and related socioeconomic variables of such goods and services. This may reflect the more obvious relevance of some of those goods and services to developing countries (e.g., direct use for food, disaster, e.g. flood, mitigation etc.) – although the goods and services provided by inland waters (collectively) are in reality probably of equal importance amongst country groupings.

Overall assessment of achievements and challenges

Challenges

1114. Challenges to implementation are addressed in question 147. The summary of responses is provided in Table 33 – implementation of this programme of work being amongst the most challenging.

Table 33: The average score given by Parties regarding challenges to implementation for each programme of work. (Possible answers: 3 = High Challenge, 1 = Low Challenge, 2 = Medium Challenge, 0 = Challenge has been successfully overcome; scores below reflect means of these responses).

Agriculture	Forest	Marine and Coastal	Inland water	Dry and subhumid lands	Mountain
1.8	1.8	1.4	1.8	1.4	1.4

1115. Main challenges identified by many countries for implementing this work programme include:

(a) Lack of mainstreaming inland waters ecosystem management into broader relevant policy frameworks;

(b) Limited capacities for inland waters ecosystem management;

(c) Lack of adequate information, monitoring, technical standards and practices for inland waters ecosystem management;

(d) Lack of financial, human and technical resources;

(e) Inadequate policy and legislative frameworks and weak enforcement capacities; and

(f) Lack of inter-sectoral coordination or synergies.

1116. There are a few challenges rated as high by a considerable number of countries – including weak law enforcement capacity, in particular for the programme of work on inland waters biodiversity.

Overall assessment

1117. There is a relatively high degree of incorporation of the objectives and relevant activities of the programme of work on the biological diversity of inland waters, whether partially or fully, through NBSAPs, wetland policies and strategies, Integrated Water Resources Management and water efficiency plans, or enhanced coordination plans. Similarly, there is a reported high degree of incorporation of the objectives and relevant activities of the programme of work into enhanced coordination and cooperation between national actors. For Parties to both the CBD and Ramsar, most are promoting synergies between the CBD programme of work and related activities under the Ramsar Convention as well as the implementation of the Joint Work Plan (CBD-Ramsar) at the national level.

1118. Only some Parties have identified priority activities or developed outcome-oriented targets. Some Parties, however, have well developed procedures to develop integrated policies and management which lead to the more balanced management approach that inland waters require. Throughout the comments received there is limited mention of the ecosystem approach – although a number of activities reported (such as integrated water resources management, water framework directives etc.) represent applications of the approach using different terminology.

1119. Data generation for inland waters continues to be dominated by technical and biological interests whereas socioeconomic data are clearly still weak. Likewise, data generation on threats is also a weak area. Realisation of this is perhaps one factor contributing to the limited uptake of the guidelines for the rapid assessment of the biological diversity of inland water ecosystems (largely focussed on biological aspects) although a few Parties, mainly developed countries, report they have not used the guidelines because they have more comprehensive guidelines available.

1120. In the second national reports, the programme of work on biological diversity of inland water ecosystems is recognized as priority programme by a majority of responding Parties. However, two thirds of the Parties did not have adequate resources for implementation of the programme of work. Responses showed that the programme of work on biological diversity of inland water ecosystems was reviewed by only nine Parties, which identified priorities for national action in implementing the programme. However nearly half of the responding Parties reported on developing national and sectoral plans for conservation and sustainable use of inland water ecosystems. This indicates that the majority of the national sectoral plans for conservation and sustainable use of inland water ecosystems are developed irrespective of the programme of work. Assessing progress between the second and third national reports is difficult because the questions differ, as does the status of development of the programme of work, and the response rate for the second national report relatively low.

1121. Intuitively, the third national reports suggest much improved engagement in and attention to inland waters since the second report but this cannot clearly be attributed to the existence of the programme of work. It remains difficult to assess for particular activities whether these are (i) in response to the programme of work itself, or (ii) they are activities which would in any case be carried out but are consistent with the programme of work and therefore reported against it. There are few clear examples of

Parties in the first category although the level of influence of the programme of work no doubt various amongst these. It is highly likely that a considerable proportion of Parties fall into the second category, in particular the developed countries. This uncertainty makes it difficult to assess the impact of the implementation of the programme of work on the achievement of the 2010 target. This has to be assessed through a multitude of additional, mainly indirect, approaches.

B. The Fourth CBD National Reports

1122. Fourth national reports have been assessed based on 70 submissions (as of 30 October 2009). They contain a wealth of information on the programme of work on inland waters, including status and trends, main drivers, constraints, responses and progress in implementation; much more so than previous reports. It is clear that the greater flexibility in reporting in the fourth report has yielded improved information. But this is difficult to analyse systematically or quantitatively, in particular with this programme of work because much information in other subject areas is also relevant (especially in relation to trends in, and activities regarding, land based activities that influence, or which are influenced by, inland waters). Therefore, individual reports are used to illustrate subjects/conclusions elsewhere in this document (and in document UNEP/CBD/SBSTTA/14/3). The reports generally support observations already made regarding status and trends, the main drivers and constraints. They also indicate a relatively high degree of attention to inland waters and water/land based subjects more generally, irrespective of whether this is an increase in attention since the third reports (which cannot be adequately assessed due to differing report formats). Integrated Water Resources Management (IWRM) and similar approaches feature prominently in the majority of reports. There is much attention to efforts towards cross-sectoral integration, including many Parties reporting on this in the context of enhanced legal frameworks, particularly for water use and protection, and the application of impact assessments. There is also more evident attention to ecosystem services aspects and in particular widespread attention to water related services, such as drinking water and flood mitigation. This is supported by the majority of Parties emphasising efforts towards the rehabilitation of inland water ecosystems. Progress with target setting for the programme of work would also appear to be advancing compared to what the third national reports might imply; the majority of Parties specify relevant targets, and many refer to monitoring and indicators. Only a limited number of SIDS had submitted reports (to date) but amongst these there is a more clear expression of interest in water-related issues which most identify as being significant (e.g., Dominican Republic, Niue).

C. Voluntary reports

1123. In support of the in-depth review process, the Executive Secretary issued notification 2008-18 (18 September 2008) inviting Parties and relevant international and non-governmental organisation to submit voluntary reports to the in-depth review. Submissions were received from Canada, the European Union (which included reports from the European Commission, Finland and Spain), France, the Islamic Republic of Iran, The United Kingdom, and the Unions des Comores, available at https://www.cbd.int/waters/responses.shtml. Some of the observations from these very useful reports are noted elsewhere in this document.

V. WORK OF SELECTED NON-GOVERNMENTAL ORGANIZATIONS WORKING ON INLAND WATER BIODIVERSITY AND WETLANDS

A. Introduction

1124. Freshwater ecosystems provide a wide range of ecosystems services that are crucial for human well-being. Despite this value, they are among the most imperiled ecosystems on Earth and actions are urgently needed for their conservation and protection. Non-governmental organizations are aware of this situation and have already initiated various efforts to protect and conserve freshwater ecosystems. This report aims to summarize some of their current work on conservation of freshwater ecosystems, with particular emphasis on the actions conducted by Conservation International (CI), the International Union for Conservation of Nature (IUCN), The Nature Conservancy (TNC), Wetlands International (WI) and the World Wide Fund For Nature (WWF). All five of these NGOs are actively involved in this area at the global level and have projects at regional, national and local levels, in most cases in collaboration with national and local governments. Because of this experience in practical implementation, their perspectives on constraints, priorities and successes and failures are extremely valuable for the purposes of the in-depth review of the CBD programme of work on inland waters.

1125. This section is divided in two main parts. The first reviews the major conservation activities and/or programmes of work of the selected NGOs, with emphasis on climate change and freshwater conservation through Integrated Water Resources Management (IWRM). The second part presents fifty case studies (ten for each NGO) that exemplify the various alternatives available to promote the conservation of freshwater ecosystems and their services. In the selection of these case studies, work conducted in other areas and ecosystems was also considered. This was done to demonstrate that freshwater conservation and management is a cross-cutting issue and that actions are needed at different levels and sectors and with the participation of various actors. In particular, most problems with the degradation of inland waters originate from unsustainable land practices and therefore land and water management cannot be separated.

1126. The description of the work of the selected NGOs and the case studies included is mainly based on the information provided in their websites. For the description of the case studies, however, project managers were contacted via e-mail or telephone calls as well. Positive feedback was obtained for most of the contacted people.

1127. It should be noted that this is not a "review" of the work of the various NGOs. It is a snapshot of *some* of their relevant activities. Neither does this report in any way necessarily represent the official views or policies of any of the NGOs on particular subjects.

B. Summary of activities of the NGOs collectively – common but differentiated approaches

1128. The work conducted by Conservation International (CI), the International Union for Conservation of Nature (IUCN), The Nature Conservancy (TNC), Wetlands International (WI) and the World Wide Fund For Nature (WWF) indicates that, in general, these Non-Governmental Organizations (NGOs) work in similar thematic areas, share similar priorities and apply broadly comparable conservation strategies. Conservation work on forest, species, oceans, freshwater ecosystems and climate change are common to them all, with a high priority on the latter theme. The establishment of partnerships is their main strategy, along with the use of cutting edge science. Governments, local communities and indigenous peoples are considered strategic partners. A high interrelation among their different areas of work is also a common characteristic of these organizations, which is the result of applying an “ecosystem approach” to biodiversity conservation.

1129. The IUCN has the most comprehensive scope of work, with working programmes touching all aspects of biodiversity conservation, including business and biodiversity, economics, environmental law, gender, social policy and global policy, whereas WWF is perhaps second in terms of range of activities, followed by TNC and CI. But these differences largely reflect size of the organisations. The relatively higher profile (within the organisations) of fire management and eco-tourism as specific areas of work is a characteristic of TNC and CI respectively. Wetlands International (WI) is the only NGO, amongst the five selected, that focuses specifically on wetlands and the only one at the global level to do so (which is why it was selected). Conservation-livelihoods-poverty reduction linkages are a strong theme with all these NGOs and Wetland International's work is characterized by the high priority given to these linkages for wetlands. There is a clearly discernible shift in historical emphasis of the five NGOs from a "conservation" to a "people" focussed approach, which mirrors the evolution of such emphasis with the CBD itself, if not in fact being the forerunner of it. This is particularly so for freshwaters, or is at least clearly demonstrable there. This is likely driven by the long experience that people need to be considered as integral to effective conservation, but probably more so by the recognition that effective management of freshwater ecosystems, balancing both conservation and sustainable use, is essential to achieve sustainable human development. Not only is the latter a good thing, but also generally the most effective strategy to achieve effective "conservation".

1130. In relation to freshwater ecosystems, all these organizations consider their conservation as a priority. They also concur that the main threats to these ecosystems are the alteration of river flows due to dams, reservoirs and water abstraction, water pollution resulting mainly from agricultural run-off and industrial discharges, invasive alien species, land change caused by agriculture and urbanization, over-harvesting of freshwater species and climate change. They also generally and broadly agree that the best strategy to tackle the various threats to freshwater ecosystems is the application of the ecosystem approach, which in the case of water resources is articulated more often as "Integrated Water Resource Management" (IWRM)[68]. However, the approach, methods and tools used to apply this strategy vary among them.

1131. In general, many projects conducted by WWF in IWRM focus on establishing a water management authority (in the form of water users’ associations or integrated river basin councils, etc.) with representatives of relevant stakeholders groups. Such institutions are responsible to design consensual solutions for water management within a basin. IUCN, although also encompassing institutional reforms, has given notable attention to environmental flow assessments as a preliminary step for the design of an integrated river management plan for a basin. TNC’s work is also centered on environmental flow assessments, but with emphasis on dam and reservoir operations. In the case of WI, the formulation of conservation plans that follow an integrated water management approach has been the target of their efforts, with special attention to the design of measures that reduce poverty of local communities. These subjects are of course inter-related; for example institution building and/or environmental flows can both be mechanisms to address an over-arching objective of poverty reduction.

1132. Through the implementation of IWRM projects, WWF, IUCN, TNC and WI are successfully influencing water policy and strengthening water governance at different levels. Positive results have been more notable in projects where governmental institutions had an active participation and where the decision for integrated water management was a result of political will. Through their IWRM projects,

68 This term is used by IUCN, TNC and WI. CI uses Integrated Resource Planning, while WWF uses Integrated River Basin Management (IRBM). The concepts behind these terms are mainly the same. Thus, for this report, the Integrated Water Resource Management term is used.

these NGOs are also acting towards climate change adaptation. One aspect that requires more attention, however, is considering the impact of climate change on river flows, especially when conducting environmental flow assessments that are the base for developing IWRM plans. TNC and WWF are starting to take this into account more explicitly in their IWRM projects by including climate change vulnerability assessments. Yet, this practice needs to be further applied.

1133. Conservation International has a particular approach to deal with the impacts of climate change on freshwater ecosystems. Based on the strong relationships among climate change, forest and freshwater ecosystem services, this NGO is implementing water funds and carbon forest projects worldwide. These projects are based on payment for ecosystem services and carbon markets mechanisms, with conservation agreements as the main tool. Similar projects are being also implemented by The Nature Conservancy, which is leading the creation of an innovative water-related certification programme that is expected to have major impacts on the protection of water and freshwater ecosystems. WI is also taking advantage of carbon mechanisms to implement a Global Peatland Fund to support projects that protect peatlands and avoid the emission of large quantities of carbon dioxide from these wetlands.

1134. Finally, it is important to mention that while IWRM, water funds, conservation agreements and carbon forest projects are some of the main strategies that NGOs are using to conserve freshwater ecosystems and address climate change and poverty alleviation, their activities on other areas (e.g. establishment of protected areas and biodiversity corridors, promotion of sustainable agricultural practices, restoration activities, conservation of threatened species, strengthen of traditional knowledge and policy influence) also support efforts to conserve freshwater ecosystems and increase their resilience to climate change.

C. Individual NGO activities in more detail

1. Conservation International (CI)

1135. Conservation International’s mission is “*to conserve global biodiversity and demonstrate that human societies can live in harmony with nature”*. Its work is based on three guiding principles: cutting-edge science, comprehensive partnerships and concern for human well-being. These delineate CI’s three-fold strategy: dedication to innovation, raising awareness of conservation and maintenance of business-like effectiveness. CI's work is mainly conducted in the biodiversity hotspots.

1136. CI activities are supported by the work of three research centers, the Center for Applied Biodiversity Science (CABS), the Center for Conservation and Government (CCG) and the Center for Environmental Leadership in Business (CELB). CABS projects provide the scientific basis for CI’s conservation strategies and help building local capacity for conservation. Through the CCG, Conservation International supports governments’ efforts for developing policies that consider the conservation of biodiversity, while CELB help companies achieve greener business practices.

1137. Currently, Conservation International has four main programmes: the Conservation Leadership Programme (CLP) that promotes the development of conservation leaders; the Marine Programme that unifies international marine stakeholders through knowledge sharing and information exchange; the Population, Health and Environment Programme that seeks to reduce human impact on areas with high biodiversity; and the Sea Turtle Flagship Programme, which provides critical support to the World Conservation Union Species Survival Commission Marine Turtle Specialist Group.

Areas of Work

1138. Conservation International activities mainly cover eight thematic areas: forest, species, communities, oceans, eco-tourism, land use, freshwater and climate change. The first five are briefly describe next, with a detail description of the last two in the following sections.

1139. Conservation International is working to reforest and conserve forest worldwide through the implementation of forest carbon projects. These integrate forest conservation, reforestation, forest restoration and agro-forestry measures at the regional or national level to reduce atmospheric carbon and benefit both human welfare and biological diversity. Currently, thirteen forest carbon projects are underway in Madagascar, China, Ecuador, Philippines, Liberia, Guatemala, Brazil, Peru, Mexico, Colombia and Indonesia (see case study section). These projects are described in the document *Linking Forests, Climate Change and Biodiversity*, available at http://www.conservation.org/Documents/Forest%20Carbon%20Projects.pdf .

1140. One of CI's priorities is to end species extinctions. CI conducts assessments of endangered species to understand their conservation status. Based on this information, CI proposes actions to reverse population declines. Currently, CI is carrying out assessments for marine species including sharks, rays and reef corals as well as terrestrial mammals. CI is also supporting the creation of protected areas as a complementary approach to stop species extinction and it is a partner of the Alliance for Zero Extinction (http://www.zeroextinction.org). CI has also started the *Stop the Clock* campaign to collect signatures that will be presented to policymakers to demand an end to species extinction.

1141. Through its Indigenous and Traditional Peoples Programme (ITPP), CI works directly with indigenous and traditional peoples and supports their efforts to gain legal designation and management authority over ancestral lands and their resources. Communities' capacity to manage those areas is also enhanced by CI's projects within this programme. The main tool that CI uses to promote conservation actions from local communities is "conservation incentive agreements". These are signed between local communities or private owners, who commit to conserve key areas or species, and conservation organizations or governments, who commit to provide concrete and periodic benefits in exchange (see Alto Mayo Case Study).

1142. CI is working with various partners to understand where species and marine ecosystems are most threatened and what actions can be implemented to reverse them. The Global Marine Partnership Fund is part of CI's Conservation Funding Division and exclusively supports conservations actions on marine habitats. Through this fund conservation projects have been completed in Madagascar, the Galapagos Islands, Indonesia and Colombia.

Freshwater ecosystems

1143. Conservation International's actions on freshwater ecosystems are conducted through its Ecosystem Services and Freshwater Initiative available on-line at http://www.conservation.org/Documents/CI_Freshwater_and_Ecosystem_Services.pdf. This initiative was launched in 2007 and will be effective until 2011. Its main objective is to address the threats to freshwater ecosystem services. The key strategy to accomplish this goal is working in partnership with a wide variety of stakeholders including research institutions, national and international non-governmental organizations (including development and humanitarian organizations), governments, corporations and local organizations, among others.

1144. The activities of the Ecosystem Services and Freshwater Initiative are organized in three areas:

- Development of a scientific base for understanding ecosystem services, identifying threats and determining priority areas;
- Promotion of innovative policies that support human development and the conservation of freshwater and ecosystem services; and
- Implementation of field programmes to test new approaches on the ground.

Scientific research

1145. In this area, CI is conducting a Global Freshwater Biodiversity Assessment along with the International Union for Conservation of Nature (IUCN). This assessment will determine global freshwater hotspots based on the IUCN Red-Listing process. In parallel, a sub-set of areas that offer immediate opportunities to conserve freshwater biodiversity are being identified. CI is also collaborating with local partners to establish three regional freshwater research centers in Mexico and Central America, South-east Asia and China.

1146. CI and its partners have developed two tools to support science-based decision-making in conservation, land-use planning and the value of ecosystems. The first one is the interactive database Consvalmap (www.consvalmap.org) that holds information about ecosystem services, valuation methods and case studies. The second one is the ARIES (Artificial Intelligence for Ecosystem Services) database that contains multiple data layers (e.g. vegetation, water flows, land tenure, land value and population) and probabilistic decision models. These can be adjusted according to the user's specific needs. CI is currently testing ARIES in Madagascar, the Australian wet tropics and Mexico.

Policy promotion

1147. CI is promoting different policy tools to manage the threats to freshwater ecosystems. To maximize water and electricity services required for human livelihoods and minimize the impacts of hydropower dams on freshwater ecosystems, CI supports the application of an ***Integrated Resource Planning*** approach. Water efficiency use, particularly important in the agriculture sector, and other policy and economic mechanisms developed and promoted by CI are carbon markets, payment for freshwater ecosystems services programmes and conservation incentive agreements.

Field Projects

1148. CI and partners are implementing pilot projects in different regions to test the viability of the proposed strategies for conservation of freshwater ecosystems and their services. These projects integrate science and natural resource management to inform policy and land-use decisions regarding dam, agricultural and tourism development, as well as watershed management. Descriptions for some of these field projects are included in the case study section of this report.

Climate change

1149. The approach that CI is using to tackle the impacts of climate change on biodiversity and freshwater ecosystems is the conservation nature. This means that all CI's conservation projects, directly or indirectly, are oriented to climate change mitigation and adaptation. Nevertheless, CI has designed a climate change business plan title *Harnessing Nature as a Solution to Climate Change* (http://www.conservation.org/Documents/CI_climateChange_bizPlan.pdf) that proposes CI actions on climate change for the period 2008 - 2010. These are organized in four areas: science and knowledge, field experience, framework of policy and markets and communications.

1150. In the application of its climate change business plan, CI is already developing cutting-edge scientific research and implementing forest carbon projects in various countries. Through these projects, CI and its partners expect to reduce greenhouse gas emissions by 1 to 2 billion tons per year. This represents 3 to 5 percent of the entire global reduction of emissions needed by 2030.

1151. Conservation International is also working with government officials to develop new policy frameworks that combine innovations in energy efficiency with financial incentives to preserve forests. This is the case of the Forest Partner Programme in Ecuador or the Liberia's Protected Area Strategy (see case study section). In these projects, countries' strategies for mitigating and adapting to climate change are based on afforestation/reforestation and Reducing Emissions for Deforestation and Forest Degradation (REDD) mechanisms.

1152. CI has also started a communication campaign to raise public awareness worldwide about the need to harness nature to address climate change and to spur behavioral changes within key audiences, including global opinion leaders and other influential constituencies, policy makers and business leaders.

2. The International Union for Conservation of Nature (IUCN)

1153. IUCN is a membership organization with the mission "to influence, encourage and assist societies to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable." It is composed by more than 1,000 governments and NGO member organizations and around 10,000 individual scientists and experts.

1154. The work conducted by IUCN is framed by a global programme, developed with and approved by IUCN members every four years. The current global programme was approved in the IUCN World Conservation Congress in 2008 and it will run from 2009 to 2012. The conservation of biodiversity is at the core of this programme, which proposes actions in four priority areas: climate change, energy policy, livelihood improvement and a green economy. The IUCN Programme 2009-2012 is available at http://cmsdata.iucn.org/downloads/iucn_programmeme_2009_2012_dfc.pdf.

1155. The IUCN global programme is coordinated by the IUCN Secretariat and delivered in partnership with IUCN member organizations and six Commissions[69] through individual ecosystem or theme-based programmes. These cover thirteen areas: business and biodiversity, economics, ecosystems management, environmental law, forest, gender, global policy, learning and leadership, marine ecosystems, protected areas, social policy, species conservation and freshwater ecosystems. There are also special initiatives that coordinate work across these programmes. They are focused on the following specific issues: climate change, energy, ecosystems and livelihoods, mangrove ecosystems, conservation for poverty reduction and sustainability.

1156. IUCN's Programme strategy is based on the assumption that when knowledge is available and people and institutions are empowered to use it, they can often participate more effectively in decision-making to improve laws, policies, instruments and institutions. For this reason, IUCN is involved in developing new methods and tools for biodiversity conservation. This scientific knowledge along with that of local and indigenous people is used to empower individuals and institutions to plan, manage, conserve and use natural resources in a sustainable and equitable manner. By doing so, the capacity for governance increases at all levels (local, national, regional and global), which in turn leads to a better management of ecosystems services.

[69] IUCN Commissions are networks of volunteer scientist and experts that are sources of guidance on conservation knowledge, policy and technical advice. There are currently six commissions: ecosystem management, education and communication, environmental economic and social policy, environmental law, protected areas and species survival.

Main areas of work

1157. A brief description of some of the IUCN theme-based programmes related to freshwater ecosystems management follows. The IUCN Water Programme and the Climate Change Initiative are described in detail.

1158. The Business and Biodiversity programme seeks to engage businesses in the pursuit of biodiversity conservation. This is done following different strategies, which include increasing companies' awareness on conservation issues, encouraging and supporting businesses to develop and follow good practices in biodiversity management, and helping them finding solutions to avoid or effectively manage biodiversity risks associated with their operations.

1159. Four groups of business have priority for this programme: large' footprint industries (mining, oil and gas, construction, automotive and energy suppliers), biodiversity dependant industries (hunting, wildlife trade, fishing, agriculture and forestry), financial services (banking, insurance investment and other financial intermediaries) and "Green" enterprises (organic farming, low-impact logging, renewable energy, nature-based tourism, ethical traders). To engage these industries on biodiversity conservation efforts, IUCN follows the strategy proposed on the *2009 Operation Guidelines for the Private Sector Engagement*. Currently, IUCN has signed partnerships agreements with four major industrial groups, Holcin, Shell, ICMM and Rio Tinto. In addition, IUCN has established a partnership with the World Business Council for Sustainable Development (WBCSD) to mainstream biodiversity in business operations.

1160. Through its economics programme, IUCN supports efforts to integrate economic perspectives and methods into nature conservation. Work is completed in three main areas: environmental valuation, development of positive economic incentives for nature conservation, and removing or reforming of "perverse" incentives that cause loss of biodiversity. Current projects in this programme focus on economic valuation of ecosystem conservation, developing of international payments for ecosystems services and making Reducing Emissions from Deforestation and Degradation (REED) mechanisms work for the poor.

1161. The Ecosystem Management programme aims to promote the wider application of the Ecosystem Approach, which is a "*strategy for the integrated management of land, water and living resources that places human needs at its center"*. Activities of this programme are implemented in four areas: drylands, disaster risk reduction, climate change and islands. Work in the latter is completed through the IUCN Climate Change and Islands Initiatives respectively. This programme also provides technical input on integrating wider ecosystem-scale biodiversity issues into IUCN's programmes globally, regionally and nationally.

1162. The Environmental Law programme integrates various activities that aim to assists decision makers with information, legal analysis, advisory services, legislative drafting, mentoring and capacity building at national, regional and global levels. The IUCN Commission on Environmental Law (CEL), the Environmental Law Center (ELC) and IUCN lawyers in regional and country offices implement this programme worldwide.

1163. The activities of the IUCN's Forest Programme are conducted in six thematic areas: forest law and governance, forest landscape restoration, forest and poverty reduction, forest and climate change, forest resources and markets, and securing rights to forest resources. The projects *Strengthening Voices for Better Choices (SVBC)* and *Livelihoods and Landscapes* are the main ones in the area of forest governance. The work conducted on forest landscape restoration (FLR) is part of the Livelihoods and

Landscape Programme, and one of its main outcomes has been the completion of National FLR workshops in 10 countries. The focus of the forest and poverty reduction initiative is on non-timber forest products. Projects in this area are being conducted in South and Southeast Asia, Latin America and Africa.

1164. The work conducted as part of Marine Ecosystems programme is organized in eight broad themes: climate change mitigation and adaptation, conservation of threatened species, energy and industry, fisheries and aquaculture, managing marine invasive species, marine protected areas, ocean governance, and securing coastal governance. The activities conducted in these thematic areas are cross-cutting and the projects developed under this programme may feature more than one theme's focus of work.

1165. The main objective of the Species Programme is to produce, maintain and manage the IUCN Red List of Threatened Species. This goal is accomplished through various activities, among which conducting freshwater biodiversity assessments is included. These are carried on by the Freshwater Biodiversity Unit whose work aims to determine priority conservation actions for freshwater biodiversity conservation and management. This unit has recently conducted a Pan African Freshwater Biodiversity Assessment, an Eastern Himalayas Freshwater Assessment and a Global Freshwater Crab Assessment, among other activities.

Freshwater ecosystems

1166. IUCN's work on freshwater ecosystems is conducted through its Water Programme, which was established in 1985. This programme aims for healthy river basins that provide ecosystem services to sustain people and nature. The activities of this programme cover the areas of integrated water resource management, environmental flows, water economics, watershed ecosystems, river bank rehabilitation and the effects of climate change on global water supply and distribution.

1167. The main strategy of this programme is to make local communities, research organizations, expert networks, governments and non-governmental organizations work together to find sustainable solutions for water management. These can be applied by water resource managers and support the development of policies agreements and practices that allow healthy freshwater ecosystems to continue providing services needed for human well-being.

1168. The Water Programme has currently three initiatives: the Water and Nature Initiative (WANI), Waters for Schools and Environmental Flows.

1169. The IUCN Water & Nature Initiative (http://www.iucn.org/about/work/programmes/water/wp_our_work/wp_our_work_initiatives/wp_our_work_wani/) was established with the objective to develop and demonstrate practical approaches to the implementation of **Integrated Water Resources Management** (IWRM). From 2001 to 2008, the WANI Initiative implemented IWRM projects in 12 river and lake basins: Huong, Mekong, El Impossible-Barra de Santiago, Guayllabamba, Tacana, Komadugu-Yobe, Lake Tanganyika, Pangani, Senegal, Okavango, Volta and Limpopo. In these projects, IUCN established partnerships with local communities, IUCN members, civil society and governments to promote changes in water resources management. These projects have promoted the conservation of ecosystems services, water security, poverty reduction, governance reform, new financing for basin restoration and transboundary cooperation.

1170. As part of the WANI, a toolkit series was also prepared in the areas of water management, governance and economic tools. Each series contains case studies that demonstrate how mainstreaming ecosystem services strengthen the outcomes from IWRM. These series have been used in training courses for water professionals and in river basin projects developed by other non-governmental organizations. They are available online at http://www.iucn.org/resources/publications.

1171. The second phase of the WANI started in 2009 and will run until 2012. The goal of the initiative remains to be "*mainstreaming of ecosystem services into water management, planning and policies, to support sustainable use of water resources for poverty reduction, economic growth and protection of the environment.*" The projects included in this phase will build on the results obtained on the previous one. The objective is to scale-up the implementation of IWRM from demonstration projects to country-wide initiatives. The WANI second phase is described in the document *Water for Live* available at http://cmsdata.iucn.org/downloads/wani_brochure_en.pdf.

1172. The objective of the Water for Schools campaign (http://www.iucn.org/about/work/programmes/water/wp_our_work/wp_our_work_initiatives/wp_our_work_wfs/) is to provide schools with safe drinking water and include basic water and hygiene education concepts in schools' curricula. This initiative is currently working in schools located in Ecuador, Guatemala, Burkina Faso, Tanzania, Lesotho and Lao PDR. More information about this initiative can be found at www.waterforschools.net.

1173. The Global Environmental Flows Network (EFLOWNET) is virtual network was established to disseminate the eFlow concept among river basins' managers, policy makers, NGOs, governmental and international agencies and to a wider public. The eFlow concept refers to "the water provided within a river or wetland to maintain ecosystems and the benefits they provide for people." The eFlowNet operates through its interactive website www.eflownet.org.

Climate change

1174. IUCN's actions on climate change are coordinated across IUCN's thematic and regional programmes, Commissions and member organizations through its Climate Change Initiative, which puts biodiversity at the centre of climate change solutions. Current actions of this initiative are focusing on climate change impacts on biodiversity, adaptation and mitigation. To address the impacts of climate change on biodiversity, IUCN is developing a tool to assess the vulnerability of species to climate change impacts, promoting large-scale connectivity of protected areas and facilitating a Climate Change and Coral Reefs and Marine Working Group (CCCR).

1175. In relation to adaptation, IUCN is working to enhance ecosystem-based climate change adaptation strategies worldwide. The integrated water resource management projects, included under IUCN WANI, are part of IUCN ecosystem-based adaptation response to climate change. Other activities completed by IUCN to support adaptation to climate change include the development of the Community-Based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL), the Mangroves for the Future Initiative and the Ecosystems and Livelihoods Adaptation Network (ELAN), among others.

1176. To support climate change mitigation, IUCN is implementing "Reducing Emissions from Deforestation and Degradation" (REDD) pilot projects in 5 countries through its Forest Programme. The impacts of ocean fertilization as a potential mitigation option are also being assessed through IUCN's Marine Programme. IUCN is also working in partnership with the Swedish International Development Agency (SIDA) and E.ON (an energy company) in a project that aims to minimize the impacts of offshore and marine-based renewable energy sites. This project is also part of its Marine Programme.

4. The Nature Conservancy (TNC)

1177. The Nature Conservancy (TNC) is currently working in all 50 US States and in more than 30 countries worldwide, with the mission to "*preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive*". TNC work is based on a scientific approach that is non-confrontational and offers pragmatic, science-based solutions to conservation challenges.

1178. *Conservation by Design* is TNC scientific framework. It supports TNC decisions on where to work, what to conserve, what strategies to use and how effective they are. This framework has two main elements: a science-based approach and a set of analytical methods. The approach consists of four basic concepts that follow an adaptive management framework: setting goals and priorities, developing strategies, taking action and measuring results. This approach is applied at multiple scales using three analytical methods: global habitat assessments, eco-regional assessments and conservation action planning. The first two methods allow TNC to take a global view of the threats to biodiversity such as climate change, habitat fragmentation and invasive species. With this information, conservation projects are planned at a local scale.

1179. Partnering with communities, businesses, government agencies, multilateral institutions, individuals and other non-profit organizations is one of TNC greatest strengths. This strategy helps TNC to expand its work at different levels and regions, and design realistic conservation solutions. It also allows integrating policy, funding and training into its activities.

1180. The Conservation by Design framework has been used by TNC in the last 10 years and is fast becoming a standard guiding for other conservation projects around the world. A detailed description of how TNC applies the Conservation by Design framework can be found in the following website link: http://www.nature.org/aboutus/howwework/about/conservation.html.

Main areas of work

1181. The Nature Conservancy (TNC) has conservation initiatives for Lakes and Rivers, Marine, Climate Change and Protected Areas. A brief description of these initiatives is provided below, with the latter two described in more detail.

1182. TNC is working to control deforestation through a conservation approach that integrates compatible economic development with responsible forest management practices. Specific activities to conserve forest include combating illegal logging, advancing sustainable forest trade, securing innovative conservation finance, protecting, restoring and managing forest and advocating supportive public policies.

1183. TNC is currently working to create new protected areas, in particular ones that include marine and freshwater ecosystems, which are under-represented in the protected areas system worldwide. Special attention is being given to increase the economic and human resources allocated to the management of protected areas, and to support governments' efforts for their design and management.

1184. TNC's work to conserve marine ecosystems is channelized through is Global Marine Initiative. Conservation strategies proposed within this initiative include building resilience of protected areas, applying market-based strategies, protecting and restoring oceans and coast and setting priorities with science.

1185. TNC is addressing fire-related threats to both biodiversity and people through an Integrated Fire Management framework, which aims to maintain fire's role where it benefits people and nature, and keep fire out of places where it is destructive. TNC is also conducting scientific assessments to understand the causes and consequences of altered fire behavior, developing site-based solutions to maintain and restore habitats that require fire to exist, and advancing laws and policies that conserve fire's natural role.

1186. Invasive species are appearing around the world at an unprecedented rate and scale. The most effective strategies to control invasive species are prevention and early detection. TNC efforts are focusing on these activities. TNC is also working with various partners to find science based solutions to manage invasions and restore habitats. It is also encouraging better business practices and promoting stronger public policies.

Freshwater ecosystems

1187. TNC has been designing and implementing various responses to protect freshwater ecosystems worldwide. These include establishing environmental flows in rivers and lakes with dams, creating tools to design environmental flows, establishing water funds to pay for watershed protection and reforestation, promoting sustainable agricultural practices, protecting coastal rivers and estuaries, guarding freshwater ecosystems from invasive species, advancing water policies and water certification.

1188. Dams have been constructed in rivers worldwide to supply energy, drinking water, grow food and control floods. This has caused serious ecological damage to many rivers and their aquatic life. TNC is working with partners and stakeholders to minimize these negative effects through the implementation of environmental flows, a concept that refers to "*the quality, quantity and timing of water flows required to sustain healthy freshwater ecosystems and the benefits they provide to human communities*". TNC is also working to integrate freshwater conservation with hydropower development planning at the river basin scale in order to design options which maximize ecological health as well as hydropower development.

1189. The Sustainable Rivers Project (SRP) is TNC largest effort to implement environmental flows. This project was launched in 2002 in collaboration with the Army Corps of Engineers, the main water manager and hydropower producer in the United States. The SRP currently involves nine rivers, the West in Vermont, the Ashuelot in New Hampshire, the Roanoke in North Carolina and Virginia, the Savannah in Georgia and South Carolina (see case studies), the Big Cypress in Texas and Louisiana, the White, Black, and Little Red Rivers in Arkansas and Missouri, the Green in Kentucky (see case studies), the Bill Williams in Arizona, and the Willamette in Oregon.

1190. Today, Green River is the SRP's most advance site. The plan to change dam operations to restore a more natural pattern of river flow has become permanent and positive ecological responses have already been reported (see case studies). The work on the Savannah River (see case studies) has evolved into a model for sustainable dam operations and management worldwide. The methodology used to create the environmental flow prescription for this river is now widely applied by TNC in the United States and other countries such as China and Honduras. In the former, TNC is finalizing a Memorandum of Understanding (MoU) with the Changjian Water Resources Commission (CWRC) to include the environmental flows concept into the design of new dams in the Upper Yangtze. In the latter, TNC conducted an environmental flow assessment to guide decisions about a proposed hydroelectric project in the Patuca River. The environmental flows methodology was adapted to incorporate the concerns of indigenous communities (see case studies).

1191. TNC has developed environmental flows tools and methodologies for application at local or regional scale. The main ones include two frameworks (Ecological Limits of Hydrological Alteration [ELOHA] and Ecological Sustainable Water Management [ESWM]) and two software programmes (Indicators for Hydrologic Alteration [IHA] and Regime Prescription Tool [HEC-RPT]). The frameworks support assessment of environmental flow needs across large regions, while software programmes help to develop environmental flow recommendations.

1192. ESWM is TNC's integrated water resource management framework. It consists of six steps designed to help water managers identify incompatibilities among various human and ecosystem needs for water and resolve those incompatibilities through collaboration. First, ecosystems flow requirements are estimated (step 1) along with the influence of human activities (step 2). With these results incompatibilities between water users and ecosystems needs are identified (step 3) and solutions proposed by all stakeholders (step 4). These solutions and then tested (step 5) and if they work well implemented following an adaptive management approach (step 6). A completed description of the Ecological Sustainable Water Management framework can be found at: http://www.nature.org/initiatives/freshwater/files/hydro_review_july_2005.pdf

1193. TNC staff provides training for these tools on a regular basis. In addition, TNC is working to make training available on-line. The offerings are posted at www.nature.org/freshwater.

1194. Water funds are mechanisms for the payment of ecosystem services. Water users pay into the funds in exchange of fresh clean water. The funds are used to pay for watershed protection and reforestation along rivers, streams and lakes so that drinking water provision is ensured. Over the past ten years, The Nature Conservancy has helped launch water funds in Latin America. To date, successful water funds have been established in the cities of Bogota (see case study), Cuenca, Quito, the Rio de Janeiro State and the municipality of Extrema (see case study). This year, two new water funds will be launched in Lima (Peru) and Zamora (Ecuador).

1195. Irrigated agriculture requires great amount of water. In addition, pesticides, fertilizers and animal waste from agriculture and farming activities are washed into rivers constantly. TNC is addressing these threats to freshwater ecosystems by working with agricultural companies, government agencies and groups to disseminate sustainable farming practices. It is also collaborating with regional irrigation institutions to find solutions for providing water for farms while protecting rivers. One central approach that TNC is using to attain a more sustainable irrigation is the concept of more "crop per drop" or water efficient farming.

1196. Freshwater ecosystems are under-represented in the world's protected areas system. TNC has developed various methods and tools to improve protected areas designation, design and management. These efforts include adaptation of the HydroSHEDS database to conduct gap assessments, development of systematic conservation planning approaches and assessment tools for effective protected areas management (PAME). A full description of the methods and tools proposed by TNC and partners can be found at the following web links: www.protectedareatools.org and http://conserveonline.org/workspaces/cbdgateway/era/index_html.

1197. TNC work on aquatic invasive species is focused on preventing invasions before they occur. Special attention is given to identifying and closing the pathways through which invasions occur without impeding trade or traveling. In areas where invasive species have already established, managing plans are developed to restore freshwater habitats. This is the case of the Tamarisk Control Project in the San Miguel River, which successfully eradicated tamarisk from 120 miles of the river (see case study).

1198. Certification programmes can provide a powerful tool for improving practices for the benefit of nature. Currently, TNC is supporting a water-related sustainability certification programme to encourage and recognize progressive water suppliers and users that are conducting their operations in a way that is environmentally sustainable and socially responsible. TNC has helped launched the Alliance for Water Stewardship in 2008 to facilitate stakeholders participation on the programme's development. Some key partners are already part of this alliance and initial workshops have taken place to develop the programme (see case study).

Climate change

1199. TNC efforts on climate change are focused on reducing emissions from deforestation, making people and natural areas more resilient to climate change impacts by protecting ecosystems so they can continue to support biodiversity and deliver the services people depend on, and supporting policies to reduce emissions. Currently, TNC is managing nine climate action projects that are expected to reduce more than a million tons of carbon dioxide emissions in the coming years through protection of forested areas and reforestation. These projects are located in the United States, Belize, Bolivia, Brazil, China and Indonesia, and range in size from 200 to 607 000 hectares. Governments and business looking to offset their carbon emissions can buy carbon credits from these projects (see Garcia River Forest Project case study).

1200. Climate change issues are not only considered within the TNC climate change initiative. Other TNC initiatives take into account climate change in the solutions and activities proposed. For example, environmental flow projects are now considering the effects of climate change on freshwater ecosystems to design flow prescriptions for rivers with constructed dams (see Evaluating Reservoir Operations and the Impacts of Climate Change in the Connecticut River Basin case study). TNC strategies on floodplain conservation and restoration, as well as water funds, are emphasizing ecosystem-based approaches to help people and nature adapt to climate change using natural infrastructure.

5. Wetlands International (WI)

1201. Wetlands International's mission is "to sustain and restore wetlands, their resources and biodiversity for future generations". To achieve this goal, WI's work aims to maintain stakeholders and decision-makers well-informed about the status and trends of wetlands, their biodiversity and priority actions; to integrate the functions and values of wetlands into sustainable development; and to apply integrated water resource management and coastal zone management in wetland conservation actions. The work of WI is conducted at all levels, from on-the ground projects to global conventions, and from community activities to scientific research. These activities are conducted through partnerships with a wide range of organizations and are based on sound science.

Main areas of work

1202. Wetland International's work covers the following areas: protecting wetlands biodiversity, improving people's livelihoods, increasing resilience of vulnerable coast, mitigation of and adaptation to climate change, and improving water management.

Wetlands and livelihoods

1203. WI projects in this area aim to demonstrate that by conserving wetlands' biodiversity it is possible to reduce poverty. Currently, three main initiatives are conducted within this area of work: the Wetland and Poverty Reduction Project (WPRP), the Green Coast Project (GCP) and the Central Kalimantan Peatlands Project (CKPP). The last two are also part of the WI's work on coastal management and climate change, respectively.

1204. The main goal of the WPRP is policy change at international, national and local levels. To achieve this goal, WI is partner with non-governmental organizations, governments, research institutes, and conducting capacity building activities on wetland management and policy. WI is also implementing four demonstration projects in Africa and South-east Asia to show how sustainable wetland management contributes to reduce poverty.

Coastal management

1205. The main project in this area of work is the Green Coast Project, which is a partnership initiative led and managed by WI. The most important characteristic of this project is the application of a community-based approach for restoration of wetlands. More than 1100 hectares of mangrove and coastal forests, 2.5 km of sand dune and 100 hectare of damaged coral reef and sea grass beds have been restored and protected through this project. In addition, 12,000 people have benefit from increased income from livelihood activities supported by the project such as fishing, small scale aquaculture, eco-enterprises, home gardening and livestock. A second phase of the project is currently under implementation in Aceh, Thailand and West Africa.

Water Management

1206. Wetland International is implementing an integrated water resource management approach in its work on wetland management. This mainly involves working in close coordination with local communities, development authorities, governments and other organizations to manage and restore wetlands, as well as facilitating training, demonstration and conducting capacity building activities.

1207. In this area of work, WI has started a new programme on wetlands, water and sanitation in partnership with WASTE, advisors on urban environment and development. This programme aims to integrated wetland ecosystem health into planning and implementation of sanitation and water supply provision. Actions in this programme target areas where abstraction of water supply and/or disposal of waste rely on wetlands ecosystems services or impacts upon wetlands. As the project progresses, collaboration between a wider group of people and organizations active in water supply, sanitation and wetland conservation is expected. Wetlands International is working on a partnership of local and international conservation and WatSan organizations to achieve this.

Wetlands and climate change

1208. Wetlands International is conducting several activities to raise awareness about the strong linkage between climate change and peatlands, including the elaboration of reports and outreach material on peatlands emissions to influence climate change policy, and the implementation of projects to reforest and/or restore peatlands. These include the Central Kalimantan Peatland Project (CKPP) and the Sumatran Peatswamps Project in Indonesia.

1209. In addition, WI is structuring a Global Peatland Fund to support projects that are able to avoid large quantities of carbon dioxide emissions by protecting and restoring peatlands and promoting sustainable development. These projects will guarantee Voluntary Emissions Reductions and emissions removals (VER's). Actions conducted in these projects will include re-flooding previously drained peat forests and deforested peatlands by building dams in the drainage canals, reforesting deforested peatlands using native species, protecting peat forests from deforestation, and elaborating fire management plans to prevent and control peat fires. The Fund website is http://global.wetlands.org/Whatwedo/Wetlandsandclimatechange/TheGlobalPeatlandFund/tabid/1309/Default.aspx.

6. Word Wild Fund for Nature (WWF)

1210. The World Wild Fund for Nature was established with the mission to *"stop the degradation of the planet's natural environment, and build a future in which humans live in harmony with nature"*. To accomplish this mission, WWF uses the best available scientific information, seeks dialogue and builds partnerships with other organizations, governments business and local communities. With their partners, WWF develop and implement conservation solutions that combine field-based work, policy initiatives, capacity building and education work.

Main Areas of work

1211. Currently, WWF efforts are focused on 35 priority places, 36 priority species and 5 priority footprint areas: climate, carbon and energy, farming, fishing, forest and water.

1212. WWF is working on forest certification, trade reforms efforts and actions to combat illegal logging. The Forest Stewardship Council (FSC) is the certification system that WWF supports to ensure environmentally responsible, socially beneficial and economically viable management of forest. WWF has established the Global and Forest Trade Network (GFTN) to eliminate illegal logging and improve forest management and trade practices. This network brings together suppliers, producers and purchasers from across the forest industry supply chain and currently it has 319 partners.

1213. WWF efforts in fishing are related to reduce by-catch. WWF is working with fishers, fisheries managers, governments, fish buyers, sellers, processors and consumers to: identify and implement more selective fishing gear; implement and enforce management zoning for fisheries; create, implement, and enforce better fisheries policies; implement observers on fishing vessels to monitor by-catch and learn where, how and why by-catch is occurring; and inform and encourage fish buyers, processors, sellers, and consumers to purchase seafood from responsible fisheries. Currently, WWF has 70 by-catch projects in over 40 countries.

1214. WWF is working to promote a responsible agriculture through its Forest Conversion Initiative (FCI). This initiative aims to reduce the threats of palm oil, soy and other plantations on forests. As part of this initiative, WWF has initiated and establish round tables on sustainable palm oil (RSPO) and responsible soy (RTRS). It has also developed RSPO Principles and Criteria for better practices in production of palm oil globally, and arranged tree-planting initiatives with oil palm companies in Malaysia and Indonesia.

Freshwater ecosystems

1215. WWF activities on freshwater ecosystems are focused on facilitating Integrated River Basin Management (IRBM) processes in major river basins around the world, with an emphasis on bio-diverse and transboundary basins. In its Freshwater Eco-region Sourcebook (available at http://assets.panda.org/downloads/freshwater_sourcebook.pdf) WWF outlines a method for prioritizing actions needed to conserve biodiversity within each river basin.

1216. WWF considers that an IRBM framework provides the holistic approach needed to tackle the various threats to freshwater biodiversity. Such framework allows implementing various conservation tools and approaches simultaneously and brings multiple water users together to manage and conserve freshwater ecosystems in a sustainable and equitable manner. WWF has successfully implemented IRBM processes in 14 rivers worldwide (Danube, Eveglades, Ganges, Great Barrier Reef, Gwydir, Kafue Flats, Kinabatangan, La Cocha, Lake Chad, Loire, Prespa, Sao Joao, South Africa and Yangtze) and its currently conducting similar efforts on other rivers (see case studies section).

1217. This work is complemented by conservation actions in other areas. WWF is supporting the creation of protected areas to safeguard headwaters and wetlands, implementing forestry practices that are compatible with the protection of freshwater resources, fostering sustainable agricultural practices that use less water and is not so dependent on chemical pesticides and fertilizers, changing dam and reservoir operations to mimic natural flow regimes, and restoring heavily degraded ecosystems.

Climate, carbon and energy

1218. Three of WWF's Global Initiatives are focused on climate change: Global Climate Deal, Smart Energy and Forest and Carbon. The first one is related to the work WWF does with decision-makers in governments to shape policies that will help to mitigate and adapt to climate change. The second initiative is related to the promotion of new low and zero-carbon technologies, such as wind power, hydro power, solar power, biomass energy and geothermal energy. The Forest and Carbon initiative works to reduce deforestation and forest degradation, in particular in the Amazon Forest. WWF solutions for climate change are proposed in the document *Climate Solutions, WWF's Vision for 2050*, which is available at http://assets.panda.org/downloads/climatesolutionweb.pdf.

D. Case studies

1219. 50 cases studies (10 for each NGO) were gathered for this report. In the selection process, no restrictions on location or implementation status were made. In addition, the selection was not only limited to freshwater management issues (e.g. integrated river basin management or restoration). Case studies on climate change, forest management, policy-making, conservation of species or habitats and poverty alleviation were also considered. This was done to demonstrate that freshwater management can be positively or negatively affected by actions in other sectors and that water management involves working in different sectors.

1220. The information of these case studies was mainly obtained from the NGOs' websites. However, information was also requested via e-mail or through telephone conversations with the project managers. In most cases, positive feedback was obtained. The description of the case studies has nine sections: background information, proposed solution, implementation, challenges, partners, key principles, contact information and reference website(s). For each case study, some specific lessons learned are also proposed. However, together, these case studies also provide relevant general messages.

1221. The case studies are presented in Annex I to this section.

1. Main messages from the case studies

- Inland water ecosystems and their services are facing similar challenges worldwide. These are mainly caused by the uncoordinated actions of multiple water users, acting at various levels and with different water demands and needs. To attain the conservation of freshwater ecosystems and their services, an integrated water management response that recognize ecosystems' interconnectivity across time and space is needed.
- Integrated water management processes can be implemented using various approaches and tools. Therefore, they are applicable at different socio-political and economic contexts. They also require long-term financial and technical investment (*Integrated River Basin Management in the Sepik River*). One common element, however, is that all relevant stakeholders and interest groups from different levels of governance and economic sectors need to work together to find consensual solutions that correspond to their needs and demands. Effective communication among stakeholders

can be accomplished through dialogues (*Mekong River Dialogues Project* or the *Azraq Basin National Dialogue Project*) or forums (*Komadugu-Yobe Integrated Management Project* and *Pangani River Basin Management Project*).

- Governments are important stakeholders on integrated water management processes. With their support, integrated responses for freshwater management can be mainstreamed into policies ensuring their long-term implementation. A high level panel of experts can guide governments' decisions to this end (*Taking stock of Integrated River Basin Management in China*). Other tools can also be used such as Strategic Environmental Assessment (*Seeking Alternative Energy along the Mekong)* or capacity building activities *(Municipal Governance, Capacity and Social Responsibility in Wetland Biodiversity Conservation*).
- Integrated water management processes can create political will for such initiatives when it does not exist (*Komadugu-Yobe Integrated Management Project)* and support effective water governance at the municipal (*Tacana Watershed Project),* provincial, federal (among ministries, *Conservation and Sustainable Development of Vembanad-Kol Wetlands)* and regional (among countries, *Protection of Biodiversity of the Sava River Basin Floodplains*) levels.
- Local communities and indigenous people are relevant stakeholders of integrated water management processes because they directly use freshwater ecosystems and their services. Their participation in these processes is active when the outcomes are clearly and directly linked to the improvement of their livelihoods (*Volta River Water Governance Project, Central Kalimantan Peatlands Project, Wetland and livelihoods in the Sand River Catchment, Protecting the Mahavavy-Kinkony Wetlands Complex)*. This can be achieved by designing water management solutions based on local communities and indigenous people's knowledge and organizations (*Managing community resources in the Peruvian Amazon, Freshwater conservation in the Peruvian Amazon, Developing Community Based Mangrove Replanting and Monitoring in Sedili Kecil Mangroves*) and by understanding local communities needs *(Wetland and Poverty Reduction in Henshui Lake, Darwin Integrated Wetland Assessment).*
- Consensual stakeholders' decisions on integrated water management should be reflected in a common strategy such as a watershed plan (*Tacana Watershed Project)* or a river basin management plan (*Regional Strategy and Action Plan for wetlands wise use in the Moscow Region)*. The implementation of this strategy should be overseen by an institution formed by representatives from different stakeholders such as integrated river basin councils (*Sustainable Water Management as a Climate Change Adaptation Strategy),* river basin development authorities (*Komadugu-Yobe Integrated Management Project, Management Planning for Wular Lake*) or watershed councils *(Tacana Watershed Project).*
- Stakeholders' decisions should also be based on scientific information. Environmental flow assessments provide this type of information. They can be conducted with the support of software programmes (*Green River Case Study)* or based on researchers' recommendations (*Savannah River Case Study)* or local communities' knowledge *(Patuca River Case Study*). They can also be applied as independent processes (*Environmental Flow Assessment in the Huong Basin River)* with results that can later support the implementation of integrated water management responses (*The Pangani River Basin Management Project).*
- Restoration actions are recurrent integrated water management responses *(Zarqa River Restoration Project)*. These could include the removal of dams, when feasible (*Mill River Habitat Restoration Project*), the eradication of invasive species *(Tamarisk Control Project for the San Miguel River*) and reforestation and/or protection of forest in upper watersheds through conservation agreements. This last option is currently gained momentum due to the high interrelation among climate change, forests and freshwater ecosystem services. As a result, water funds and carbon forest projects are being implemented. These are based on payment for ecosystems services (PES) and carbon offset mechanisms.

- Water funds offer countries a way to conserve freshwater ecosystems, reduce poverty alleviation and mitigate climate change. Their creation can be promoted by federal *(Brazil's National Water Produce Programme)*, provincial (*Payment for Environmental Services in Espirito Santo State)* or municipal laws *(Brazil's National Water Produce Programme).* Water funds can also be voluntary (*Bogota Water Fund, Sierra de la Minas Biosphere Reserve Water Fund, Conservation Agreement in the Podocarpus National Park).*
- Governments can use carbon offset mechanisms to created protected areas (*Makira Forest Initiative, Sustainable Financing for Liberia's Protected Areas*), establish conservation corridors (*Chingaza-Sumapaz-Paramo de Guerrero Biodiversity Project)* or reforest degraded lands (*Choco-Manabi Corridor Reforestation Conservation Carbon Project*, *Alto Mayo Watershed Conservation Agreement, Forest Partners Programme*). These actions do not only promote the conservation of freshwater ecosystems and their services, but also reduce poverty in rural areas and mitigate climate change.
- Direct impacts of climate change on freshwater ecosystems can also be addressed by governments through integrated water management processes (*Freshwater conservation Programmeme in Brazil, Sustainable Water Management as a Climate Change Adaptation Strategy)*. Because these impacts are not yet fully understood, including vulnerability basin assessments in these processes can provide the knowledge needed to generate appropriate adaptation measures (*Monitoring the glaciers of the Himalayas*).

E. Conclusions

1222. The summary of the work conducted by Conservation International (CI), the International Union for Conservation of Nature (IUCN), The Nature Conservancy (TNC), Wetlands International (WI) and the World Wide Fund for Nature (WWF) demonstrates that there are various approaches available to conserve inland water ecosystems and the ecosystems services they provide. Among these, integrated water resource management (IWRM) processes stand out as the most relevant because they promote the creation of water management solutions designed by all water users and stakeholders. This is of utmost important because only by working together people have a better chance to overcome poverty, environmental degradation and social inequity.

1223. Governments play an important role in the implementation of IWRM processes. The case studies show that when governmental organizations are involved in IWRM projects, better water management solutions are obtained. In addition, the traditional sectoral approach for water management that has led, in many cases, to freshwater ecosystems' degradation is changed to one where coordinated actions are taken by water management agencies. Moreover, they act as facilitators of the decision taken by water users, giving them the power to manage their water resources.

1224. IWRM processes can also support governments' efforts to meet the Millennium Development Goals and targets; specifically the ones on combating hunger, providing access to drinking water and reduce poverty. This is because IWRM processes allow local communities to be at the centre of freshwater ecosystems management with proposed solutions designed according to their needs and water demands. When local communities are active actors on IWRM projects conservation of freshwater ecosystems can be guarantee on a long-term basis.

1225. But IWRM methods and processes are not the only tools available. Payment for ecosystems services and carbon market mechanisms are raising as powerful tools that governments can used not only to reduce poverty and secure freshwater availability, but also to promote adaptation and mitigation of climate change. Water funds and carbon forest projects have the potential to generate the financial support needed to sustainable finance countries' conservation efforts, in particular in those with needs in different fronts.

Annex I- case studies

Conservation international

Sierra de las Minas Biosphere Reserve Water Fund

CONSERVATION INTERNATIONAL

COUNTRY: Guatemala **START DATE:** Sep 2005 **STATUS:** Completed (Jun 2008) **ECOSYSTEM SERVICE(S):** Water provision

BACKGROUND INFORMATION

The Sierra de las Minas Biosphere is Guatemala's most important cloud forest reserve. It protects a mountainous region of tropical and coniferous forests home to endangered species such as the quetzal and the harpy eagle. A total of 63 watercourses originate on this reserve, including the Motagua and the Polochic Rivers, which empty into the Gulf of Honduras and Lake Izabal respectively. These rivers are the main source of water for local irrigation, small industries and household use for communities. Local water users noticed a fall in water quality and quantity, particularly during the dry season.

PROPOSED SOLUTION

Conservation International (CI) and Fundación Defensores de la Naturaleza (in collaboration with WWF and TNC) developed a project to protect the biological integrity of the reserve and its hydrological functions, particularly in terms of water delivery. This project included two main activities: the establishment of a water fund for the Motagua-Polochic watershed and the creation of watershed councils. The water fund proposes to receive user fees from watershed services (i.e., commercial and individual water consumers) and then channel these fee revenues to pay suppliers of watershed services (i.e., small farmers and landowners) for conserving the forests that help to maintain water flow and water quality. By creating watershed councils environmental governance will be strengthened.

IMPLEMENTATION

The Water Fund receives the support of water users who contributes with USD $60 000 (through a Payment for Ecosystem Services fee) and two private donors (ABASA and Agua Pura Salvavidas, bottled water companies) who contribute annually with USD $25 000 each. The compensation to farmers is in-kind (training and financial assistance to adopt best management practices). The Water Fund finances development projects for pollution reduction and watershed conservation. Until last year, six projects have been funded, including watershed management activities such as best management practices in coffee plantations, cleaning campaigns in different communities, construction of ecologic stoves, prevention of forest fires, etc.

Three watershed councils were created and legally validated at the municipal level: Achiotes, San Jeronimo and El Hato watersheds. Each council has developed a working plan and has started their implementation. The creation of the councils was possible thanks to the designation of a professional in charge of strengthening communities' relationships. The councils not only developed working plans to protect the watersheds, but also work as an ad-hoc space for dialogue between the different stakeholders in the watersheds. So far, Achiotes and San Jeronimo councils are implementing their working plans. Fundación Defensores de la Naturaleza is still looking for funds to implement El Hato working plan, and intends to create other councils or committees. The organization has been talking with leaders from Amates municipality, and with people from Mayuela watershed in Gualan, Zacapa.

CHALLENGES

The legal constitution of the Water Fund took longer than expected and that slowed down the activities of the project. Once the fund was established, another challenge was the lack of information and experience in the management of such a mechanism.

Some Lessons Learned

- Aligning local capacities with the process of decentralization of resources to the people is time consuming and represents a real challenge that should be taken into account in any planning process.
- Even when local actors know the local reality and needs, that doesn't mean that they would be able to take a step back and look at the bigger picture to determine what is the best strategy at the local level. In particular when the sponsors require them to meet certain conditions and standards. In this sense, it is of utmost importance to provide them with support and training, and to accompany them through the processes.
- Increasing local capacity for the development of small scale projects is also fundamental for the sustainability of the project in the long term.

Partners

- Fundación Defensores de la Naturaleza
- Local NGOs
- WWF
- Agua Pura Salvavidas (bottled water company)
- ABASA (bottled water company)

KEY PRINCIPLE(S)	*"Water funds are effective means for mobilizing amounts of additional funding for freshwater ecosystems' conservation from major water users such as national governmental organizations and private sector companies."*	
CONTACT INFORMATION	**John Watkin** Critical Ecosystem Partnership Fund (CEPF) E-mail: jwatkin@conservation.org	**Oscar Nunez** Fundación Defensores de la Naturaleza E-mail: onunez@defensores.org.gt
REFERENCE WEBSITE(S)	http://www.conservation.org/sites/gcf/Documents/rapid_review.pdf http://www.defensores.org.gt/index.php?option=com_wrapper&Itemid=49	

Conservation Agreement in the Podocarpus National Park

COUNTRY: Ecuador **START DATE:** Oct 2008 **STATUS:** Active **ECOSYSTEM SERVICE(S):** Provision of freshwater

BACKGROUND INFORMATION
The Podocarpus National Park in southern Ecuador expands over 360 000 acres that comprises cloud forests, high-altitude grasslands and a series of small Andean lakes. The Podocarpus National Park and its surrounding areas are important for conservation due to their high concentration of species, many of which are endemic. Heavy agricultural activity in the area, as well as infrastructure projects such as mining and road development, have impacted the biological diversity of the park and the freshwater it provides to more than one million people.

PROPOSED SOLUTION
To ensure the provision of water and water quality for the communities established around and within the Podocarpus National Park, Conservation International (CI) and the Arco Iris Foundation have developed a water fund project in the Limon watershed.

IMPLEMENTATION
This project aims to change unsustainable agricultural and farming practices in the watershed and promote its reforestation through the implementation of Water Fund. Fundación Arcoiris with support of CI is working in the design of this water fund, which will be initially applied to the Limon watershed. Ranchers living in the upper section of the watershed will receive a monetary compensation for the implementation of conservation actions in their properties. This compensation will come from payments of water users in the lower section of the watershed, in particular the cities of Loja and Zamora, and will be establish through conservation agreements.

Partners

- Municipality of Zamora
- Ecuadorian Ministry of Environment
- University Técnica de Loja
- Ecuadorian National Environmental Fund
- Arco Iris Foundation

KEY PRINCIPLE(S)	*"A conservation agreement is a voluntary and legal agreement between a landowner and a conservation organization that permanently limits uses of the land in order to protect its conservation values. These agreements can be part of a PES mechanism, such as water funds, and promote the conservation of freshwater ecosystems".*	
CONTACT INFORMATION	**Tanya Lozada** Steward Member E-mail: tlozada@conservation.org	**Patricia Zurita** Director of the Policy and Economics Programme of the Andes E-mail: pzurita@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/sites/gcf/Documents/rapid_review.pdf http://www.nature.org/wherewework/southamerica/ecuador/work/art5120.html	

Chingaza-Sumapaz-Paramo de Guerrero Biodiversity Corridor

COUNTRY: Colombia	**START DATE:** Apr 08	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Climate change mitigation, drinking water provision

BACKGROUND INFORMATION

There are three protected areas surrounding the Colombian capital of Bogotá – Sumapaz National Park, Chingaza National Park and a National Forest Reserve. These protected areas are crucial for the city's water supply and are important reservoirs of native biological diversity in the Andean and paramó ecosystems. Protecting this important watershed from agricultural encroachment is crucial to ensure both the long-term supply of Bogota's water and the rich biological diversity of the area.

PROPOSED SOLUTION

In 2008, the Bogota Water Facility Company (EAAB) and Conservation International (CI) signed an agreement to establish a biodiversity corridor that link the Sumapaz National Park, the Chingaza National Park and the area of the Guerrero Paramo.

IMPLEMENTATION

The project is currently in its inception phase, which will be completed in September 2009. During this time, the main objectives are to complete the design of the corridor, prepare a forestation project according to the clean development mechanism (CDM) and elaborate a Payment for Ecosystem Service (PES) mechanism for water provision. To date, a draft design for the corridor has been created using secondary information and results from biological assessments conducted at four sectors of the proposed corridor area.

The project has also been presented to municipalities (20), general public and private regional and local organizations established in the area proposed for the corridor. Feedback from these stakeholders has been positive and the municipalities have established working tables to actively participate in the project. Meetings with national authorities (4 Corporations, National Parks and the Environmental District Secretary) and the Cundinamarca government have also taken place. With the information gathered in these meetings, the sites with the greatest potential for the CDM forestry project have been identified. An initial proposal for restoration and silvicultural arrangements has been prepared as well.

CHALLENGES

It is expected that the project will faced two main challenges. First, reaching an agreement with authorities for an institutional arrangement that facilitates the establishment of the corridor, and second reducing the pressures that are currently affecting the Andean and paramo ecosystems.

Some Lessons Learned	**Partner(s)**
• In the first phase of a biodiversity corridor project it is important to develop a communications strategy aimed at positioning the initiative and provide timely information to stakeholders. This will open spaces for dialogue and feedback from key stakeholders.	• Bogota Water Facility Company (EAAB)

KEY PRINCIPLE(S)	*"Biodiversity conservation corridors are strategically located regions that link key habitats for plants and animals, including protected areas. They help maintaining critical ecological processes within their boundaries and enhance ecosystems' resilience to climate change."*
CONTACT INFORMATION	**Keith Lawrence** Conservation Strategies E-mail: klawrence@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/explore/asia-pacific/philippines/Pages/eastern_mindanao.aspx

Makira Forest Initiative

CONSERVATION INTERNATIONAL

COUNTRY: Madagascar **START DATE:** Jun 2003 **STATUS:** Active **ECOSYSTEM SERVICE(S):** Forest related ecosystems services

BACKGROUND INFORMATION
Located off the East coast of Africa, Madagascar is home for unique plant and animal species. The forests that hold this remarkable biodiversity are, however, rapidly disappearing. Eastern Madagascar has been hit particularly hard. Decades of forest destruction and high local deforestation rates have resulted in only 8.5 % of its original forest cover remaining. The direct cause of this problem is the cultivation of hillside rice by burning down trees and irrigating with rainfall, a practice known as "tavy". This traditional practice has exhausted soils, increased erosion and contaminated water supplies.

PROPOSED SOLUTION
Conservation International (CI) has partnered with the Wildlife Conservation Society (WCS) and Madagascar's Ministry of Environment to implement the Makira Forest Project. The project aims to create a new legally protected area, reduce deforestation from agricultural encroachment and promote responsible land use planning. Through the protection of the remaining forest and the reduction of the deforestation rate, the quantity of CO_2 released into the atmosphere will also decrease, contributing to climate change mitigation.

IMPLEMENTATION
The creation of a 4 600 km^2-protected area is currently under development in close collaboration with the government of Madagascar. The project's partners are also training farmers on permaculture practices and irrigation systems for lowland rice fields to reduce deforestation from agricultural encroachment. These practices allow farmers to continually produce good harvests from the same land as opposed to cutting new fields every few years. Ecotourism opportunities are also being explored because they will have economic benefits for the local communities through employment opportunities. The protection and reforestation activities in the Makira Forest are being financed using a carbon offset mechanism. Companies seeking to reduce their carbon footprint are investing in the project. To date, the Mitsubishi Group, Nav Tech, SC Johnson and the music bands Peal Jam and Dixie Chicks are supporting the project.

Some Lessons Learned

- Conservation projects financed through carbon offsets mechanisms support climate change mitigation, but also promote maintenance of critical ecosystems services such as soil conservation and water purification.

Partners

- Madagascar's Ministry of Environment
- Wildlife Conservation Society (WCS)
- Water and Forests (MEEF)

KEY PRINCIPLE(S)	*"Protection and restoration of forests removes carbon from the atmosphere and provide local communities opportunities to improve their livelihoods."*
CONTACT INFORMATION	**Olaf Zerbock** Manager, Climate Change Projects, E-mail: ozerbock@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/learn/forests/Pages/project_makira.aspx http://www.celb.org/ImageCache/CELB/content/climate/conservationcarbon_5fmakira_2epdf/v2/conservationcarbon_5fmakira.pdf

The Choco-Manabi Corridor Reforestation Conservation Carbon Project

CONSERVATION INTERNATIONAL

COUNTRY: Ecuador **START DATE:** 2007 **STATUS:** Active **ECOSYSTEM SERVICE(S):** Forest related ecosystems services

BACKGROUND INFORMATION

The northwestern region of Ecuador is home to more than 2 000 species of plants, over 450 species of birds and an array of mammals and reptiles, many of which are threatened with extinction. Forests in this region are also highly threatened. Over the past 35 years, deforestation caused by logging, agriculture and population growth has resulted in the loss of more than two-thirds of the region's original forest cover. Today much of the area has been converted to pasture and commercial agriculture or simply left abandoned.

PROPOSED SOLUTION

To protect the region's biodiversity, support local communities and combat global warming, Conservation International (CI) and the Maquipucuna Foundation proposed the Choco-Manabi Corridor Reforestation Conservation Carbon project (ChoCO2). This project supports the reforestation of at least 265 hectares. Implemented activities will meet the eligibility requirements of the Kyoto Protocol for Afforestation/Reforestation (A/R) projects under the Clean Development Mechanism.

IMPLEMENTATION

The project sites are within the Maquipucuna Reserve, a cloud forest ranging from 1 000 to over 2 800 meters in elevation and owned by the Maquipucuna Foundation. They are comprised of abandoned pasture and agricultural lands overgrown with introduced African pasture grasses and low shrub-like vegetation. In 2007, 38 hectares were reforested using a mixture of 15 native tree species. These native tree seedlings will soon become trees that provide bankable CO_2 credits. Over the 30-year life of the project, the reforested areas will store at least 80 000 tons of CO_2. The Ricoh Corporation of Japan has already purchased a majority of these carbon credits.

Local community members have been employed for seed collection, nursery establishment, planting and maintenance of the forested areas. In the coming years, the project will continue to provide additional income to local people from activities tied to healthy forests, such as ecotourism. Newly forested areas will also help protect clean water supplies, reduce water-borne diseases and expand habitat for native plants and animals.

Some Lessons Learned

- Land use changes are among the main threats for biodiversity. Forest carbon projects support the implementation of activities that promote sustainable land management practices and thus contribute to reduce the impact of land use changes on biodiversity.
- Establishing value through carbon offsets provides the only economic incentive for reforesting degraded lands and maintaining the ecosystems services provided by forests.

Partners

- Maquipucuna Foundation

KEY PRINCIPLE(S)	*"Forest carbon projects enables companies, organizations and governments to reduce their climate impacts while contributing to biodiversity conservation and community livelihoods"*
CONTACT INFORMATION	**Olaf Zerbock** Manager, Climate Change Projects, E-mail: ozerbock@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/learn/forests/Pages/project_choco_manabi.aspx http://www.celb.org/xp/CELB/news-events/press_releases/03292007.xml

Protecting the Mahavavy-Kinkony Wetlands Complex

COUNTRY: Madagascar **START DATE:** April 2004 **STATUS:** Completed (2006)

BACKGROUND INFORMATION

The Mahavavy-Kinkony Wetlands Complex covers an area of 268 236 hectares in Madagascar. Lakes, rivers, marshes, shorelines and mangroves in this area are home to 12 globally threatened species of birds, reptiles and fishes, including the endangered Madagascar teals and Madagascar sacred ibises. Hunting, overfishing and wetland conversion to agribusiness are the main threats to this freshwater ecosystem.

PROPOSED SOLUTION

With support from the Conservation International - Critical Ecosystem Partnership Fund, BirdLife International developed a model for managing the Mahavavy-Kinkony Wetlands Complex in Madagascar that actively involves local communities, governmental institutions and industrial food producers established in the area.

IMPLEMENTATION

The project launched ecotourism activities, established community-based fisheries management, controlled hunting activities and formed partnerships with large private sector food producers active at the site. The key to conservation of the Mahavavy-Kinkony Complex was natural resource management by local communities because the vast majority of impacts on biodiversity came from the activities of local communities. Through the project, local associations were created and their capacity built so that they were able and legally eligible to take on management of resources. In January 2007, the government of Madagascar included the Mahavavy-Kinkony Wetlands Complex in the declaration of an additional 1 million hectares of new protected areas in the island nation. This further strengthened the achievements of the project.

Some Lessons Learned

- All stakeholders and in particular local communities play an important role in conservation of freshwater ecosystems. Their support is crucial to achieve success.
- In order perpetuate the conservation activities' impact, it is necessary to include actions that have an economic development component.

Partners

- Bird Life International
- Local communities
- Local government
- SIRAMA (sugar company)

KEY PRINCIPLE(S)	*"The implementation of freshwater ecosystems conservation projects can be guarantee on a long-term basis only when there is consent from and collaboration with local and indigenous communities."*
CONTACT INFORMATION	**Bruno Rajaspera** CI-Madagascar E-mail: b.rajaspera@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/FMG/Articles/Pages/01310801.aspx http://www.cepf.net/Documents/final_mahavavy_birdlife.pdf

Sustainable Financing for Liberia's Protected Areas

CONSERVATION INTERNATIONAL

COUNTRY: Liberia **START DATE:** Mar 2009 **STATUS:** Active

BACKGROUND INFORMATION

Liberia contains 4.5 million hectares of lowland tropical forest that are important for their biological diversity as they contain the last long-term viable populations of several endemic species. These forests also provide important ecosystem services and hold the potential to help reduce high levels of poverty in the country. After 14 years of civil war, the government is rebuilding its civil society and government structure, and planning new development strategies, including ones to reduce deforestation rates and conserve the country's forests.

PROPOSED SOLUTION

The government of Liberia with support from Conservation International has created the Liberia's Carbon Working Group to ensure that REED financing is an integral part of the overall country forestry strategy.

IMPLEMENTATION

Liberia's Carbon Working Group is co-hosted by Liberia's Forestry Development Authority and the Environmental Protection Agency. Several government institutions are also members including the Ministry of Lands, Mines and Energy, Ministry of Planning and Economic Affairs and the National Investment Commission, as well as several international non-government organizations and lending institutions.

This working group is leading the integration of reducing deforestation emissions and carbon financing into the forest strategy of the country. The group is collaborating with the government to design a project that will leverage carbon financing (from avoided deforestation) to fund the establishment and maintenance of a 1.5 million hectare protected area network, which will protect the habitat of endangered species, contribute to the continuation of ecosystem services provision and human well-being.

Some Lessons Learned

- Forests provide ecosystem services that can contribute to poverty reduction. Forest carbon markets can help governments to put this concept into action while conserving forest and freshwater biodiversity and mitigating climate change.
- When governments develop policies with biodiversity conservation in mind they are also targeting other country's priorities such as poverty alleviation.

Partners

- Liberia's Carbon Working Group
- Liberia's Forestry Development Authority
- Environmental Protection Agency
- Fauna and Flora International
- The US Forest Service
- World Bank
- Other Liberian civil society organizations
- Local NGOs

KEY PRINCIPLE(S)	*"Global forest carbon markets have the potential to generate tens of billions of dollars annually and provide forest-rich nations with access to sustainable financial resources."*
CONTACT INFORMATION	**Olaf Zerbock** Manager, Climate Change Projects, E-mail: ozerbock@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/FMG/Articles/Pages/liberia-forest-legacy.aspx

Forest Partners Programme

COUNTRY: Ecuador **START DATE:** Dec 2008 **STATUS:** Active **ECOSYSTEM SERVICE(S):** Forest related ecosystem services

BACKGROUND INFORMATION

Ecuador has approximately 10 million hectares of native forests. These store a large amount of carbon, hold levels of biodiversity that are among the highest on the planet, and generate other environmental services crucial for human well being, including freshwater ecosystem services. Around 60% of the forest area is located outside the National System of Protected Areas, most of which is owned by private land owners and indigenous communities. Population in these forests lives in poverty and/or extreme poverty. Under these conditions, pressure to exploit and convert forests is high mainly because there is a lack of economic incentives for conservation. Ecuador has one of the highest deforestation rates in the region. Around 200 000 hectares of native forest are lost each year, which represents CO_2 emissions of about 55 million tons per year.

PROPOSED SOLUTION

With support from Conservation International and other key partners, the Government of Ecuador launched its national Forest Partners Programme ("Programmea Socio Bosque" in Spanish) to protect and conserve the country's forest and associated ecosystems services. Through this programme, the Ecuadorian government is providing direct annual monetary incentives to individual landowners or indigenous communities who voluntarily decide to protect their native forest. The government expects to protect 4 million hectares of native forest, significantly reduce GHG emissions caused by deforestation and improve the living conditions of 1 million of the poorest people of the country.

IMPLEMENTATION

The Forest Partners Programme started operations in 2008. The first agreements were signed with the province of Esmeraldas, an area that has the highest deforestation rate in the country. To date it has benefited 15 000 people and has conserved 150 000 ha. The programme prioritizes areas with the highest deforestation threat, the most important areas for carbon storage and other ecosystem services and areas with the highest levels of poverty. Individuals or communities interested in the programme need to comply with certain requirements and conditions. Once these are verified, they sign an agreement to protect their forest in return of an economic incentive given by the State. The compliance of beneficiaries is verified using remote sensing and random on site inspections.

Some Lessons Learned

- By providing compensation for forest protection, governments make biodiversity and ecosystems services conservation people's choice.
- With political will it is possible to close the gap between conservation and the fight against poverty, even in small developing countries that have needs in many fronts and also high biodiversity.

Partner

- Ministry of Environment

KEY PRINCIPLE(S)	*"Provision of economic incentives to local farmers and indigenous communities in exchange for their commitment to protect key biodiversity areas supports biodiversity and ecosystems services conservation and poverty alleviation."*	
CONTACT INFORMATION	**Tanya Lozada** Conservation Stewards Programme E-mail: tlozada@conservation.org	**Patricia Zurita** Director of the Policy and Economics Programme of the Andes E-mail: pzurita@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/FMG/Articles/Pages/grand_plan_ecuador_and_forest_partners.aspx http://www.conservation.org/newsroom/pressreleases/Pages/Ecuadorian-Communities-Conserve-Forests.aspx http://www.ambiente.gov.ec/paginas_espanol/sitio/index.html	

Payment for Environmental Services in Espirito Santo State

CONSERVATION INTERNATIONAL

COUNTRY: Brazil **START DATE:** Mar 2007 **STATUS:** Completed

BACKGROUND INFORMATION
The Atlantic Forest is a biodiversity hotspot with an extremely diverse and unique mix of vegetation and forest types. It stretches along Brazil's Atlantic coast, from the northern state of Rio Grande do Norte south to Rio Grande do Sul, passing by the Espirito Santo State. Fuelwood harvesting and slash and burn clearing are among the mean threats to the Atlantic Forest in the Espirito Santo State, where there is a lack a legal framework to recognize the forest ecosystem services and to compensate people for ecosystem conservation.

PROPOSED SOLUTION
The objective of this project is to influence the decision-making in the Congress to pass a state law recognizing the benefits of ecosystem services and their benefits to human well-being. The project also aims to provide technical support and expert advice to draft a law project for the payment for ecosystem services in the Espirito Santo State.

IMPLEMENTATION
The state of Espirito Santo passed a law (Projeto de Lei No. 251/2008) for creating the Programme of Payment for Ecosystem Services in which the government is the buyer and the forest landowners are the sellers. The amount of the compensation was calculated taking into account the opportunity costs of the communities.

Some Lessons Learned	**Partners**
• Laws that incorporate the environmental services concept can support the conservation and restoration of areas with high biodiversity. They also provide a solution to improve the livelihoods of people that live in these areas.	• Espirito Santo State Government

KEY PRINCIPLE(S)	*"Payment for ecosystem services (PES) is an instrument that benefits farmers, rural communities and indigenous communities that practice environmental conservation and/or sustainable development."*
CONTACT INFORMATION	**Alexandre Prado** Economy of Conservation Manager E-mail: a.prado@conservacao.org
REFERENCE WEBSITE(S)	http://www.conservation.org/EXPLORE/PRIORITY_AREAS/HOTSPOTS/SOUTH_AMERICA/ATLANTIC-FOREST/Pages/conservation.aspx

Alto Mayo Watershed Conservation Agreement and Forest Carbon Project

COUNTRY: Peru **START DATE:** Jul 2007 **STATUS:** Active **ECOSYSTEM SERVICE(S):** freshwater provision

BACKGROUND INFORMATION

The Alto Mayo River watershed in the province of San Martin in northern Peru holds Andean Forest areas of high biological diversity. Illegal settlements and logging on the lower elevation portions of the basin have dramatically affected the availability of freshwater for municipal use and downstream agriculture.

PROPOSED SOLUTION

Conservation International has designed a synergistic project to reduce greenhouse gas emissions from deforestation and land use change in the Alto Mayo watershed. This project includes the negotiation of conservation agreements with local inhabitants to conduct reforestation and agro-forestry activities in the watershed.

IMPLEMENTATION

The project has two objectives, provide communities with benefits and capacity-building in exchange for their participation in effective conservation of the area (signing a tailor-made Conservation Agreement) and create a community protected area in the Awajun territory in exchange for water payments in Nueva Cajamarca. The project's first activities have focused on updating deforestation analysis for the watershed, identifying priority areas for conservation and deforestation and measuring forest carbon stocks. Once these are completed, the conservation agreements will be designed. These agreements will be partially funded by the sale of carbon offsets.

Some Lessons Learned	Partners
• Conservation strategies must generate income for local people as a means to address the opportunity cost of forgoing unsustainable resources use. • Conservation agreements empower local people to drive conservation solutions.	• GTZ • Local government • Local NGOs • Local universities

KEY PRINCIPLE(S)	*"In conservation agreements, resource users choose conservation in exchange for benefits that compensate for foregone income."*
CONTACT INFORMATION	**Olaf Zerbock** Manager, Climate Change Projects, E-mail: ozerbock@conservation.org
REFERENCE WEBSITE(S)	http://www.conservation.org/Documents/Forest%20Carbon%20Projects.pdf

The International Union for the Conservation of Nature (IUCN)

Tacana Watershed Project

COUNTRIES: Guatemala and Mexico **DURATION:** 4 years **STATUS:** Completed

BACKGROUND INFORMATION

The Tacana Basin in the border between Mexico and Guatemala faces various environmental problems. Coffee-farmers in the upper watershed cultivate on steep hillsides, a practice that causes erosion and increase the risk of floods and mudslides. Sugar cane and coffee industries pollute the water in the middle basin. Downstream, water scarcity in the dry season affects communities and industries that depend on this resource. But the problems to tackle are not only deforestation or pollution. Dispersed authority, sectoral approaches, inadequate laws and regulations, budgetary constraints, the absence of integrated policies, and the lack of participation and transparency also affects water availability in the basin.

PROPOSED SOLUTION

IUCN – Mesoamerica worked with various partners to implement an integrated management approach in the Tacana Watershed. This four-year project had four main objectives: 1) consolidate mechanisms for the coordination and management of water resources with an integrated approach, 2) gather information for creating sub-basin management plans, 3) implement a strategy for raising awareness and information sharing, and 4) build strategic alliances for the implementation of sub-basin management plans in the short, medium and long term. These objectives were fulfilled in the project's timeframe.

IMPLEMENTATION

Through the implementation of the Tacana Watershed Project seven micro-watershed councils were created in Guatemala. This was very important to strengthen water governance in the country because no general law regulating water management existed. Municipalities that participate in the project in both Mexico and Guatemala integrated the micro-basin concept in their development plans as a result. An agreement between the two countries, the Tapachula Declaration, was signed by the two countries to develop joint projects on watershed management.

The project also led to the creation of the Coatan River Watershed Committee in Chiapas, Mexico. The National Water Commission (CONAGUA) and the municipality of Tapachula supported the establishment of this committee as well. During the timeframe of the project strategic alliances were established to carry out important activities on environmental management in the watershed. Voluntary actions were also conducted, in particular by youth people. They formed an association and built 19 greenhouses for growing flowers and plants that received the certification of the Exporters Association of Guatemala.

Some Lessons Learned

- Watershed Plans should be made based on the interests and needs of local actors not rather than on an institutional vision. This implies the creation of individual micro-watershed plans following a participatory approach, which could be later merged into sub-watershed and watershed plans.
- As an IRBM project is developed, experiences among local actors should be exchange. This facilitates the implementation of good water management practices as participants become convinced when they see that others have already used certain technologies or knowledge, as opposed to simply hearing that they work.
- An IRBM project can support a country's water law enforcement at the local level. Many municipalities in the Mexican side of the Tacana Basin did not consider the existing water law in their development plans. Through the project many municipalities adopted the micro-watershed concept as the unit of planning.

Partners

- Towns and town council in Mexico and Guatemala
- Government of Mexico
- Government of Guatemala
- Tapachula Water
- COAPATAP
- TUXTLA Chico Town Council
- UNESCO
- Gonzalo Rio Arronte Foundation (FGRA)

KEY PRINCIPLE(S)	*"When working together, stakeholders of a basin stand a better chance to overcome poverty, environmental degradation and social inequity."*
CONTACT INFORMATION	**Ms. Rocio Cordova** Water and Wetlands Coordinator – IUCN ORMA E-mail: rocio.cordoba@iucn.org
REFERENCE WEBSITE(S)	http://www.iucn.org/about/work/programmemes/water/wp_where_we_work/wp_our_work_projects/wp_our_work_trb/

The Pangani River Basin Management Project

COUNTRIES: Kenya and Tanzania	**START DATE:** 2001	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Water supply

BACKGROUND INFORMATION

The Pangani River Basin covers an area of about 43 650 km^2, mostly in Tanzania with approximately 5% in Kenya. Generally, the basin comprises a low elevation slope that drops gently south and southeastwards towards the Indian Ocean. Flows in the basin have been reduced from several hundreds to less than 40 m^3/s and the remaining water is seriously over-allocated. The shortage of water is affecting all water users, from the irrigation fields in the center of the basin and the electricity producers further downstream, to the coastal communities that see saltwater move inland and fish stocks decline. Large and smaller conflicts are on the rise between waters users from various sectors.

PROPOSED SOLUTION

The IUCN, through its Water & Nature Initiative (WANI), started the Pagani River Basin Management Project in 2001 to improve management of the basin's water resources and reduce the conflicts that exists between the users.

IMPLEMENTATION

The project was initiated with three main actions in mind: 1) assess environmental flow requirements to effectively conserve the basin's natural resources, 2) establish forums for community participation in water management, and 3) raise awareness about climate change impacts and adaptation strategies. A workshop with key stakeholders was conducted in May 2002 as the first main activity of the project. Information about past and present interventions in the basin was reviewed. Data availability and data gaps were also discussed, as well as the different water issues in the basin. Following this workshop, a Situation Analysis Report was commissioned. This report was based on interviews with a wide variety of stakeholders and the various existing sources of information about the Pangani Basin. A draft version of the report was completed in late 2002 and distribute to stakeholders for review and comment. At a second workshop with stakeholders in May 2003 comments and suggestions for this document were discussed.

The flow assessment component of the project started in 2004 and ended in 2008. Field and desk work was completed by a multidisciplinary group of scientists, including experts in hydrology, water quality, riverine and estuary ecology, socio-economic and geographic information systems. A team of Tanzanian specialists were mentored by the project's team throughout the process as a mean to create capacity building on environmental flows in the country. Eighth technical reports were prepared as a result, including a State of the Basin Report, a Pangani Flows DSS Report, and a Water Allocation Scenarios Report.

The various scenarios and technical information obtained during the flow assessment are currently being presented to stakeholders at all levels, with particular emphasis on the Basin Water Board, which is the governmental organization responsible for allocating water in the basin. Consultations with stakeholders will not only raise awareness of the water issues in the basin, but also help selecting the best development path for the river. This process will also facilitate the integration of the selected environmental flow scenario into an Integrated Water Resource Management (IWRM) Plan for the Pangani Basin.

CHALLENGES

While conducting the project, no reliable data about how climate change will affect the Pagani River was available. Detailed studies need to be undertaken to this end, so that climate change is also included in the future design of an IWRM Plan for the river.

Some Lessons Learned

- Before the project started, water scarcity in the Pangani River was acute and water users were blaming each other for this situation. Subsistence farmers blamed dry river beds on the growing number of large commercial plantations. The commercial farmers accused thirsty towns of waste. Towns complained that hydropower dams lost 70% of power production capacity to upstream withdrawals. Farmers warned salty tides were invading upstream. The friction created was the push needed to initiate the project. Now, water users can better understand the choices they faced among different water allocations and work towards consensus based on priority needs and transparency. By sitting down together, they could find solutions. With better knowledge and forums for negotiation, they can rebuild the health of their river basin to get ready for climate change.

Partners

- Pangani Basin Water Office
- Government of Tanzania
- Global Environmental Facility (donor)
- Netherlands Environmental Organization (SVN) – donor
- Pamoja Trust

KEY PRINCIPLE(S)	*"Rivers are the lifeblood of national economies, the source of most water for drinking, washing, cooking, crops, power generation and industry. Environmental flows ensure the continued availability of these benefits."*
CONTACT INFORMATION	**Katharine Cross** Programmeme Officer – Water Programmeme E-mail: Catharine.cross@iucn.org
REFERENCE WEBSITE(S)	http://www.panganibasin.com/project/index.html http://www.iucn.org/about/work/programmemes/water/wp_where_we_work/wp_our_work_projects/wp_our_work_pan/index.cfm http://www.riversymposium.com/index.php?element=SADIKIppt

Komadugu-Yobe Integrated Management Project

COUNTRY: Nigeria **START DATE:** 2007 **STATUS:** Completed (2008)

BACKGROUND INFORMATION

The Komadugu-Yobe (KYB) Basin covers a total area of about 148 000 km^2 in Eastern Nigeria and it is a sub-basin of the Lake Chad Basin. The inhabitants of the basin make their living in recession agriculture, pastoralism, forest use, fishing and tourism. Decreasing rainfalls, possibly due to climate change, have already reduced flows in the basin. The result is a growing tension among water users. The lack of coordination between the two River Basin Development Authorities adds to the water problems in the basin.

PROPOSED SOLUTION

In response to the water problems in the Komadugu-Yobe Basin, IUCN in partnership with the Nigeria Federal Ministry of Agriculture and Water Resources (FMAWR) and the Nigerian Conservation Foundation (NCF) proposed the Equitable and Sustainable Management of Land and Water Resources of the Komadugu-Yobe Basin Project. The main objective was to improve the institutional framework for managing water resources in the KYB, which was to be done through consensus on key integrated water management principles and institutionalized consultation and coordination mechanisms.

IMPLEMENTATION

To achieve the main objective of the project, environmental studies were conducted to understand the conditions of the basin. These knowledge-base studies led to a common understanding of the issues and challenges facing the basin in terms of the land and water resources. They also supported the consultation and dialogue processes with stakeholders.

To facilitate the participation of all stakeholder groups in the development of key principles for the management of the KYB a basin-wide stakeholder forum was established. The Project also supported the creation of a Komadugu-Yobe (Basin) Coordinating Committee (HJKYCC). All States in the basin are represented in this Committee as well as the Federal Ministry of Agriculture and Water Resources and Federal Ministries responsible for Environment and Health. Through the project a Komadugu-Yobe Basin Trust Fund was created.

Some Lessons Learned	Partners
• The stakeholder forum supported by the Project has helped to foster understanding and increase participation in decision-making processes by all stakeholders. • The project demonstrated that once politicians are sensitized on the problems of the basin their support can be gained. In the case of the project, a Komadugu Yobe Basin Trust Fund was created.	• Federal Ministry responsible for Water Resources (FMAWR) • Nigerian Conservation Foundation (NCF).

KEY PRINCIPLE(S)	*"Informed decisions help to break barriers and generate the needed support from policy-makers."*
CONTACT INFORMATION	**Daniel Yawson** Project Coordinator - FMAWR-IUCN-NCF Komadugu Yobe Basin Project E-mail: daniel.yawson@iucn.org
REFERENCE WEBSITE(S)	http://www.kyb-project.net/deliverables.html http://www.kyb-project.net/

The Mekong River Dialogues

COUNTRIES: Cambodia, China, Lao PDR, Thailand and Vietnam **START DATE:** 2006 **STATUS:** Active

BACKGROUND INFORMATION

The Mekong Region is shared among five countries: Cambodia, China, Lao PDR, Thailand, and Vietnam. These are among the fastest growing economies of East and Southeast Asia. Upstream, China, Laos, Myanmar and Vietnam are planning massive hydropower dams, while downstream Thailand and Cambodia are considering major irrigation diversion projects. There are different visions for the sustainable development of the Mekong Region and the way in which regional waters (in many different river basins) are used. These different perspectives cause conflicts in water management and decision making, resulting in risks to equitable development.

PROPOSED SOLUTION

The Mekong Region Water Dialogues is an IUCN Programmeme designed to improve water governance in the Mekong Region by facilitating transparent and inclusive decision-making among business, government and civil society.

IMPLEMENTATION

Region-wide and national dialogues were convened to help build multi-stakeholder participation in water decisions. Civil society, governments, the Mekong River Commission and multi-lateral development banks participate in these meetings, where strategies for hydropower and water resources development were discussed. The dialogues process built understanding of rights and responsibilities and increased stakeholder consultation.

Some Lessons Learned	Partners
• Dialogues –at different scales– can make a significant contribution to improving the use and governance of water resources in a region. If done well, dialogues can reduce conflicts and make the voice of marginal groups be heard.	• Thailand Environment Institute • International Water Management Institute • Mekong Programme on Water Environment & Resilience

KEY PRINCIPLE(S)	*"Multi-stakeholders platforms such as those provided by dialogues exercises help to build consensus and to coordinate water resources development and ecosystem management, encouraging benefit sharing at local, basin, national and transboundary levels."*
CONTACT INFORMATION	**Erik Nielsen** Country Programmeme Coordinator - IUCN Lao PDR Email: erik@iucnlao.org
REFERENCE WEBSITE(S)	http://www.iucn.org/about/work/programmemes/water/wp_where_we_work/wp_our_work_projects/wp_our_work_mrb/ http://www.iucn.org/about/union/secretariat/offices/asia/regional_activities/mekong_dialogues/

Volta River Water Governance Project

COUNTRIES: Benin, Burkina, Faso, Cote d'Ivoire, Ghana, Mali & Togo **START DATE:** 2004 **STATUS:** Completed (December 2008)

BACKGROUND INFORMATION

The Volta River Basin covers an estimated area of 400 000 km^2 of the sub-humid to semi-arid West-African savannah zone. The basin is shared by six countries, namely Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali and Togo. Like other shared basins in Africa, the Volta is confronted by a number of water management challenges including rapid population growth, soil and land degradation, extreme climate variability, risks of conflicts resulting from diverging upstream-downstream interests, and lack of mechanisms for public participation in decision making. Erratic climate variability and poor soil quality have forced the local communities to follow unsustainable development paths such as farming on the river banks, setting of bushfires and deforestation, which have altered the ecosystems and their services.

PROPOSED SOLUTION

The International Union for the Conservation of Nature (IUCN) implemented the "Volta Water Governance Project (PAGEV)" to address some of the water management challenges in the basin. The project's strategies focused on combining the long-term benefits of ecosystem conservation with immediate impacts on meeting the livelihood needs of marginalized communities. Three main activities were proposed: 1) compilation of knowledge and decision-support information to support planning and decision making, 2) community based IWRM actions to promote local participation in transboundary waters management, and 3) improving institutional and legislative instruments to promote transboundary cooperation.

IMPLEMENTATION

The implementation of the project supported river banks reforestation. In 2007, farmers in 7 pilot villages in Burkina Faso and Ghana were motivated to reforest 16 km stretch of river banks by growing trees for fuel and fruits. In 2008, 77 new farmers joined this initiative and reforest additional 8km of river banks. Other activities to protect river banks were completed in parallel. For example, small-scale farmers were encouraged to introduce high-value crops in their lands so that their incomes could increase. Conscious efforts were also made to promote gender equity in the communities. At least 20 to 25% of the beneficiaries of the project were women and 10 to 20% of women were executive members within various committees.

Multi-stakeholder institutions were formed to coordinate transboundary Integrated Water Resources Management (IWRM) at sub-basin, national and basin-wide scales. Transboundary community forums led to resolution of local water conflicts across the Ghana- Burkina Faso border and resulted in the negotiation of a transboundary Code of Conduct. An agreement by all six Volta-basin states of a Water Charter to guide the newly-formed Volta Basin Authority was established at the end of the project.

Some Lessons Learned

- Through education and sensitization of the local communities on the potential benefits to be derived from creating buffer zones on the banks of the Volta River and introduction of "economic" trees, PAGEV has brought the communities to give up part of the lands along the river banks they used to farm on for the conservation of the river banks.
- Communities are willing to participate in water and other natural resources conservation interventions when the outcomes of participation are clearly and directly linked to the improvement of their livelihoods. Conscious efforts must be made to integrate livelihood needs of communities into IWRM by including income generation, safe water supply and hygiene education in the water resources management interventions.

Partners

- Directorate General of Water Resources (DGRE) of Burkina Faso
- Water Resources Commission (WRC) of Ghana
- Swedish International Development Cooperation Agency (Sida)
- The Netherlands Directorate General for International Development Cooperation (DGIS)
- Governments of Ghana and Burkina
- West Africa Water Partnership of the Global Water Partnership (GWP/WA).

KEY PRINCIPLE(S)	*"With locally-owned knowledge, communities are empowered to act as their own advocates in otherwise expert-driven decision processes."*
CONTACT INFORMATIO N	**William Darwall** Manager - Freshwater Biodiversity Unit - IUCN Species Programmeme E-mail: william.darwall@iucn.org
REFERENCE WEBSITE(S)	http://www.iucn.org/about/work/programmemes/species/our_work/about_freshwater/what_we_do_freshwater/darwin_freshwater/index.cfm

Darwin Integrated Wetland Assessment

COUNTRIES: Cambodia and Tanzania **START DATE:** April 2005 **STATUS:** Completed (March 2009)

BACKGROUND INFORMATION

Wetlands contain biodiversity of exceptional conservation significance, comprising many unique ecosystems and a wide array of globally-threatened species. At the same time they typically form an essential component of local, national and even regional economies, as well as underpinning the livelihoods of many rural communities. Yet, despite their importance, they are under increasing pressure. Weak consideration of wetlands in decision-making remains one of the major factors leading to their degradation. Management decisions affecting wetlands rarely consider the wider biological, ecological, development or economic values of wetlands as they are.

PROPOSED SOLUTION

This project developed a toolkit of methodologies to assess the value of wetland biodiversity to livelihoods, particularly of the poorest, and to find ways to clearly present this information to decision makers. The methodologies are integrated and incorporate biodiversity, economics and livelihoods approaches. The toolkit was put in practice in two demonstration sites: Stung Treng Ramsar Site in Cambodia and Mtanza-Msona Village in Tanzania.

IMPLEMENTATION

Following initial scoping exercises to generate broad basic data, capacity and awareness on wetland values within the demonstration sites, fieldwork was completed and integrated reports on the livelihood, biodiversity and economic values of the areas were prepared. These assessments yielded detailed scientific and management information, including GIS maps and databases, which document key values and overlaps between threatened species and areas of high human dependence. Information obtained in the Stung Treng Ramsar site was included in the management and zoning plan for this site, supporting pro-poor wetland conservation and sustainable use to the benefit of local livelihoods and biodiversity. Data obtained in the second demonstration site helped local communities to understand the importance of wetlands resources in their livelihoods.

The main output of the project is "An Integrated Wetland Assessment Toolkit: A guide to good practice." This guideline provides a set of integrated assessment methods that combine and investigate the links between biodiversity, economics and livelihoods, with a particular focus on strengthening pro-poor approaches to wetland management. It aims to assist in overcoming the current methodological and information gaps in wetland planning, factor wetland values into conservation and development decision-making and management planning, and assist in identifying areas of potential conflicting priorities. It is expected to be of use by wetland site managers, conservation and development planners, and researchers from both natural and social science disciplines.

CHALLENGES

The project brought experts from the social, ecological and economic background to work together. It was not easy to convince them of the value of the work in each of the other two disciplines. For example, it was challenging but ultimately successful to convince social scientist of the value of biodiversity assessment and vice-versa. Because the project proposed an integrated approach for wetland management, it was challenging to find good models and tools as examples of integrated work.

Some Lessons Learned	**Partners**
• Integrated Wetland Assessment can inform policy decisions that better reflect synergies and trade-offs between biodiversity, economics and livelihoods, including protection for the most vulnerable.	• Overseas Development Group • Darwin Initiative • Overseen Development Group - University of East Anglia. Norwich

KEY PRINCIPLE(S)	*"Integration of biological, livelihoods and ecosystem services valuation assessments through various methodologies are important to improve wetlands planning and management"*
CONTACT INFORMATION	**William Darwall** Manager - Freshwater Biodiversity Unit - IUCN Species Programmeme E-mail: william.darwall@iucn.org
REFERENCE WEBSITE(S)	http://www.iucn.org/about/work/programmemes/species/our_work/about_freshwater/what_we_do_freshwater/darwin_freshwater/index.cfm

Protection of Biodiversity of the Sava River Basin Floodplains

COUNTRIES: Bosnia Herzegovina, Croatia, Slovenia and Serbia **START DATE:** Jan 2007 **STATUS:** Active

BACKGROUND INFORMATION

The Sava River in Southern Europe is the second largest tributary to the Danube River. It originates in Slovenia and runs for 562 km through Croatia, Bosnia and Hezegovina and Serbia. The Sava is a unique example of a river where the floodplains are still intact, supporting both floods alleviation and biodiversity. It also hosts the largest complex of alluvial floodplain wetlands in the Danube basin and the largest lowland forests. Lack of environmental infrastructure and institutional mechanisms for addressing transboundary impacts is causing serious environmental concerns in the basin.

PROPOSED SOLUTION

The International Union for Conservation of Nature (IUCN) and Wageningen International (WI) have initiated the *Protection of Biodiversity of the Sava River Basin Floodplains* project to support the Sava Basin countries in protecting and managing biological and landscape diversity along the Sava River. The project will support transborder co-operation and agreement between the Sava countries to designate and manage an ecological network of protected areas. It will also promote sustainable land use practices and rural tourism. The outcomes of this project will furtherance the elaboration of an Integrated Sava River Basin Management.

IMPLEMENTATION

The project is coordinated by a Project Management Team formed by IUCN and WI. A Project Steering Committee (PSC), a Technical Coordination Group (TCG) and four Working Groups (WGs) have also been formed to support the project's activities. The PSC is mainly formed by ministries' representatives from Sava Basin countries and it oversees the work of the WGs, which is directed by the TCG. The WGs' work focus in the areas of biodiversity, land use, GIS and awareness.

To date the following activities have been completed. First, a list of core nature areas has been identified and field formats and guidelines for site, habitat and species mapping have been prepared. These were tested in the field during a joint workshop of the biodiversity and land use WGs. These activities are the first step to design the ecological network. Second, a GEO portal has been designed and installed. Biodiversity and land use data collected and generated by the project will be posted in this website. This portal will also be a communication platform for the project. A newsletter published in English and the native languages of the Sava countries has been also prepared. Finally, an initial agreement for future collaboration has been signed with the International Sava River Basin Commission (ISRBC). The projects' activities will be considered within the Integrated Sava River Basin Management Plan.

The project will be completed in December 2009. By that time, improved transboundary co-operation on the protection and management of the landscape and biodiversity along the Sava River is expected. Other outcomes include the signature of a Letter of Intent (LoI) between the Sava countries to designate and manage an ecological network of protected areas, ecological corridors, buffer zones and restoration areas in accordance with the EU Birds & Habitats Directives and WFD. This will increase co-operation between the nature protection sector and the water management sector on the management within and among countries.

CHALLENGES

Communication and coordination of activities has not been an easy task. Partner organizations representing governments do not always have the resources needed for prompt coordination. Some organizations are overstaffed and/or overloaded to perform all the planned activities. This has hold up some activities. Extra efforts will be needed to coordinate actions in the future.

Some Lessons Learned

- Transboundary Rivers' management requires intense coordination among countries with different political and legislative backgrounds and priorities. This can hinder plans for integrated responses for water management.
- The establishment of an ecological network along a river can further support the development of an integrated river basin management plan.

Main Partners

- LIFE-III Countries Programmeme
- Swiss Agency for Development and Cooperation
- Wageningen International (WI)
- Centre for Ecology and Natural Resources of the Faculty of Science – Sarajevo
- Agricultural Institute of Republic of Srpska
- State Institute for Nature Protection of Croatia
- Institute for Nature Conservation of Serbia
- Institute for Nature Conservation of the Republic of Slovenia.

KEY PRINCIPLE(S)	*"The concept of ecological networks offers the possibility to reconcile preservation of freshwater ecosystems with demands for economic development."*
CONTACT INFORMATION	**Boris Erg** Project Manager E-mail: boris.erg@iucn.org
REFERENCE WEBSITE(S)	http://www.iucn.org/about/union/secretariat/offices/europe/work/?uNewsID=125 http://www.savariver.com/

Environmental Flow Assessment in the Huong Basin River

COUNTRY: Vietnam	**START DATE:** 2003	**STATUS:** Completed	**ECOSYSTEM SERVICE(S):** water supply

BACKGROUND INFORMATION

The Huong (Perfume) River Basin is situated in the Hue Province in central Viet Nam. Before reaching the sea, the river opens into a lagoon system that extends about 70 km along the coastline. This system supports a number of livelihood activities and a lucrative aquaculture industry. The river is characterized by a steep gradient of 28.5%. Rainfall is very abundant, with an annual rainfall of 2 500 mm in coastal areas to 3 500 mm in the upper part of the basin. Due to these two physical characteristics, frequent downstream flooding occurs in the rainy season (Sep - Nov) resulting in large losses to crops, regional infrastructure and life. During the dry season (Feb - May) reduced flows and salinity intrusion threatens irrigation and domestic water intake of Hue city.

PROPOSED SOLUTION

The immediate responses to the various challenges in the Huong River Basin have been structural interventions, including flood protection dams and a salinity barrage to prevent salinity intrusion. Yet, the devastating floods of 1999, and the less severe floods of 2000, indicate the shortcomings of this structural approach to flood management and mitigation. IUCN proposed preparing an integrated river basin management plan to address water issues in the basin instead. The first step in the IRBM process was the elaboration of an Environmental Flow Assessment (EFA).

IMPLEMENTATION

Between 2003 and 2004, IUCN and partners organized three workshops in Hue city to assess possible models for a river basin organization and to discuss the implementation of the Environmental Flow Assessment (EFA) process in Huong River. During the first workshop, the EFA methodology was selected and the institutional and legal framework discussed. In the second workshop, a multidisciplinary team of experts was composed, the EFA methodology discussed in detail and an EFA plan proposed. The participants also identified the sites in the basin where field work should be conducted and what disciplines should be studied (hydrology, aquatic ecology, salinity, fisheries, socio-economics, etc.). The Huong River EFA Project moved then into the phase of field work, data collection and analysis. When this was completed, a rapid EFA specialist workshop with stakeholders was held in Hanoi in December 2004. Preliminary EFA recommendations were prepared in this workshop.

Some Lessons Learned

- In the Huong Basin, a flow assessment made clear how changes in river flow affect both economic returns and ecosystem health. Basin authorities were able to determine which flow options accommodate economic goals while protecting downstream ecosystems and their services. As a result of the increasing awareness and capacity created by the flow assessment, environmental flows have been incorporated into planning for the Huong Basin by the provincial People's Committee and, at national level; the government has included environmental flows in the natural resources strategy and in water sharing plans.

Partners

- Provincial People's Council of the Hue Province
- Huong River Project Management Board
- International Water Management Institute (IWMI)

KEY PRINCIPLE(S)	*"An environmental flow in a river basin refers to the water provided in an appropriate way to maintain downstream ecosystems and their benefits. An environmental flow assessment is an important foundation of an integrated water resources management (IWRB) process."*
CONTACT INFORMATION	**Ly Minh Dang** Wetlands and Water Resources Programmeme Manager E-mail: dang@iucn.org.vn
REFERENCE WEBSITE(S)	http://www.iucn.org/about/work/programmemes/water/wp_where_we_work/wp_our_work_projects/wp_our_work_hrb/ http://www.csdwand.net/data/sheet.asp?cn=Vietnam&fn=LA1838

Zarqa River Restoration Project

COUNTRY: Jordan **START DATE:** 2006 **STATUS:** Active

BACKGROUND INFORMATION

The Zarqa River is the second tributary to the Jordan River. It rises in springs near Amman and flows through a deep and broad valley into the Jordan River. Around 65% of the Jordanian total population and more than 90% of the small-medium industries of Jordan are concentrated in the Zarqa River Basin. The demands for water are very high. This has lead to over-pumping of groundwater for agriculture, drinking and industrial uses that have reduced the natural base flow of the river. The flow characteristics have been further modified by the discharge to the river of treated domestic and industrial wastewater that compose nearly all of summer flow and substantially degrade the water quality.

PROPOSED SOLUTION

In 2006, IUCN helped the Jordan Ministry of Environment to develop a long-term strategy for the restoration of the Zarqa River with the support of strategic partners. This year, with the financial support from the Spanish Agency for International Cooperation the first phase of the strategy will be implemented.

IMPLEMENTATION

The Ministry of Environment placed the rehabilitation and integrated environmental management of the Zarqa River Basin at the top of its priorities in 2006. With support of IUCN, the Ministry formed a Committee with representatives of governmental institutions, research organizations, universities and local NGOs to develop a national strategy for the restoration of the Zarqa River. The proposed strategy builds on the principles of integrated water resources management (IWRM) combining development of effective governance, application of economic tools, knowledge management and capacity building, civil society engagement and implementation of restoration and sustainable management.

The restoration strategy has three phases. In the first one, which will run over 3 years, urgent pilot restoration activities will show people how progress can be achieved and the benefits of a healthy river. At the same time, planning will take place for cleaning up the rubbish in the river, re-establishing riverside vegetation and managing water resources sustainably. This will be backed by participation of river users and communities in decision making and action. Economic benefits from restoration will grow, including opportunities in the agricultural, recreation and tourism sectors. Under phases 2 and 3, the whole river and its ecosystems will be restored to health, over a period of 10-15 years.

CHALLENGES

In a heavily populated and industrialized region, it will be a challenge to establish a solid waste management strategy to stop the contamination of the river.

Some Lessons Learned

- The application of an integrated approach for river restoration make it possible to restore the benefits people obtain from this freshwater ecosystem and also provides a framework for sustainable management of the basin in future.
- It was the Ministry of Environment decision to implement this project. Their support is important to fully achieve the objectives of the project.

Partners

- Ministry of Environment
- Ministry of Water
- Greater Amman Municipality
- Zarqa Governorate
- Zarqa Municipality
- Rusaifa Municipality
- Hashmiya Municipality
- Zarqa Chamber of Industry
- Hashemite University
- Royal Scientific Society

KEY PRINCIPLE(S)	*"An ecosystem based approach to sustainable water resources management incorporates all levels of interventions from research to policy development to field testing and involves all relevant stakeholders and interest groups from government, non-government, private and local communities sectors"*
CONTACT INFORMATION	**Mufleh Al Abbadi** Project Coordinator E-mail: mufleh.abbadi@iucn.org
REFERENCE WEBSITE(S)	http://www.iucn.org/about/union/secretariat/offices/rowa/iucnwame_ourwork/iucnwame_reward/iucnwame_zarqariverrestoration_/ http://cmsdata.iucn.org/downloads/iucn_reward_brochure_english.pdf http://www.moenv.gov.jo/arabicmoe/EditorDocuments/Project_Formulation_Document.pdf

Al Azraq Basin National Dialogue

COUNTRY: Jordan	**START DATE:** 2007	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** drinking water and water provision for agriculture

BACKGROUND INFORMATION

The Azraq basin in located in Northeastern Jordan and it is one of the most important recharging groundwater basins in the country. The basin consists of three aquifer systems. The upper shallow fresh water basalt aquifer, the middle limestone brackish water aquifer, and the deep sandstone aquifer. The over-extraction of groundwater from the shallow aquifer has resulted in a significant reduction of the groundwater reserves and increased salinization of groundwater and soil.

PROPOSED SOLUTION

The World Conservation Union (IUCN) and strategic partners in Jordan have initiated the Al Azraq Basin National Dialogue Initiative to explore solutions and scenarios for the sustainability of Al Azraq Basin and the sustainable future use of its ground waters.

IMPLEMENTATION

The inception phase of the project started in 2007. Since then, a large group of government and civil organizations and a group of elected local community representatives are actively participating in the Al Azraq Basin National Dialogue. IUCN is playing an important role in providing technical and logistic support and facilitating dialogue within the initiative. The Ministry of Environment is providing the overall political and institutional support and umbrella for the initiative. Al Azraq District Administration, Ministry of Water and Irrigation, Ministry of Agriculture, The Royal Society for the Conservation of Nature, Azraq Farmers Water Management Association as well as a group of local elite residents and resource exploiters representing local stakeholder communities are all part of the initiative. To date all stakeholders have decided to formulate and agreement on a feasible and practical national vision backed up by an agreed upon strategy for implementation. They have also agreed to establish a National Forum for Azraq basin, and document the experiences and lessons-learned to be employed in its development and achieving sustainability.

Some Lessons Learned

- Local water governance can be improved through stakeholder dialogue because the same understanding of water related problems is shared.
- When water users receive the right information and have a good dialogue coordinator, they can make good decisions about their resources and services.
- Political will, institutional commitment and effective enforcement are keys to the success of dialogue implementation.

Partners

- Ministry of Water and Irrigation
- Ministry of Agriculture
- Azraq Community
- Royal Society for Conservation of Nature
- Mercy Corps

KEY PRINCIPLE(S)	*"Centralized decision making over water resources has caused freshwater ecosystems' degradation. Dialogues help changing this water management approach common to many regions."*
CONTACT INFORMATION	**Haifaa Abdulhalim** Protected Areas Programmeme Assistant E-mail: haifaa.abdulhalim@iucn.org
REFERENCE WEBSITE(S)	http://www.iucn.org/about/union/secretariat/offices/rowa/iucnwame_ourwork/iucnwame_reward/iucnwame_azraqoasisdialogue/ http://www.iucn.org/about/union/commissions/wcpa/wcpa_resources/wcpa_project/?228/Al-Azraq-Basin-National-Dialogue-lifts-hopes-for-a-better-future

The Nature Conservancy (TNC)

Brazil's Water Producer Programme

COUNTRY: Brazil **START DATE:** March 2005 **STATUS:** Active **ECOSYSTEM SERVICE(S):** Drinking water

BACKGROUND INFORMATION

The Parana River is the second longest river in South America running through Brazil, Paraguay and Argentina over a course of 2 570 km. The Parana River provides multiple ecosystem services to the populations living within its watershed, including the provision of drinking water to South America's largest city, São Paulo. However, the water quality of the Parana river has declined over time due to the intensive deforestation of the Atlantic Forest at its headwaters. Without forest cover around the river's edge (riparian zone) rainwater washes away soil leading to a build-up of sediment that alters the water quality.

PROPOSED SOLUTION

In an effort to improve the water quality of the Parana River while protecting the biodiversity of the Atlantic Forest, The Nature Conservancy developed the Water Producer Programme. The Programme proposes using a portion of water fees collected from major water users such as water supply companies and major industries to plant trees along riparian zones in the river's headwaters. These activities are executed by farmers and ranchers who receive a payment to reforest and/or maintain key sections of their land that are critical to the health of the Parana river. Landowners also receive technical assistance on reforestation, soil conservation and erosion prevention from the Programme's partners.

IMPLEMENTATION

The design of the Water Produce Programme started in late 2005 when The Nature Conservancy (TNC) organized a workshop with the Brazil's National Water Agency (ANA) and the Agriculture and Environment Secretaries of São Paulo. These organizations were also interested in implementing a payment for water services programme. In 2006, the programme was presented to the Piracicaba-Capivari-Jundiai (PCJ) Watershed Committee and the municipal government of Extrema in the State of Minas Gerais. The PCJ watershed is one of the two watersheds in Brazil that have a water use payment system according to the Brazilian Water Law (1993). It also supplies water to 50% of the metropolitan area of São Paulo. The Municipality of Extrema has developed its own payment system and it is an example for other municipal governments.

A cooperation partnership with the PCJ Watershed Committee, the municipal government of Extrema, governmental organizations and local NGOs was formalized through memoranda of understanding (MOUs) in 2006. The definition of the payment structure, as well as the identification and engagement of landowners was also completed that year. The first trees were planted in March of 2007 in three micro-watersheds located within the PCJ watershed: the Posses, Moinho and Cancã. It is expected that the programme will continue for three years at the regional level and for four years at the municipal level, which is the timeframe of the contracts signed with landowners. However, it is hope that the programme continues indefinitely and currently a monitoring system for it is being developed.

CHALLENGES

During the inception phase of the programme, gaining the PCJ Watershed Committee's approval was a challenge. Several meetings and discussions took place at this stage. To obtain the Committee's support it was key to show that the Programme could help enforcing the Brazilian Forestry Law. With the implementation of the programme, local landowners would stop converting areas considered as legal reserves by the Forest Code to agriculture and pastures. When the partnerships were established, defining landowner's payments was also challenging. The best amount was considered to be one that covers the opportunity cost for farmers and ranchers.

Some Lessons Learned

- A water ecosystem services payment system could be successfully implemented when key governmental water management agencies at different levels work together with landowners to reach the same goal.
- Restoring buffers along streams is one land management technique that improves water quality and benefits people living downstream who depend on the river for drinking water.
- Landowners could become strategic partners in the restoration of forests if they receive a payment equivalent to their opportunity cost.
- An ecosystem payment system can support the enforcement of environmental law and also promote sustainable livelihoods.

Partner(s)

- Brazil National Water Agency (ANA)
- Agriculture and Environmental Secretaries of Sao Paulo State
- Extrema Municipality in the State of Minas Gerais
- Forestry Agency of Minas Gerais State (IEF-MG)
- PCJ Watershed Committee

KEY PRINCIPLE(S)	*"Healthy forests provide important ecosystem services related to inland water ecosystems. They regulate water flows, protect watercourses and maintain water quality by reducing sediment and filtering pollutants."* *"People who benefit from a service should compensate the provider of that service."*
CONTACT INFORMATION	**Fernando Veiga** Acting Director - Atlantic Forest Conservation Programme E-mail: fveiga@tnc.org
REFERENCE WEBSITE(S)	http://www.nature.org/initiatives/freshwater/work/art24057.html http://www.nature.org/wherewework/greatrivers/samerica/art16572.html

Patuca River Case Study

COUNTRY: Honduras	**START DATE:** Aug 2006	**STATUS:** Completed	**ECOSYSTEM SERVICE(S):** Food and drinking water provision, transportation

BACKGROUND INFORMATION

The Patuca River is the second largest river in Central America. It begins in the mountains of central Honduras and travels eastward to the Caribbean Sea near the Nicaragua border. The area through which the river flows is part of the largest uninterrupted rainforest north of the Amazon and it functions as a biological corridor for Central American wildlife. Three indigenous communities also live in this area: Tawahka, Pech and Miskito. They rely extensively on the river and its surrounding landscape to maintain their traditional ways of life. The government plans for the construction of a hydropower dam to address the increasing energy demands of the country are threatened the intricate link between these indigenous communities and the Patuca River.

PROPOSED SOLUTION

The Nature Conservancy (TNC) entered into a unique agreement with Honduras' National Utility Company (ENEE) to design flow recommendations that would maintain the rivers' health and the ecosystems services it provides to indigenous communities. TNC developed a collaborative process to formulate these recommendations. Scientific experts, water managers and indigenous communities were engaged in this process, in particular the latter. ENEE is willing to include these recommendations in the design and management plan of the dam.

IMPLEMENTATION

The first step in the process was to learn more about the river system - the linkages between its ecology and hydrology - and the people who depend on it. In August 2006, a group of 12 researchers visited local communities during 11 days, and interviewed local individuals and small groups of fishermen. These interviews helped identifying locations for cross-sectional surveys (e.g. location of highest flow from past wet seasons), creating species list and fish ecology descriptions, and elaborating maps with locations of communities, river features and resources (agriculture, fish, etc.).

Using researchers' findings and hydrological analyses, ENEE conducted an environmental flow workshop for the Patuca River in December 2006. During the first day, information about the ecology of the river, flow regimes, hydrological alterations and the outcomes of the trip to riverside villages were discussed. In the following two days, workshop participants composed mostly of agency and academic scientists worked in groups to develop preliminary environmental flow recommendations. Once defined, these were shared with indigenous communities.

In August 2007, a workshop with 12 representatives of downstream communities (Tawahkas and Miskito villages) was conducted. Community members worked in groups to discuss the effects of the flow recommendations on fish, agriculture and transportation. As a result, maps depicting seasonal flow levels and critical sites where low flow hinder boat traffic and graphics showing the specific months when flows are preferred for crops were prepared. These outputs were integrated into the draft flow recommendations, which would be considered by dam engineers and operators.

CHALLENGES

Local communities have an understanding of river hydrology and ecology, and so water managers, representatives from governmental agencies and dam proponents. However, their perspectives are different. Generating a common vocabulary between these two groups of stakeholders to generate the final flow recommendations was a challenge. When conducting the workshops to generate the draft flow recommendations it was also noticed that capacity building at different levels is needed. The utilization of the Regime Prescription tool, a specialized computer software programme developed jointly by the U.S. Army Corps of Engineers and TNC, helped generating the recommendations

Some Lessons Learned

- It is possible to positively influence new dam initiatives in developing countries, when projects' proponents are willing to incorporate stakeholders flow recommendations in the design and management of dams.
- Local communities' knowledge is of utmost important in the design of flow recommendations for hydropower projects, in particular in developing countries where lack of hydrological and other baseline data is common.
- When working together, indigenous communities, conservationist, water managers and project proponents can reach decisions to ensure a sustainable future for both people and the natural world.

Main Partner(s)

- Empresa Nacional de Enegia (ENEE)
- The University of Michigan, School of Natural Resources
- Tawhkas and Miskito indigenous communities

KEY PRINCIPLE(S)	*"Local communities hold unique traditional knowledge that could be used to design dams and reduce their impacts on rivers, ecosystems services and indigenous people livelihoods."*
CONTACT INFORMATION	**Jeff Opperman** Senior Advisor for Sustainable Hydropower E-mail: jopperman@tnc.org
REFERENCE WEBSITE(S)	http://www.nature.org/initiatives/freshwater/files/final_patuca_case_study_low_res_new_logo.pdf http://www.nature.org/tncscience/worldwaterday/features/honduras.html http://utopia.sbs.ohio-state.edu/faculty/mcsweeney/FORO%20PATUCA%20III/Articulos%20y%20otros%20documentos/TNC%20Presentacion.pdf

The Sustainable Rivers Project - Savannah River Case Study

COUNTRY: United States **START DATE:** April 2003 **STATUS:** Completed

BACKGROUND INFORMATION

Originating in the Blue Ridge Mountains of North Georgia, the Savannah River flows for more than 300 miles into the Atlantic Ocean. The lower Savannah River watershed encompasses more than 10 577 square miles and supports extremely high species diversity, including the greatest number of native fish species (108) of any river draining into the Atlantic. Despite its scenic beauty and natural diversity, the ecological health of the river system — from the headwaters to the estuary — is declining. The construction of three dams and reservoir systems just 50 years ago has negatively altered the natural flow patterns that support the wildlife and natural communities of the Savannah River, its floodplain and its estuary.

PROPOSED SOLUTION

In 2002, the US Army Corps of Engineers (Corps) and The Nature Conservancy (TNC) launched the Sustainable Rivers Project (SRP) to restore rivers below Corps dams. One of these rivers was the Savannah River. The main restoration strategy was to define flow regimes that restore downstream ecosystems processes and services, while continuing to meet other human uses of water such as power generation, recreation and flood control.

IMPLEMENTATION

The project began in April 2003, when TNC and Corps convened an orientation meeting with more than 50 leading scientists from the Georgia and South Carolina state governments, federal agencies, academic institutions and other non-governmental organizations. In this meeting, the preparation of a literature review and summary report was agreed. Using this historical data, the team defined the seasonal water flows needed to support the freshwater, floodplain and estuary during a flow recommendation workshop. A plan for executing a series of seasonal controlled releases (or flow prescription) was then designed. In March 2004, this plan was put to the test with the release of the first controlled flood. For five days, the Corps released 450 cubic meters per second (cms) of water from the Thurmond Dam, a sizable increase from the existing daily release of 130 cms.

Several controlled floods have been conducted since March 2004 to present time. These control releases mimic flow conditions prior to the construction of dams. The ecological effects of the water flow restoration efforts have also been evaluated through a number of projects. These included monitoring the potential regenerative benefits to floodplain forest, tracking the movement of shortnose sturgeon, monitoring floodplain invertebrates and fish, and measuring the effects of the controlled floods on the salinity of the estuary. Through this process, TNC and its partners have gained valuable insight to the water flow patterns necessary to support native wildlife. The Savannah River project is today a model for sustainable dam operations and management worldwide.

CHALLENGES

It was quite difficult to get the participants in the flow recommendations workshops to suggest any quantitative flow targets. However, by reminding them that their recommendations were a first approximation that would be refined over time through an adaptive management process, the targets could be established. Working with many scientists and agencies could be onerous and time-consuming. These constrains were avoided by given the most time-consuming activity (literature review and summary report) to only one research team. This report became the base-knowledge for the other scientists in the project and it was easier to reach consensus during the flow recommendations workshop. Costs were reduced because researchers contributed their time as part of their regular job duties and because a considerable volume of relevant information already existed for the Savannah River.

Some Lessons Learned

- Impacts from dams can be mitigated by developing environmental flows recommendations.
- These can be designed following a four-step process: 1) orientation meeting, 2) baseline data report, 3) flow recommendations workshops, and 4) implementation of the recommendations.
- Engaging a large number of scientists from agencies and institutions gives the flow recommendations a high level of credibility. It also results in a coordinated and consistent vision for the protection and management of the river.
- Participation of regulatory agencies' representatives results in inclusion of flow recommendations in their regulatory decisions.

Main Partner(s)

- U.S. Corps of Engineers
- South Carolina Department of Natural Resources
- University of Georgia (UGA)
- Savannah District Water Management Group

KEY PRINCIPLE(S)	*"Innovative science can help protecting the ecological health of a river, while addressing the growing needs for drinking water, power generation and flood control."*
CONTACT INFORMATION	**Andrew Warner** TNC Senior Advisor for Water Management E-mail: awarner@tnc.org
REFERENCE WEBSITE(S)	http://www.nature.org/partners/commonground/partnership/savannah.html http://www.nature.org/initiatives/freshwater/files/savannah_case_study_v1_new_logo.pdf

Tamarisk Control Project for the San Miguel River

The Nature Conservancy
Protecting nature. Preserving life.

COUNTRY: United States of America **START DATE:** 2001 **STATUS:** Completed (Oct 2008).

BACKGROUND INFORMATION

The San Miguel River is one of the last free flowing rivers in the Colorado River Watershed. The river supports dynamically functioning riparian and aquatic habitat types and associated species. In the 1930s, tamarisk or salt cedar was planted by the millions in the West Region of US as part of a federal government programme to control erosion: the Shelterbelt Programme. This small, tree-like species forms dense thickets that choke out native plants and consume massive quantities of water (more than 200 gallons of water a day) draining precious water resources. In addition, tamarisk's dense growth harms wildlife by blocking entrance to the water. It is also a nuisance to boaters and fishermen because it narrows streams and chokes out campsites.

PROPOSED SOLUTION

The Nature Conservancy developed a Tamarisk Control Project to remove this aggressive invasive species from Colorado's San Miguel River. The project ran for eight years and two main methods were used to remove the species: a biological control agent and the cut-stump method. Today, 120 miles of the river are tamarisk-free.

IMPLEMENTATION

An inventory of the species within the project area (lower San Miguel River Watershed within the San Miguel and Montrose Counties) was conducted at the beginning of the project. The data obtained was used to prepare maps showing species location and density. It also helped to select the eradication method. An education and outreach campaign was initiated in parallel. The project was presented in public forums throughout the watershed. Press releases, radio spots and ads were also disseminated. This campaign continued until the end of the project.

The field work was completed by trained crews that worked simultaneously along the main stem and the other tributaries. The cut-stump method, which combines mechanical and chemical techniques, was used. Tamarisks were cut using chainsaws, clippers and heavy equipment. Then, an herbicide (Garlon 4) mixed in oil was directly applied to the cut tamarisk stumps. Native willows and/or cottonwoods where planted in some areas as needed. This work was mainly completed by volunteers. Follow-up and evaluation activities started the fifth year of the project. Tamarisk re-grow was monitoring in control points along with plant communities, birds and invertebrates' presence. In the sixth year of the project, a new control method was introduced, the tamarisk beetle. This beetle defoliated a majority of the tamarisk on a 60-mile reach of the Colorado River the last three years of the project.

CHALLENGES

Removal of the tamarisk in the San Miguel River was not an easy task. This species re-grow very fast. Without the support of dozens of volunteers to clear tamarisk the results obtained would not have been achieved. The tamarisk also beetle played an important role in the success of the project.

Some Lessons Learned

- Removal of invasive species required long term commitment from project's partners. The use of different eradication methods (cutting down, herbicides and biological control) is crucial to achieve success.
- A strong educational and outreach campaign is a key element of an invasive species control project. It facilitates the in kind participation of local individuals and companies, which is important to complete eradication activities in the field.

Partner(s)

- The Bureau of Land Management
- Marathon Oil Corporation
- Fish and Wildlife Foundation
- US Department of Agriculture
- Tamarisk Coalition
- Volunteers

KEY PRINCIPLE(S)	*"The cost and damages of invasive species are great. A combination of prevention, early detection, eradication, restoration, research and outreach is necessary to control the threat posed by invasive species to terrestrial and freshwater species and ecosystems."*
CONTACT INFORMATIO N	**Aaron Drew** The Nature Conservancy in Arizona E-mail: adrew@*tnc*.org
REFERENCE WEBSITE(S)	http://www.nature.org/wherewework/northamerica/states/colorado/press/press3745.html http://www.nature.org/wherewework/northamerica/states/colorado/features/art26631.html http://www.nytimes.com/2008/12/27/us/27tamarisk.html?_r=2

Sustainable Rivers Project – Green River Case Study

COUNTRY: United States	**START DATE:** 1999	**STATUS:** Active

BACKGROUND INFORMATION

The Green River is a tributary of the Ohio River and it is located in south-central Kentucky. It harbors one of the most diverse assemblages of fish and freshwater mussels in the United States. More than 150 fish species and more than 70 mussel species have been found in the river, which is also connected to and supports a host of cave-adapted species within Mammoth Cave National Park, the world's most extensive known cave system. The natural functions of the Green River system have been altered by the construction of the Green River Dam, which negatively impacted the river. As a result, there is rarely enough flow when the river should be flooding, far too much when it should be trickling, and the water is almost always too cold for its native inhabitants. This puts great stress on the river system and the species that have evolved to live in it.

PROPOSED SOLUTION

In 1999, The Nature Conservancy (TNC) met with managers at the Corps' Louisville District office in Louisville, Kentucky, to discuss the effects of dams on the health of the Green River. In this meeting, both organizations decided to create a project to restore more natural regimes of flow and stream temperature by changing the way the water was released from the Green River Dam.

IMPLEMENTATION

To evaluate options for changing operations of the Green River Dam, two computer programmes were used, a reservoir operations model created by the Corps and the Indicators of Hydrological Alteration (IHA) programme created by TNC. IHA is a specialized computer programme designed to evaluate trends in river flows and compare differences in flow patterns under different conditions, such as before and after a dam is constructed. Based on the computer programmes' results, a plan was designed to change dam operations so as to restore more natural patterns of river flow and temperature and also improve downstream flood control while extending the recreation season on the reservoir.

According to the plan proposed, the level of the reservoir was raised in the winter about a meter. This reduced the difference between the summer and winter levels. It also eliminated the need to capture as much water in the spring or to release as much in the autumn. This solution met the needs of multiple stakeholders. Downstream landowners were not adversely affected as reservoir releases during crop season remained unchanged. Moreover, certain flood control benefits were improved and the recreational period on the reservoir was extended by six weeks.

In May 2002, the plan was approved and officially integrated into the water management policies of the Louisville District. In 2006, these operations became permanent. Although the long-term ecological effect of the dam's re-operation is still being studied, one promising sign has been an increase in the abundance and diversity of native mussels found at a site close to the dam. In addition, National Park Service scientists are also encouraged by improved hydrological conditions seen downstream within Mammoth Cave.

Some Lessons Learned	**Partner(s)**
• It is possible to modified dam operations so that key ecological processes, such as fish spawning and forest regeneration, endure while maintaining the benefits of dams such as flood control, recreation and power generation. • Flow recommendations can be generated using specialized computer programmes such as the Indicators of Hydrological Alterations (IHA) created by TNC.	• U.S. Corps of Engineers

KEY PRINCIPLE(S)	*"Every river system has a natural, seasonal flow pattern—often referred to as the environmental flow—that sustains the health of the ecosystem."*
CONTACT INFORMATION	**Andrew Warner** TNC Senior Advisor for Water Management E-mail: awarner@tnc.org
REFERENCE WEBSITE(S)	http://www.nature.org/initiatives/freshwater/press/press2982.html http://www.nature.org/initiatives/freshwater/files/green_river_case_study_final_high_res_new_logo.pdf

The Alliance for Water Stewardship

START DATE: 2008 **STATUS:** Active

BACKGROUND INFORMATION

The current demand for freshwater from cities, agriculture and industry is already unsustainable and is projected to increase dramatically in coming years. Nearly two billion people lack access to clean water for drinking or sanitation. In addition, many of the rivers and lakes that provide water are polluted or running dry. It will not be possible to avert a global water crisis without efforts to improve management of water resources. This could be achieved through the development of common water stewardship standards.

PROPOSED SOLUTION

TNC has supported the creation of the Alliance for Water Stewardship (AWS), an international partnership with the mission to develop the world's first water stewardship certification programme for people involved in water management. This programme will define standards for water use and management in a way that minimizes impacts on freshwater ecosystems. It will also provide an incentive for large-scale water users to meet these standards so that their water management practices can be certified as sustainable.

IMPLEMENTATION

In late 2006, TNC facilitated a roundtable meeting with more than 50 water experts that included leaders from the drinking water community, local governments, sustainability and certification programmes, NGO and other water community stakeholders. Participants agreed that the creation of a freshwater certification was a good idea; however, they also stated that an extensive outreach, partnership and collaborative efforts were needed. This was the first step in the creation of AWS. In early 2008, the signature of a Memorandum of Understanding among TNC, WSI and the Pacific Institute finally establish the AWS.

Involved in the effort to date are TNC, WWF, the Water Stewardship Initiative, Water Witness International, the Water Environment Federation, the European Water Partnership and the Pacific Institute. The international standards for the certification programme are currently under development. A first workshop took place in December 2008 in England, and a second one was held at the Water Footprint Summit in USA in February 2009. In the coming months, AWS will continue its outreach campaign to involve new organizations in the effort to create the first freshwater certification programme. AWS is also beginning a multi-year global roundtable process. Through the global water roundtable, AWS will convene an internationally representative group of water stakeholders to establish a universally-accepted international framework for water stewardship.

Partner(s)

- Pacific Institute
- WWF
- The Water Stewardship Initiative
- Water Witness
- Water Environment Federation
- European Water Partnership

KEY PRINCIPLE(S)	*"Social and environmental certification programmes have emerged as powerful tools to influence business practices and respond to consumer preferences."*
CONTACT INFORMATION	**Karin Krchnak** Director of International Water Policy E-mail: kkrchnak@tnc.org
REFERENCE WEBSITE(S)	http://www.allianceforwaterstewardship.org/ http://www.allianceforwaterstewardship.org/about_pdfs/AWS%20Fact%20Sheet_letter.pdf

The Bogota Water Fund

COUNTRY: Colombia **START DATE:** April 2006 **STATUS:** Active **ECOSYSTEM SERVICE(S):** Drinking water supply

BACKGROUND INFORMATION
The water supply for the city of Bogotá, Colombia's capital, is provided by the water supply systems Chingaza, Tunjuelo and Tibitoc. Forest and páramos (high-altitude grasslands) within these watersheds harbor extraordinary biological diversity and are essential habitat for many endangered species, including spectacled bears and Andean condors. Unsustainable agriculture and ranching practices, however, are converting these ecosystems from their natural state and causing soil erosion and sedimentation. In addition, conservation activities in the protected areas of the Chingaza watershed are limited by budget constrains. With none incentives or sufficient resources to effectively conserve the watersheds, the water consumed in Bogotá requires additional treatment to reduce sediment concentrations.

PROPOSED SOLUTION
The Nature Conservancy (TNC) proposed the creation of a water conservation fund to guarantee clean drinking water provision for Bogotá's eight million residents. Through the fund, voluntary contributions from Bogotá's water treatment facilities and other project's partners will subsidize conservation projects that will keep sedimentation and runoff out of the region's rivers. Besides lowering water-treatment costs due to decreased sedimentation levels, this type of fund will also help conserve biological diversity and have a positive social impact.

IMPLEMENTATION
The design of the Water Conservation Fund for the city of Bogotá started in 2006 based on a similar experience developed by TNC in Ecuador. In 2007, a Memorandum of Understanding was signed by the Bogotá Water Facility Company, Patrimonio Natural Foundation, The National Parks Service and The Nature Conservancy. A Technical Committee was then formed and a feasibility study initiated. This study included hydrological and socioeconomic models to define sedimentation loads. It also identified priority areas for conservation and investment alternatives. Five possible investment lines were proposed: sustainable productive systems (e.g. silvopastoral systems), eco-tourism, climate change adaptation, protected areas management plans, and land management. These alternatives contribute to ecosystem conservation, but are also attractive for local communities and environmental authorities.

The results of the feasibility study were presented to a broad range of public and private stakeholders. The fund was officially launched in April 16, 2008 with the support of the municipality of Bogotá and the brewery company Bavaria Sab-Miller. A key strategy to gain support from new partners was to show that investment in the conservation of the watersheds surrounding the city will save 88 billion Colombian pesos over the next 10 years in water treatment costs. It was also important to demonstrate that the water costs for residents will not raise because the fund is voluntary.

The fund is projected to raise more than 100 billion Colombian pesos (60 million US dollars) for conservation projects over the next 10 years. As an endowment, the conservation investments will be raised from the benefits produced by the interest rates —an estimated seven billion Colombian pesos per year. This figure allows for the fund to be self-sustaining, but also provides for the long-term financing of watershed conservation from the yields generated by financial markets. The fund will be managed by an Executive Board of key water users' representatives that will define its guidelines and areas of investment. This will guarantee an efficient allocation of resources.

CHALLENGES
Political changes within the public institutions supporting the establishment of the fund affected the project timeline. New negotiations with managers and governmental representatives were needed. Demonstrating with numbers the tremendous return on investment that could be achieved through the fund was strategic to regain support from public entities.

Some Lessons Learned

- A voluntary Water Conservation Fund can guarantee water quality and supply for a city, while contributing to the conservation of biodiversity in related watersheds. In addition, it can reduce water treatment cost without increasing the citizens' user fees.
- Isolated decisions from different water users do not allow long-term watershed conservation and management. Because a Water Conservation Fund includes the creation of a technical committee that control resource allocation, a more efficient management can be accomplished.

Partner(s)

- Bogotá Water Facility Company (EAAB)
- National Park Service
- Patrimonio Natural Foundation
- Bavaria Sab-Miller

KEY PRINCIPLE(S)	*"Payment for environmental services (PES) mechanisms in the water sector such as water conservation funds, promote the conservation of upstream areas and, thus, ultimately entire watersheds, through compensation for ecosystem friendly land use practices."*
CONTACT INFORMATION	**José Yunis** TNC Colombia External Affairs Director E-mail: jyunis@tnc.org
REFERENCE WEBSITE(S)	http://www.nature.org/wherewework/southamerica/colombia/work/art24802.html

Evaluating Reservoir Operations and the Impacts of Climate Change in the Connecticut River Basin	The Nature Conservancy. Protecting nature. Preserving life.

COUNTRY: United States	**START DATE:** August 2008	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Habitat, water supply, flood control and hydropower generation

BACKGROUND INFORMATION

The Connecticut River is the largest river in the New England Region of Northeastern United States. With a total length of 655 km and a drainage basin of 29 100 km^2, the river flows through four states: New Hampshire, Vermont, Massachusetts and Connecticut. Intense human use has affected this freshwater ecosystem. Most of its streamside forests are now farms and those still remaining are fragmented by the expansion of cities. Dams and mills have changed its flows and polluted its waters taking a toll on fishes and other wildlife. Currently, there are more than 2 700 dams in the Connecticut River watershed. While dam removal may be an option for some of them, alternative solutions for large dams are needed, in particular ones that consider climate change impacts on freshwater ecosystems.

PROPOSED SOLUTION

As part of its programmeme of work in the Connecticut River, The Nature Conservancy (TNC) and partners have started a project to evaluate reservoir operations and the impacts of climate change. The project aims to understand how dam management can be modified so that environmental benefits are obtained while maintaining beneficial human uses. Two key instruments will support this objective: a basin-wide hydrological model and a decision support tool that will allow water managers and other key stakeholders to evaluate environmental and economic outcomes based on various management scenarios.

IMPLEMENTATION

A Project Cooperation Agreement (PCA) between the US Army Corps of Engineers, the University of Massachusetts (UMASS) and TNC was signed in August 2005 to develop this project. However, legal issues temporarily stopped the project until 2007. During that year discussion about modeling approaches took place and the scope of the project was redefined to include all Corps impoundments in Connecticut River Basin. The formulation of the project's plan also started and four interrelated activities were proposed: creation of downscaled climate and hydrology data to investigate climate change, construction of climate informed streamflow forecasts, development of decision support tools to guide river operations and facilitation of stakeholder involvement.

The first activity involves using statistical downscaling methods to create future climate and hydrological data that could be later input in a hydrology model to simulate runoff processes for individual watersheds. Generated runoff values will be coupled with the current USGS models to determine the impacts of climate change on streamflow for many locations within the basin. The second activity consists of developing seasonal streamflow forecasts using current data from environmental monitoring and climatic models. Based on these forecasts, a seasonal reservoir operating guidance and a multi-objective optimization model will be developed. The model will compute daily releases from dams while addressing all operational concerns in the basin (power production, flood control, water supply and replication of naturalized streamflows). A series of workshops will be conducted throughout the project to ensure stakeholder engagement in the modeling process.

The first and fourth activities have started. Climatic and hydrological data are being collated. Around 100 stakeholders (dam owners, local governments, governmental organizations and abutters) have been informed about the project and their active participation is expected in the coming years. The project would be completed in five years, with the multi-objective model completed by the third year.

CHALLENGES

Legislative and fiscal challenges emerged early in the project holding it up for two years. During this time, TNC was able to move forward with scientific analysis using private funds until modifications in the Water Resources Development Act of 2007 allow the project to continue. Currently, challenges related to downscaling data have emerged (scale of work, management of statistical errors, among others). Support from the UMASS' researchers will be very important to solve these issues. Once the model of the project is developed, sharing results with stakeholders would also be an important challenge for the project.

Some Lessons Learned

- Basin-wide hydrologic models that take into account climate change are important tools to understand current and future stream flow variations and develop appropriate reservoir management guidelines, while assuring beneficial human uses and biodiversity conservation.
- Understanding how stream flow may vary under a changing climate could also assist with decision making around future reservoirs' licensing processes.
- The disciplined and organized involvement of stakeholders in the modeling process is one of the key components in developing acceptance of modeling results and the overall success of the project.

Partner(s)

- The US Army Corps of Engineers (Corps)
- University of Massachusetts (UMASS)
- The US Geological Service (USGS)
- The US Fish and Wildlife Service (USFW)

KEY PRINCIPLE(S)	*"Streamflow alteration due to dam operations is one of the most critical threats to freshwater ecosystems. Hydrological models at a basin- scale can support sustainable management of dam impacted rivers in a changing climate."*
CONTACT INFORMATION	**Kim Lutz** Director, Connecticut River Programme E-mail: klutz@tnc.org
REFERENCE WEBSITE(S)	http://conserveonline.org/workspaces/ctriver

Garcia River Forest Climate Action Plan Project

COUNTRY: United States	**START DATE:** 2004	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Carbon storage

BACKGROUND INFORMATION
The Garcia River is one of the most important rivers of the Californian Redwood Region. For decades, logging has been the predominant land use in the watershed. Increased uncertainty about the timber industry in the California North Coast changed this situation and forced some timber industrial and non-industrial forestland owners to sell their properties. Fragmentation of the Garcia River's forest then started as new rural residential subdivisions and vineyards were established. The preservation of this forestland through public acquisition was not viable, thus, a new protection approach was needed, in particular one that include climate change issues.

PROPOSED SOLUTION
In February 2004, The Nature Conservancy and The Conservation Fund (TCF) purchased a 23 780-acre property along the upper Garcia River Basin in the redwood forest of Mendocino County, California. The goal of this purchase was to protect significant natural, ecological and aesthetic values, and to develop and implement a model of sustainable forestry practices that would be in accordance with climate change mitigation efforts.

IMPLEMENTATION
Since 2004 various activities are being developed in the Garcia River Forest to accomplish the project's goals. These can be classified in three areas: restoration and enhancement, watershed management and silviculture. Additional management activities included public use, monitoring and research, and education and demonstration. These activities are fully described in the Integrated Management Plan for the Garcia River Forest, which was completed in August 2006.

As part of the restoration activities, poorly planned logging roads in the Garcia River Forest are being upgraded. These roads run through the forest and transport sediment to rivers and streams. This fine sediment can smother salmon nests and fill the pools were it rears. Because filled pools are also shallower, streams become wider and water temperatures increase limiting coho rearing. Natural wood structures are being built in the streams to encourage scour and create the deep pools that coho need to rear. This species has been seen in the area, which indicates an improvement of the river's health.

Silviculture activities are also having good results. In early 2007, the first light-touch logging took place on Garcia River. This method of timber harvesting selects inferior trees for removal, thus promoting the growth of stronger trees. It's a process that maximizes carbon storage and accelerates the recovery of the forest ecosystem. As a result of light-touch logging, the local mill received 350 000 board feet of timber.

In February 2008, the California Climate Action Registry (CCAR) — the most prescriptive set of standards for forest management carbon projects in the world — certified the 23 780-acre Garcia River Forest as a source of carbon credits. It is expected that over its 100 year lifetime, the Garcia River Forest project will absorb and store 4.2 million metric tons of carbon dioxide by ensuring high forest growth rates and the development of larger and denser stands of redwood and Douglas fir.

CHALLENGES
The main challenges to the success of this project include low current timber volumes, a predominance of hardwoods in many stands, the burden of maintaining and improving an extensive road system, as well as the uncertain economic, regulatory and political environment affecting the timber industry as a whole.

Some Lessons Learned	Partner(s)
• The restoration of a commercial forest can support forest carbon storage, but also the rehabilitation of streams and creeks by improving water quality and creating important habitat for freshwater species.	• The State Coastal Conservancy • Wildlife Conservation Board • Friends of the Garcia

KEY PRINCIPLE(S)	*"Sustainable timber production can go hand-in-hand with not just maintaining but actually improving the ecological health of forest and the rivers within them, while supporting climate stabilization."*
CONTACT INFORMATION	**Zoë Kant** Manager of Carbon Markets E-mail: zkant@tnc.org
REFERENCE WEBSITE(S)	http://www.nature.org/initiatives/climatechange/work/art23798.html http://www.conservationfund.org/node/750 http://www.nature.org/initiatives/climatechange/files/garcia_river_fact_sheet_final.pdf

Mill River Habitat Restoration Project

The Nature Conservancy
Protecting nature. Preserving life.

COUNTRY: United States	**START DATE:** June 2007	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Fish habitat, recreation, water supply & climate change adaptation

BACKGROUND INFORMATION

The Mill River in Taunton, Massachusetts (MA), is a tributary of the Tauton River, one of the highest quality coastal rivers in New England. When the first settlers arrived in the Mill River Valley the fisheries were abundant. This changed, however, as Tauton developed into an industrial manufacturing and shipbuilding city during the 1800s. Mills and dams were built and fish migration was affected as a result. Today four dams remain on the Mill River: Morey's Bridge, Whittenton Mill, West Brittania and Tauton State Hospital. In 2005, the Whittenton Mill Dam nearly failed during a storm event and approximately 2 000 people were evacuated from their homes. With storm events expected to increase in Northeastern United States due to climate change, there is a concern about the occurrence of similar incidents in the future.

PROPOSED SOLUTION

The Southeastern Regional Planning and Economic Development District (SRPEDD) in partnership with the Massachusetts Field Office of The Nature Conservancy (TNC) and other organizations are proposing a restoration project in the Mill River. This project aims to reduce future risks of flooding while reconnecting and restoring 37 miles of aquatic habitat and maintaining the historical and recreational value of the Mill River. The Whittenton Mill Dam, the West Brittania Dam and the Tauton State Hospital Dam will be removed, while the dam farthest upriver, the Morey's Bridge Dam, is proposed to remain in place. This is because it enlarges the natural Lake Sabbatia, which is valued by residential abutters as a recreational amenity and also supports water supply wells of some homeowners. Installation of a fish ladder at this dam is also proposed to improve upstream spawning access.

IMPLEMENTATION

In its inception phase, the project partners met several times to plan fundraising activities for a feasibility study. Grants from American Rivers/NOAA and Jefferson Development were obtained and the study was completed and published in late 2008. It includes cost estimates and conceptual designs for alternatives at each site, as well as channel restoration options, sediment quality and quantity, historical and community issues. For the three downstream dams, the study recommends removal as the option that best meets the combined goal of fish passage, habitat restoration, public safety, and restoration of the riparian area. A three-year monitoring plan after completion of restoration activities is also proposed.

Early in the project, a Citizen Advisory Group (CAG) consisting of city officials, residents and local groups was formed to help the project partners to understand local needs and issues including safety, recreation and scenic quality. The CAG reviewed the findings of the feasibility study in February 2009 and expressed its support for the proposed recommendations. In addition, throughout the feasibility/design process to date, TNC and project partners have been meeting and consulting with the dam owners, abutters, City and State elected officials and other community stakeholders to provide information and build support for the project.

While the ultimate decision about the restoration activities will remain with the dam owners, taking input from all stakeholders is a key strategy in the project. Thus, community involvement will continue for the coming project's phases (construction and monitoring), as well as fundraising activities for final engineering and permitting at each site. The project is proposed to be completed by 2011.

CHALLENGES

Two project challenges have arisen to date. The owner of the Morey's Bridge Dam has been slow in address actions required under a state dam safety order and a DEP enforcement order. A suit against him was filed by the MA Attorney General's office and a preliminary injunction was issued in Superior Court on November 2008. Some of the actions suggested have been taken, but a multi-party mediation is scheduled for Spring 2009. This situation has resulted in some uncertainty in the restoration activities proposed for the Morey's Bridge Dam and negative media exposure of the project. To overcome this situation a press strategy is under development to place positive stories on the project. The second challenge is related to some Whittenton Dam abutters' concerns about losing their impoundment. While the owner of that dam is fully supportive of removal, both he and local elected officials are sensitive to neighborhood sentiment. It is expected that through the community involvement work proposed as part of the project, these concerns will be addressed and solved.

Some Lessons Learned

- Successful restoration of urban rivers requires participation of local, state and federal governmental organizations and local communities, which should be involved in the project as early as possible.
- The creation of a Citizen Advisory Group is a good strategy to gain community support for a restoration project.
- Local communities' questions and concerns can be addressed through public meetings, while those of abutters and dams owners should be addressed individually.

Main Partner(s)

- American Rivers (NGO)
- Jefferson Development Partners (Developers)
- Save The Bay (NGO)
- Mass Audobon (NGO)
- MA Division of Marine Fisheries
- MA Riverways Programme, Department of Fish and Game
- NOAA Restoration Center (Federal organization)
- SRPEDD (Regional organization)
- Taunton River Watershed Association(TRWA)
- US Fish and Wildlife Service (Federal)

KEY PRINCIPLE(S)	*"Dam removals and aquatic habitat restoration are adaptation options that maximize freshwater ecosystems' resilience to climate change, while reducing risks of flooding and enhancing public safety."*
CONTACT INFORMATION	**Alison Bowden** Freshwater Programme Director E-mail: abowden@tnc.org
REFERENCE WEBSITE(S)	http://www.srpedd.org/environmental.asp (Feasibility study) http://www.mass.gov/dfwele/river/programmes/priorityprojects/millriver.htm

Wetlands International

Management Planning for Wular Lake

COUNTRY: India	**START DATE:** December 2006	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Freshwater provision

BACKGROUND INFORMATION
Wular Lake is one of the largest freshwater lakes in Asia and a designated Ramsar wetland since 1990. The lake acts as a huge absorption basin for the annual floodwaters within the River Jhelmun basin. It is also an important habitat for wildlife and a fishery resource for the population living along its fringes. The state government constituted the Wular and Mansbal Development Authority to coordinate developmental activities in the lake's basin. However, unsustainable agricultural practices, pollution from fertilizers and animal wastes, among other developmental activities are still affecting the lake and its ecological integrity.

PROPOSED SOLUTION
Wetlands International (WI) – South Asia prepared a Comprehensive Management Plan for Wular Lake to support the Government of Jammu and Kashmir in its decision to improve the management of this Ramsar Site. Emphasis was given to the development of an effective institutional mechanism to conserve and manage Wular Lake. The principles of integrated water resource management were taken into account to this end.

IMPLEMENTATION
The Wular Lake Management Plan was based on a rapid inventory and assessment of hydrological, ecological, socioeconomic and institutional features of the lake and its surrounding catchments. Existing information about the lake was also collated through intensive community consultations and participatory resource appraisals. Data was also provided by several state government departments including the department of archives, wildlife protection, forests, fisheries, revenue, planning, environment and remote sensing, irrigation and flood control, agriculture, tourism, Lakes and Waterways Development Authority and Wular and Manasbal Development Authority.

The plan proposes a series of measures within the lake and its catchments to ensure restoration of the wetland and livelihood security of the associated communities. These are grouped in five areas: land and water resources management, biodiversity conservation, ecotourism development, livelihood improvement and institutional development. The implementation of the plan is proposed for five years. The measures in the plan follow a community based approach to resource management with facilitation from government agencies and scientific institutions in terms of technical and financial resources.

The main recommendations of the plan are: 1) establish a Development Authority just for Wular Lake conformed by a governing body, a steering committee, scientific and community advisory groups, and a project management unit, 2) remove the 27.30 km^2-Ningli Plantation to enhance water holding capacity of the lake, 3) implement the River Jhelum Conservation Plan already approved by the Ministry of Environment and Forest to improve water quality, 4) conduct and environmental flow assessment for the Jhelum Basin, 5) aforestation of 7 436 ha of critically degraded forest in the lake catchment, 6) establish wildlife/bird sanctuaries, 7) develop recreational facilities for ecotourism, and 8) develop sustainable fishing plans with local communities.

CHALLENGES
Information about the lake and its resources was in many cases grossly inadequate for in-depth analysis; however, broad-trends were obtained based on critical evaluation of the information obtained from various sources.

Some Lessons Learned

- Coordinated sectoral management is necessary to avoid degradation and unsustainable management of wetland ecosystems. An effective institutional mechanism based on an integrated water resources management approach supports this strategy.
- Local communities should be at the center of wetland ecosystems' management, with government agencies and scientific institutions acting as facilitators of their management actions.
- Measures within a wetland management plan should seek for a balance between livelihood security of local communities and ecosystem conservation.

Partners

- Department of Wildlife Protection of the Government of Jammu and Kashmir
- Water Institute of South Africa (WISA)

KEY PRINCIPLE(S)	*"An integrated water resources management approach that recognizes the interconnectedness of wetlands with their catchments is imperative for their sustainable management."*
CONTACT INFORMATION	**Ritesh Kumar** Senior Technical Officer E-mail: ritesh.kumar@wi-sa.org
REFERENCE WEBSITE(S)	http://south-asia.wetlands.org/WHATWEDO/Allourprojects/tabid/639/mod/601/articleType/ArticleView/articleId/2135/Management-Planning-for-Wular-Lake-Kashmir.aspx

Integrated Management of Wetlands in the Ruoergai Plateau and Altai Mountains

COUNTRY: China | **START DATE:** June 2007 | **STATUS:** Active | **ECOSYSTEM SERVICE(S):** Carbon sequestration, water provision

BACKGROUND INFORMATION

China has about 6 million hectares of mountain wetlands of which the largest majority is peatlands. They provide key habitats for endangered wildlife and plant species and they also maintain water levels in streams, rivers and adjacent grasslands. Peatlands also provide important ecosystem services in storing and sequestrating huge amounts of carbon. However, they are negatively impacted by unsustainable farming practices (drainage, over-grazing), mining and infrastructure development, and by climate change.

PROPOSED SOLUTION

The project aims to involve different stakeholders from various sectors and government levels (central, provincial, prefecture, county and community) to support the integrated management of mountain peatlands. The project work is being conducted in two demonstration sites: the Ruoergai Marshes on the Qinghai Tibetan Plateau and the Altai Mountains in northwestern China. In these locations, practical ways in which biodiversity conservation and provision of ecosystem services can be supported by different economic sectors and local communities are being tested.

IMPLEMENTATION

An inception meeting to inform all partners about the project scenario took place in August 2007, followed by the first Project Steering Group Meeting. During 2007, Local stakeholder meetings were also organized in Altai (Xinjiang Province), Lanzhou, Luqu (Gansu Province) and Ruoergai (Sichuan Province) to enhance understanding of the project and importance of biodiversity conservation. In parallel, biodiversity and socioeconomic data collation started for the two demonstration sites.

In 2007, field activities were also initiated by training key local personnel in the Ruoergai Plateau and Altai on peatland survey. When the training workshops were completed, field surveys and assessment started. Based on collated and field data, various strategies for protection and sustainable use of the Altai mountain wetlands were reviewed and a rapid assessment report prepared. This report was presented to all stakeholders and their input considered in its final version. Solutions proposed for the integrated management of peatlands focused on changes in infrastructure planning and grazing management. Techniques for restoring peatlands damaged by old drainage schemes were also included in the plan. Currently, other conservation strategies are under development with collaboration of local governments.

Some Lessons Learned

- The integrated management of mountain wetlands and other freshwater ecosystems requires active participation of stakeholders from different economic sectors and across different levels of governance. They should work together to find consensual solutions to water management.

Partners

- Global Environment Centre
- Ernst-Moritz-Arndt University Greifswald
- Sichuan Provincial Workstation for Wildlife Resources Survey Conservation and Management
- Gansu Wildlife Administration Bureau
- Xinjiang Altaishan Forestry Bureau
- European Union (funding provided through European China Biodiversity Programmeme)

KEY PRINCIPLE(S)	*"Integrated water resource management requires participation and commitment of governmental institutions at all levels to be successfully implemented."*
CONTACT INFORMATION	**North Asia Office** Website: http://www.wetwonder.org Email: ckl@wetwonder.org, zxh@wetwonder.org
REFERENCE WEBSITE(S)	http://global.wetlands.org/Whatwedo/Projectarchive/tabid/59/mod/601/articleType/ArticleView/articleId/1954/Default.aspx

Central Kalimantan Peatlands Project

COUNTRY: Indonesia **START DATE:** January 2006 **STATUS:** Completed (December 2008)

BACKGROUND INFORMATION

The Central Kalimantan Region in Southeast Asia contains tropical peatswamp forests that host a high biodiversity and play an important role as carbon stores, crucial for global climate change mitigation. These peatlands are also valuable for local communities who rely on them as a source of clean water and food. Unfortunately, unsustainable agricultural practices (over-drainage, peat fires) and logging activities are threaten these freshwater ecosystems. This degradation affects local people's livelihoods, their health, biodiversity, air pollution and climate change as huge quantities of organic carbon become carbon dioxide.

PROPOSED SOLUTION

Wetland International formed a consortium with poverty relief and conservation organizations to implement The Central Kalimantan Peatland Project. The objective of the project was to maintain and restore the Sebangau and Mawas (Block E) peatswamps and other parts of the Ex-Mega Rice Project (ERMP) peatlands within the Kalimantan Region.

IMPLEMENTATION

The restoration of the Central Kalimantan Region's peatlands was accomplished by working in three areas simultaneously: peatlands rehabilitation, poverty alleviation and capacity building. Rehabilitation activities focused on improving the hydrology of the peatswamp forests and degraded peatlands, re-greening degraded peatlands and reducing the incident of and damages by fires. Poverty alleviation work included improving local health facilities, developing alternative livelihoods strategies and investing in the socio-economic development of sustainable fisheries, agriculture and forestry. To increase capacity building and create awareness, interactive training events with local people were conducted, so that they can participate in project's field work. Local authorities were also involved in the project. During the inception phase, a local advisory group was created to guide the consortium activities. This advisory group was chaired by the provincial governor, and involved sectoral provincial agencies and relevant national level agencies.

The project's main achievements include reduction of emissions from drainage and peat fires, reforestation of over 1 500 hectares of peatlands, and improvement of public health along with people's livelihoods. A renewed respect for peatlands has appeared in the region with a reduction of illegal sawmills around peatlands. Moreover, the political, public and financial support for peatlands conservation has increased. The provincial government has initiated the development of a Master Plan for peatlands rehabilitation and the national government has issued a presidential instruction for the rehabilitation of the Ex-Mega Rice Project Area. The presentation of the project at key meetings and media coverage has also helped consortium members to raise global awareness of peatlands problems in Indonesia. The importance of peatlands to climate change is internationally recognized now.

CHALLENGES

Once crucial and challenging aspect of the project was increasing local communities' understanding of the problems and needs for change to stop peatlands' degradation. By actively involving communities in restoration activities they started to realize the connection between their livelihoods and the swamp forests and the importance of their conservation and restoration.

Some Lessons Learned

- Good cooperation with local stakeholders at all levels is a critical success factor for a peatlands restoration project. People's cooperation also ensures the sustainability of the project's activities beyond the end of the project.
- Local people need to be able to sustain their livelihoods in alternative ways before they can be expected to worry about conserving their natural resources.
- Efforts for nature conservation and poverty alleviation need each other in order to succeed.

Partners

- CARE International-Indonesia
- WWF-Indonesia
- Borneo Orangutan Survival Foundation (BOSF)
- University of Palangka Raya (UNPAR)
- Wetlands International.

KEY PRINCIPLE(S)	*"Sustainable use and conservation of wetlands and their ecosystem services involves focusing on their values for local people. This means that solutions for their conservation must put people first and developed community based action."*
CONTACT INFORMATION	**Project Office in Southern Kalimantan** Website: http://www.wetlands.or.id Email: aluedohong@yahoo.com
REFERENCE WEBSITE(S)	http://ckpp.wetlands.org/

Restoration of Coastal Hydrology at Tanjung Piai

WETLANDS INTERNATIONAL

COUNTRY: Malaysia **START DATE:** Jan 2006 **STATUS:** Completed (Dec 2007)

BACKGROUND INFORMATION

Tanjung Piai, a designated Ramsar site since 2003, is part of the Southwestern Johor Coastal Wetlands in Malaysia. Mangroves are the dominant wetland habitat type in this area, which safeguard a high biological diversity and provide important services for the country (commercial fisheries and designated state parks/protected areas) and the livelihood of local communities. For many years now, Tanjung Piai is suffering from acute coastal erosion. Mangrove trees are being uprooted and the ecological integrity and characteristics of the wetlands are being lost.

PROPOSED SOLUTION

Wetlands International worked with the Johor National Parks Corporation and the Ministry of Environment and Natural resources of Malaysia to restore the coastal hydrology of the Tanjung Piai wetlands. Different restoration actions were completed to achieve this objective. These were selected considering their environmental, social or economic benefits to the site.

IMPLEMENTATION

The restoration options for the site were developed through extensive consultation meetings with government agencies and main stakeholders. The Malaysian Drainage and Irrigation Department (DID) and the National Hydraulic Research Institute of Malaysia were actively involved in the project, as well as other governmental agencies such as the Department of Forestry, the Department of Environment and the Department of Fisheries. In September 2006, a first stakeholder workshop was conducted to develop a long-term restoration plan for the site. This plan was completed by the end of 2007.

Some Lessons Learned	**Partners**
• The restoration of freshwater ecosystem should be based on a strong science base. When scientific governmental institutions work together to design restoration measures this could be accomplish. Moreover, their participation facilitates measures' implementation in the short and long term.	• Ministry of Natural Resources and Environment (MNRE) • Johor National Park Corporation.

KEY PRINCIPLE(S)	*"The restoration of the hydrological attributes of a wetland is essential to the success of other aspects of a restoration project, in particular those related to the provision of freshwater services to local communities."*
CONTACT INFORMATION	**Malaysia Office** Website: http://malaysia.wetlands.org Email: malaysia@wetlands.org.my
REFERENCE WEBSITE(S)	http://www.wetlands.org/Whatwedo/Projectarchive/tabid/59/mod/601/articleType/ArticleView/articleId/148/Default.aspx

Conservation and Sustainable Development of Vembanad-Kol Wetlands

COUNTRY: India	**START DATE:** Jan 2007	**STATUS:** Completed	**ECOSYSTEM SERVICE(S):** Food provision, drinking water provision, transportation,

BACKGROUND INFORMATION

The Vembanad-Kol wetland system is part of a chain of backwaters in the Kerala coast. The biodiversity and associated ecosystem services of this wetland are critically linked to the livelihoods of marginalized communities in its surroundings. Disconnected sectoral developmental actions aimed at hydropower generation, industrial and agriculture growth and urbanization have caused shrinkage of the wetland area, deterioration of water quality, decline in agriculture productivity and overall loss of fish yield and diversity.

PROPOSED SOLUTION

Wetland international prepared a comprehensive managing framework for Vembanad Kol Wetlands to support the efforts of the Government of Kerala to restore this freshwater ecosystem.

IMPLEMENTATION

The strategy followed was to address root cause problems in the catchment area and the water body by involving concerned stakeholders and local communities in conservation actions and overall resource management. First, a review of the information available with concerned state government departments, research institutions, NGOs and other stakeholders was conducted. In parallel, a digital elevation model was used to demarcate zones with different management purpose in the wetland and its catchments. Next, rapid surveys were carried out to assess biodiversity and other ecological characteristics. Participatory rural appraisals (PRA) were also completed at strategic locations in and around the wetland to understand community resource linkages, and the needs and aspirations of the communities.

Once the field activities were completed, results were share with stakeholders at various levels and in particular with local communities. Consultations with research organizations, scientific institutions, and individual experts for updating baseline information on various issues were also completed. Planning documents of the state government to assess pattern of resource allocation and identification of gaps in the optimum resource allocation considering multifunctional aspects of wetlands were reviewed as well. With this information, an integrated management framework for the conservation and sustainable development of Vembanad Kol Wetlands was prepared.

This framework proposed activities in three main areas: catchment conservation, wetland management and management of coastal processes. Activities for catchment conservation include the control of soil erosion in degraded watersheds and the reduction of the pressures over forest resources. Wetland management actions include working on water management issues, biodiversity conservation and development of sustainable agricultural and fisheries practices. To maintain coastal processes the framework proposes monitoring of onshore and offshore sediment transportation and maintenance of the hydrological connectivity for water and species exchange. Stakeholder's participation in each of these activities is considered as well as capacity building actions. The framework also proposed the creation of a Vembanad-Kol Authority, which in coordination with the concerned line departments of the state government, would establish policy, planning, coordination and monitoring mechanisms for long-term management of the wetland.

Some Lessons Learned

- Non-coordinated actions from sectoral water management institutions (agriculture, hydropower, industries, fisheries, tourism) lead to the deterioration of freshwater ecosystems.
- The establishment of an organization that coordinates the actions of the various governmental departments involved in water management is a solution for the integrated management of wetland ecosystems.
- A community based approach needs to be adopted for conservation and sustainable use of wetlands resources by integrating ecological, economic and social aspects.

Partners

- Government of Kerala

KEY PRINCIPLE(S)	*"The strategies for management planning of wetlands should be based on a clear understanding of the structure and functioning of the ecosystem."*
CONTACT INFORMATION	**Ritesh Kumar** Senior Technical Officer E-mail: ritesh.kumar@wi-sa.org
REFERENCE WEBSITE(S)	http://south-asia.wetlands.org/WHATWEDO/Allourprojects/tabid/639/mod/601/articleType/ArticleView/articleId/1934/Default.aspx

Developing Community Based Mangrove Replanting and Monitoring in Sedili Kecil Mangrove

COUNTRY: Malaysia	**START DATE:** Sep 07	**STATUS:** Completed (Dec 2008)	**ECOSYSTEM SERVICE(S):** control erosion, food provision

BACKGROUND INFORMATION

The Sedili Kecil wetlands contain a large area of the highly threatened freshwater swamp forest ecosystem and it is an excellent example of mangrove, brackish water and freshwater riverine vegetation. Various sections of the mangrove forest are degraded because of small-scale clearance for local use, disturbance from hunting, and clearance of mangroves for aquaculture. This has reduced the beneficial services that the mangrove forest provides t local communities.

PROPOSED SOLUTION

Wetland International developed a project to raise awareness of local communities and encourage their participation in monitoring and rehabilitation activities on the Sedili Kecil mangrove forest. Replanting activities were proposed at the estuary of Sungai Sedili Kecil and two other sections at the river bank further upstream.

IMPLEMENTATION

The project was implemented in four phases: project planning and surveys, development of mangrove replanting plan, site preparation and planting operation, monitoring and maintenance programme. A planting ceremony of the mangrove replanting programme was established at the end of the project for awareness raising purposes.

Project planning took place in close collaboration with the District Forestry Office (JKKK) and local community groups. Site inspections were conducted to decide the planting areas and take stock of local people's environmental concerns. Once the areas for planting were located, a replanting plan was developed with the support the JKKK, local authorities and local communities groups. These stakeholders decided together the location of pilot areas, the size of the replanting area, how and when the replanting would take place, and the source of mangrove seeds/seedlings and species to be planted. Meetings were also performed with community village headmen to decide how communities would participate in the planting and monitoring phases of the project.

When the plan was completed, demonstrations about the proper planting method to local communities were performed. Planting operations were then organized and carried out. Once completed, a monitoring programme was established so that communities verified the growth and survival rate of mangrove seedlings, replace dead plants, and conduct weeding operations. The replanting of mangrove in the Sedili Kecil wetland has improved riverbank stabilization, reduced erosion and provided habitat for fish and shellfish populations on which the local communities depend on for their livelihood.

Some Lessons Learned	**Partners**
• Involvement of local residents and other stakeholders in all the phases of a restoration project results on a feeling of ownership and an assumption of a stewardship role.	• Forestry Department of Malaysia • National Mangrove Replanting Committee

KEY PRINCIPLE(S)	*"All stakeholders, including local communities and indigenous people and sectoral interests both in situ and ex situ, should be fully involved in a wetland restoration project from its earliest stage of consideration through its implementation to its long-term stewardship."*
CONTACT INFORMATION	**Malaysia Office** Website: http://malaysia.wetlands.org Email: malaysia@wetlands.org.my
REFERENCE WEBSITE(S)	http://global.wetlands.org/Whatwedo/AllourProjects/tabid/59/mod/601/articleType/ArticleView/articleId/1975/Default.aspx

Wetlands and Poverty Reduction in Hengshui Lake

COUNTRY: China **START DATE:** April 2007 **STATUS:** Completed (Dec 2007) **ECOSYSTEM SERVICE(S):** food and water provision

BACKGROUND INFORMATION

Hengshui Lake is 10 km south of Hengshui City in the Chinese Province of Hebei. With an area of 75 km^2, it is the second largest fresh water lake in the North China Plain and the central component of the Hengshui Lake Nature Reserve. Fishing and farming are the predominate activities of the people living around the lake, which is estimated on more than 20 000 individuals. Slowly, the lake's resources are diminishing and many of the local people live in poverty. Therefore, sustainable wetland and biodiversity conservation and management while targeting poverty reduction are challenges faced by the Nature Reserve.

PROPOSED SOLUTION

Wetlands International carried out a project to develop a proposal for the conservation of Hengshui Lake and the reduction of poverty in local communities.

IMPLEMENTATION

The proposal was based on rapid assessments of the socio-economic status of local villages around Hengshui Lake. Using the Participated Rural Assessment methodology, the following elements were evaluated: basic information of families, family property, family expenditure, social security, village finance, community relationship, village management, opinion on nature protection, family economic status and methods for economic development for the future. This information was analyzed and a draft proposed prepared. This proposal was discussed with the partners of the project and local communities. Their recommendations were included in the final proposal for Wetlands Conservation and Poverty Reduction in Hengshui Lake National Nature Reserve.

Some Lessons Learned

- A wetland impact on poverty will depend on local population size relative on its productivity, and also in demographics trends. For this reason, it is important to conduct socio-economic studies as a previous step for the design of wetland management plans.

Partners

- Hengshui Lake National Nature Reserve Management Committee
- Hengshui City Poverty Reduction Office
- Hengshui City Tourism Bureau

KEY PRINCIPLE(S)	*"Freshwater ecosystems are being degraded globally. To avoid this, it is important to build communities in which humans can live sustainably with freshwater ecosystems, based on traditional knowledge and scientific information."*
CONTACT INFORMATION	**North Asia Office** Website: http://www.wetwonder.org Email: ckl@wetwonder.org, zxh@wetwonder.org
REFERENCE WEBSITE(S)	http://global.wetlands.org/Whatwedo/AllourProjects/tabid/59/mod/601/articleType/ArticleView/articleId/2033/Default.aspx

Regional Strategy and Action Plan for Wetlands Wise Use in the Moscow Region

COUNTRY: Russia	**START DATE:** Jan 2006	**STATUS:** Active	**Ecosystem service:** water cycle regulation

BACKGROUND INFORMATION

The Moscow Region is the most developed and populated part of Russia with a water consumption of more than 4 000 million m^3 p.a. or 44% of the annual runoff. Yet, water resources are decreasing in the region and the protection of freshwater ecosystems, in particular wetlands, has become a priority. Currently wetlands are managed by multiple sectoral government agencies and local administrations, leading to duplication and confusion of authority between sectoral agencies and conservation bodies. The result is considerable ongoing degradation due to hydrological regulation, drainage, agricultural developments and burning.

PROPOSED SOLUTION

Wetlands International Office in Russia developed a programme to support the sustainable use of water resources in the Moscow Region. The programme aimed to establish the technical, legal and social conditions for the implementation of an integrated approach to land-use planning based on wetland wise use.

IMPLEMENTATION

The programme was initiated with the following main objectives: 1) develop a regional strategy and action plan for sustainable wetland use in the Moscow Region, 2) conduct an inventory of the wetlands of the Moscow Region 3) raise awareness of the general public and decision-makers concerning wetland functions, values and their importance, and 4) test at pilot wetland areas the proposed mechanisms for integrated land use planning.

The process to create the regional wetland strategy has consisted on several steps. Based on previous studies and projects, a task forced composed by key stakeholders outline the key points of the strategy. These were discussed at a workshop with experts from partner organizations and other federal and regional wetland-related organizations. At the end of the workshop, a working group was established to finalize a second draft strategy document. This was sent out for further comments and approval to relevant regional bodies. In April 2009, the final version of the strategy was presented http://russia.wetlands.org/Portals/5/%D0%A1%D1%82%D1%80%D0%B0%D1%82%D0%B5%D0%B3%D0%B8%D1%8F%D0%92%D0%91%D0%A3 %D0%9C%D0%9E.pdfto key stakeholders. Now approval from the environmental authority is pending.

The wetland inventory and evaluation activities were carried out by a multidisciplinary group of experts. The outcomes of their research were published in the document "Wetlands in the Moscow Region: natural, economic, historical and cultural aspects". This publication contains an overview of the wetlands in the Moscow Region, descriptions of wetland sites that need to be protected at national and regional level, and a list of wetlands of special significance as cultural heritage. This information was considered in the development and implementation of the regional strategy and action plan.

Education and awareness materials were prepared as part of the awareness, education and ecotourism activities of the programme. These were designed according to the various target groups, from decision makers to school children. A long-term awareness programme has been established in the Crane Homeland Pilot Area. Activities targeted at the general public, local authorities, school teachers and children are carried out all over the year. The "Sowing the Crane Field" Day and Crane Festival are celebrated each year in May and September respectively.

Activities in the test wetland pilot areas are currently undergoing. In the Faustovskaya Floodplain of the Moskva River area, regulations for the Moskvoretsky Reserve are being developed along with measure to regulate sport hunting of water birds. Recommendations for introducing an improved land use regime in the area are also under elaboration. In the Dubna Mirex Complex a wetland co-management plan is being developed. Meetings with representatives of all stakeholders groups have been organized. The goal is to integrate social, cultural and economic objectives of stakeholder groups in a management plan for this site. This plan should clearly define the functions, rights and responsibility of stakeholders and will include a conflict management mechanism.

Some Lessons Learned	Partners
• If water resources are to be protected, actions of the different stakeholders need to be coordinated around a central strategy. • For wetland conservation measures to be successful, it is important to make information on wetland functions and values and on sustainable water management available to all target groups, from decision makers to school children.	• Ministry of Environment and Nature Management of the Moscow Oblast • Taldom Administration of Protected Nature Areas • *Mosoblecologia* Research Centre.

KEY PRINCIPLE(S)	*"The development of actions plans for wetland management at a national level involves working in different fronts at the same time, from field studies to awareness raising to implementation of proposed management measures in pilot areas".*
CONTACT INFORMATION	**Olga Anisimova** Director – Wetland International Office in Russia E-mail: oanisimova@wwf.ru
REFERENCE WEBSITE(S)	http://russia.wetlands.org/WHATWEDO/Allourprojects/WetlandconservationintheMoscowRegion/tabid/1661/language/en-US/Default.aspx

Towards Integrating Wetland Biodiversity Conservation with water and agricultural management

WETLANDS INTERNATIONAL

COUNTRY: Ukraine **START DATE:** 2008 **STATUS:** Active **ECOSYSTEM SERVICE(S):** water supply, water purification, flood regulation

BACKGROUND INFORMATION

Wetlands deliver a wide range of ecosystems services such as fish and fiber, water supply, water purification, climate regulation, flood regulation, coastal protection and recreational opportunities. In Ukraine, like in other countries, wetlands are degraded due to unsustainable water management and agricultural practices. A lack of information on wetlands and the ecological networks on which they depend is contributing strongly to this. The situation is being compounded by low awareness of the issues by civil society and their resulting weak engagement in the policy and planning processes that could help to improve wetlands management.

PROPOSED SOLUTION

Wetlands International (WI) is conducting a pilot project in the South Bug River Basin to develop the foundations for integrating wetland biodiversity conservation into water related sectoral policies in Ukraine based on ecological network development and civil society engagement.

IMPLEMENTATION

The project has four main activities: 1) develop an approach that provides the foundations for integrating wetland biodiversity conservation into river basin management and that is endorsed by regional, basin and civil society stakeholder organizations,2) develop an ecological network in the South Bug River Basin to further conservation planning, 3) develop the capacity of the members of the Ukrainian Rivers Network (URN) to engage in integrated river basin management planning, and 4) conduct a public awareness campaign in the South Bug River Basin.

To attain the first objective, consultative regional workshops are conducted to develop a South Bug River Basin Strategic Action Plan with stakeholders. This process will ended in a conference with regional authorities, scientist, NGOs, farmers, water land and nature protection managers and mass media to present the strategic action plan. Based on these activities, a guidance document for national, regional and basin level authorities in the water, agriculture and environment sectors will be prepared.

Field research was completed and results published in the report *The Southern Bug Meridional River Corridor: biodiversity and valuable areas (2007).* This document describes the biodiversity, the distribution of rare plant and animal species and the most valuable areas in the basin. This information is being used to create a proposal for protected areas.

Children's drawings and professional and amateurs photos contests had taken placed as part of the awareness raising campaign. Generally accessible information about the Sough Bug River Basin has been disseminated as well.

Some Lessons Learned

- The actions for integrated wetland management should be decided by all relevant stakeholders. This actions can be framed in a Strategic Action Plan endorse by stakeholders.

Partners

- Ministry for Environmental Protection of Ukraine
- State Committee for Water Management of Ukraine
- South Bug Basin Organization of the State Committee for Water Management of Ukraine
- Institute of Zoology and Institute of Botany of the National Academy of Sciences of Ukraine
- Members of Ukrainian Rivers Network

CONTACT INFORMATION	**Vasiliy Kostyushin** Director – Wetlands International Black Sea Programmeme E-mail: kv@wetl.kiev.ua
REFERENCE WEBSITE(S)	http://www.wetlands.org/Whatwedo/Projectarchive/tabid/59/mod/601/articleType/ArticleView/articleId/2117/Default.aspx

Municipal Governance, Capacity and Social Responsibility in Wetland Biodiversity Conservation

COUNTRY: China **START DATE:** July 2008 **STATUS:** Active

BACKGROUND INFORMATION
Anqing Municipality, in the middle and lower reachers of the Yangtze River, in Anhui Province, has rich wetland biodiversity resources. Wetlands, however, are under great stress mainly due to aquaculture production with one species. The local government is concerned about this situation, but it lacks of expertise on biodiversity, best management practices and strategic planning. There is also a poor public awareness of biodiversity conservation.

PROPOSED SOLUTION
Wetlands International has proposed a capacity building project in the Anqing Municipality to support biodiversity mainstreaming into the municipality work plan. The activities proposed include training workshops and a public awareness campaing.

IMPLEMENTATION
A training needs analysis of relevant staff at municipal/country government agencies (forestry, agriculture and environmental protection departments) was conducted. Based on this information, a training plan and training materials were elaborated. Training workshops are currently taking place. The public awareness campaign was started as well based on information obtained in a survey about the level of public awareness of the local people. Different types of leaflets have been prepared, published and distributed. A wetland column has been published at the local newspaper too.

Some lessons learned	**Partners**
• Municipal governments rarely recognized the values of wetland conservation in their policies and programmemes. This lack of direction has caused a continuing and cumulative wetland loss because decisions to convert individual wetlands to other land uses are neither subject to, nor related to, overall conservation policies. Therefore, capacity building of decisions makers at this level of governance can support sustainable use of wetlands and their services.	• Anqing Municipality

CONTACT INFORMATION	**North Asia Office** Website: http://www.wetwonder.org E-mail: ckl@wetwonder.org
REFERENCE WEBSITE(S)	http://global.wetlands.org/Whatwedo/AllourProjects/tabid/59/mod/601/articleType/ArticleView/articleId/2034/Default.aspx

The World Wide Fund for Nature (WWF)

Sustainable Water Management as a Climate Change Adaptation Strategy

COUNTRY: Mongolia	**START DATE:** Aug 2008	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Food and freshwater provision, hydrological flows

BACKGROUND INFORMATION

The Great Lakes Basin (GLB) of western Mongolia is an outstanding assemblage of distinct landscapes, including mountain ranges with glaciated peaks, deep and wide valleys, forest, forest steppes, large lakes and wetland complexes, semi-desert areas, and the Gobi Desert. Hydrological processes (precipitation, evaporation, transpiration and water recharge) are carefully balanced in this region as surface runoff never drains to an ocean. Unfortunately, the GLB is subjected to increasing and multiplying threats, including overgrazing, dams and irrigation, mining and gravel extraction, tourism, climate change and high levels of water consumption by the people and stakeholders living in the GLB. To this adds the lack of water management policies and appropriated institutional frameworks to deal with these pressures.

PROPOSED SOLUTION

WWF Mongolia and the Mongolian Government are implementing an Integrated River Basin Management (IRBM) pilot project in the Khovd River Basin, one of the three most important sub-basins in the GLB. Through this project, the institutional capacity and structures needed to face the challenges in the GLB will be met while maintaining the ecological integrity of almost 60,000km^2 of wetlands, riparian forests, rangelands and protected areas (recognized at an international level as unique in the world). Enforcement of the National Water Law of 2004 will also be accomplished. In addition, the project will demonstrate that IRBM is a good adaptation strategy for sustainable management of mountainous fresh water ecosystems.

IMPLEMENTATION

The project started by involving key stakeholders in the IRBM process. A dialogue between the many water users in the Khovd River Basin was initiated, so that conflicts between their various interests (herding, agriculture, industry, production of hydropower, etc.) were understood and solved. This fully participatory process ended in March 2009 after intensive capacity building workshops with relevant stakeholders, and the Minister for Nature, Environment and Tourism (MNET) of Mongolia formed the Buyant and Khovd Integrated River Basin Councils (IRBC) as a result. The Khovd IRBC consists of 17 members and the Buyant IRBC of 15. These members represent governmental institutions at all levels (national, provincial, municipal), environmental agencies, water management organizations, universities, agriculture and industrial enterprises, and the general public.

Now that the Khovd and Buyand IRBCs are established, the next step is to prepare a river basin management plan (Khovd River Basin Management Plan). This plan will require the collation of environmental data, in particular that related to hydrological and water use conditions in the basin. Once the management plan is completed and approved by the governmental authorities, there will be a legal framework governing how the water, land and related resources can be sustainably managed for the long term in the Khovd River Basin. This will further strengthen the legal and institutional framework for water management in Mongolia.

Some Lessons Learned

- An Integrated River Basin Council (IRBC) is an institutional mechanism that allows the comprehensive coordination and supervision of water related activities because key water users are members. It also allows addressing effectively environmental challenges at the basin-scale.
- The development and implementation of an Integrated River Basin Management Plan harmonize the interests of stakeholder groups and the multiplying threats posed over freshwater ecosystems within a watershed, including climate change.
- The application of an IRBM approach supports the development of appropriate legal, institutional and financial frameworks that guarantee sustainable management of water resources.

Partners

- Minister for Nature, Environment and Tourism (MNET)

KEY PRINCIPLE(S)	*"Effective and sustained implementation of river-basin scale solutions depends on governments, the corporate sector, civil society, communities and individuals accepting and committing to the principles of Integrated River Basin Management."*
CONTACT INFORMATION	**Batnasan Nyamsuren** Coordinator for Mongolian part of Altai-Sayan Ecoregion, WWF Mongolia E-mail: batnasaan@wwf.mn
REFERENCE WEBSITE(S)	http://www.panda.org/who_we_are/wwf_offices/mongolia/index.cfm?uProjectID=MN0043 http://arigsor.mn/as_files/GLB-freshwater-final-report-en.pdf

Mara River Management Initiative

WWF

COUNTRY: Kenya & Tanzania	**START DATE:** Jan 2003	**STATUS:** Active	**ECOSYSTEM SERVICE(S):** Food and freshwater provision, hydrological flows

BACKGROUND INFORMATION
The Mara River in Eastern Africa originates in the Mau Escapement in Kenya and flows for about 365 km until draining in Lake Victoria in Tanzania. Its basin covers an area of 13,750 km^2, of which about 65% is located in Kenya and 35% in Tanzania. The Mara River runs through the Masai Mara Game Reserve on the Kenyan side and the Serengeti National Park on the Tanzanian side, both of global conservation significance and of great economic importance. Water is scarce in the Mara Basin and meeting the needs of growing human populations and nature is an enormous challenge. The main competing interests for water resources are large scale irrigation plantations in Kenya, the Masai Mara and Serengeti Wildlife protected areas, small scale farmers and pastoralists on both sides of the basin, the mining industry in Tanzania, small scale fishing activities and urban and rural domestic water supplies. Further problems are caused by the loss of forest cover in the upper catchments and along rivers, unsustainable agricultural practices (including irrigation), human population growth, poorly planned tourist facilities, water pollution from urban settlements, and mining. The situation is exacerbated by a failure of local, national and regional legislation and a lack of institutional structures to address water resource issues.

PROPOSED SOLUTION
An integrated river basin management (IRBM) strategy is being developed by WWF and key stakeholders of the Mara River Basin (industrial water users, local communities, water managers and decision-makers) to ensure adequate water supply of sufficient quality for ecosystems and basic human needs.

IMPLEMENTATION
This project has been implemented in two phases (phase I: 2003-2005, and phase II: 2006 up to date). Field operations for the fist phase started in 2004. At the regional level, activities focused on bringing together key stakeholders from all levels (government, private sector, local communities and civil society) to start a dialogue about their concerns and the various water problems in the basin. A Regional Mara River Water Users Association was established as a result of this activity. At the national level, a Water Resource Users Association with membership from large scale farmers, group ranches, hoteliers, local communities, municipalities and key government departments was formed in Kenya. On the Tanzanian side, 12 water users associations were established. Each of them developed community action plans for water management, which were merged into a Sub-catchment Joint Water Resources Management Plan.

During the first phase of the project, community outreach activities were also completed, as well as workshops with governmental organizations and private stakeholders. Stakeholders gained understanding of the Kenyan and Tanzanian Water Policies and took actions to better manage water resources. For example, hoteliers with investments along the Mara River looked for solutions to mitigate pollution from poor sewage systems, and over 1,000 families installed energy conservation stoves.

The project's second phase has five objectives: establish a trans-boundary agreement between Kenya and Tanzania to ensure adequate water flows in the basin, perform a water flow assessment, develop an ecosystem service payment plan, generate a community-based fisheries management plan, and assess water quality and quantity. To date the environmental flow assessment has been completed, as well as a baseline survey of fisheries resources in the Mara Swamp and Musoma Bay and a water quality baseline assessment for the whole basin. The results of these assessments were validated through workshops with key stakeholders.

CHALLENGES
During the implementation of the initiative on the Kenyan and Tanzanian sides, WWF realized that it would be important to engage stakeholders at higher levels to validate decisions taken at the water resource users' level. Therefore, efforts were made to involve in the project the East African Community (EAC) and the Nile Basin Initiative (NBI) and more specifically the Nile Equatorial Lakes Subsidiary Action Programmeme (NELSAP), in order to form strong, high level partnerships with stakeholders in the Lake Victoria basin.

Some Lessons Learned

- Significant achievements in this project have been accomplished mainly because of the strong support granted by the Ministry of Water and Livestock Development through the Lake Victoria Basin Water Office.
- The implementation of an Integrated River Basin Management Strategy requires working at different levels simultaneously (field/site level, national level and basin level) and with different approaches (public awareness campaigns, field projects, lobbying of decision makers, community outreach activities, etc.)
- Strong informational and science base is needed to support an IRBM strategy. Flow and water quality assessments are important, as well as biological baseline data assessments.
- Effective management of transboundary basins requires an international political agreement, which can be initiated through an IRBM strategy.

Key Partners

- Ministry of Water and Irrigation (Kenya)
- Ministry of Water and Livestock Development (Tanzania)
- Bomet & Narok Districts (Kenya)
- Seregenti, Tarime & Musoma Districts (Tanzania)
- Masai Mara National Reserve (Kenya)
- TANAPA Serengeti National Park (Tanzania)
- Lake Victoria Basin Community
- East African Community
- Mara Water User's Associations
- Global Waters for Sustainability Alliance

KEY PRINCIPLE(S)	*"Effective partnership building is an essential ingredient of Integrated River Basin Management and enables far more to be accomplished than by working alone."*
CONTACT INFORMATION	**Doris Ombara** WWF Mara Project Head, WWF Eastern Africa Regional Programmeme Office E-mail: dombara@mara.wwfearpo.org
REFERENCE WEBSITE(S)	http://glows.fiu.edu/glows/Portals/0/documents/TBW-MRB_Brief.pdf http://www.usaid.gov/our_work/environment/forestry/pubs/biodiversity_conservation_forestry_2005_508_ready_102507.pdf http://www.unesco.org/water/ihp/ecohydrology/demos/mara.shtml

Taking Stock of Integrated River Basin Management in China

COUNTRY: China **START DATE:** Mar 2007 **STATUS:** Active **ECOSYSTEM SERVICE(S):** all inland freshwater ecosystems services

BACKGROUND INFORMATION

China is going through a water crisis caused by floods, drought, soil erosion and sedimentation, water pollution, and degradation of freshwater ecosystems. Three main factors are behind these problems: physical constraints, economic stresses and traditional government-controlled water governance. Uneven temporal and spatial precipitation is the major physical constraint. Economic stresses include low efficiency of water use, and growing water and hydropower needs to support economic growth. Water governance follows a sector-based approach with each ministry implementing its own water-related legislation. This traditional approach for water administration is not appropriated for solving the current water crisis. Therefore, a new direction is needed for water management in the country.

PROPOSED SOLUTION

In 1992, the Chinese Government established the Chinese Council for International Cooperation on Environment and Development (CCICED) as a high level non-governmental advisory body. In 2004, the CCICED Task Force on Integrated River Basin Management (IRBM) proposed a comprehensive framework and a staged process to implement IRBM in China. This framework was well received by government authorities at various levels and the international community. However, not detailed guidelines were prepared for its implementation. The creation of a high level Expert Panel (EP) was then proposed to develop an IRBM road map for the country.

IMPLEMENTATION

Supported and established by WWF, the Expert Panel was set up in April 2007 and will continue to work for the next five years, with focus on the critical water issues that China is facing. The EP directly advises the Chinese government on the actions needed to improve water and river basin management. Its recommendations are based on desktop research and study tours, as well as participatory process such as workshops and knowledge exchanges that involves key ministries, international organizations with a presence in China and other high level stakeholders.

During April to July 2007, the Panel conducted a study on the IRBM Status and Strategy in China. As part of this study, a high-level roundtable on Integrated River Basin Management (IRBM) was organized with attendance of all water-related governmental departments. In September 2007, a final report was published in Chinese and in English: “Taking stock of IRBM in China”. This document provides first-hand updated information on water issues and proposes a strategy to change water resources management in China. This strategy would assist informed discussions and dialogues on IRBM in the country and also support donors’ investment decisions in the water sector.

CHALLENGES

Achieving a participatory process in the work of the Expert Panel is a challenge as governmental representatives usually have different backgrounds and it is not easy to reach consensus on agreements. It is also difficult to maintain the interest and committed from all representatives. In this case, was important that the chair of the Expert Panel is also a member of the Standing Committee of the National People’s Congress of China (NPC). Thus, the EP has full support at the highest level of decision-making in the country.

Some Lessons Learned

- An Expert Panel on Integrated Water Basin Management requires an influential leader to drive this process with strong support from a group of experts with good knowledge of water management.
- Good communications and active involvement of stakeholders through interviews, seminars, and workshops is needed to achieve a participatory process in the EP activities.

Expert Panel Members

- National Natural Science Foundation of China (NSFC)
- Yangtze River Scientific Research Institute
- Water Resources and Hydropower Planning and Design General Institute (GIWP)
- Water Environment Institute - Chinese Academy of Environmental Planning
- Yellow River Conservancy Commission (YRCC)
- School of Environment and Natural Resources, Renmin University of China
- Institute of Hydrobiology - CAS
- Environment and Resource Committee, National People’s Congress (NPC)
- School of Environment Science, Peking University
- Institute of Policy and Management Sciences, CAS
- Institute of Geographic Sciences and Natural Resources Research (IGSNRR)
- Nanjing Institute of Geography and Limnology, CAS
- School of Public Policy & Management, Tsinghua University

KEY PRINCIPLE(S)	*“Integrated River Basin Management (IRBM) must be established as a political priority. Without the support at a political level, it is impossible to convert the concept of IRBM into reality.”*
CONTACT INFORMATION	**Lifeng Li** Director – Freshwater WWF International E-mail: lli@wwfint.org
REFERENCE WEBSITE(S)	http://www.vancouver.sfu.ca/dlam/04riverbasin%20rpt.htm http://www.wwfchina.org/english/print.php?loca=272

Integrated River Basin Management in the Sepik River

WWF

COUNTRY: Papua New Guinea	**START DATE:** Apr 2004	**STATUS:** Completed (Apr 2009)	**ECOSYSTEM SERVICE(S):** Transportation, food and freshwater provision, spiritual values

BACKGROUND INFORMATION

The Sepik River is the longest freshwater system in Papua New Guinea (PNG) with a basin area of 80,300 km^2 and a total length of 1,126 km. It is also one of the most ecologically valuable rivers in the Asia Pacific region and one the biggest rivers systems in the world with no industrial development. Its catchment area contains priority wetlands, the most important and commercially significant crocodile population in New Guinea, and the largest lowland rainforest protected area in PNG. The people along the river depend heavily on it for transportation, water and food. Communities also have a close cultural and spiritual link with the river. Large scale mining and oil extraction, logging and forest conversion, invasive alien species, species over-extraction and trade, unsustainable agricultural practices, climate change, and forest fire are the main threats to this freshwater ecosystem.

PROPOSED SOLUTION

WWF developed a project to assist government and local stakeholders in the design of an Integrated River Basin Management (IRBM) framework for the Sepik River Basin. An IRBM framework support biological diversity and ecological processes protection while promoting the sustainable management of natural resources through properly implementation of catchment management policy. Three main outputs were expected from the project: a comprehensive IRBM plan, strong stakeholder awareness of and commitment to effective river basin management, and mechanisms to ensure stronger protection for areas of ecological importance.

IMPLEMENTATION

Project’s activities started in February 2005. Project partners and stakeholders at different levels were identified early in the project so that the activities proposed were compatible with their interests and the project’s goals. At the national level, an agreement with the PNG Department of Environment and Conservation (DEC) to develop a governmental policy for Total Catchment Environmental Management (TCEM) was signed the inception phase. Throughout the project, meetings were held to explore how IRBM principles can be included in the TCEM policy and how resource limitations within DEC could be overcome. Support to this policy initiative was provided by the elaboration of a guidance document on IRBM planning by WWF. As a result, DEC decided to decentralize its operations to catchment-based office; however, implementation of the TCEM policy is still pending.

Work at the local level was done with major institutional partners, in particular the Ambunti Government, and with the communities living along the river. WWF develop a five-year development plan for the Ambunti Government, which considered IRBM principles. Local communities were reached through a constant awareness campaign that included field visits, workshops on IRBM and a Sepik River Crocodile Festival held in March of 2007. This event attracted media interest and because it was sponsored by a range of business, local NGOs and the government, it became an important instrument to raise awareness of the importance of integrated river basin management among stakeholders.

Stakeholders support was channeled through the Sepik Stakeholder Initiative. As more awareness about IRBM was gained, this initiative led to the formation of a Sepik River Stakeholder Committee (SRSC) in mid 2006. This committee facilitated the planning and implementation of the IRBM in the Sepik River and created a working group to implement the Sepik River Action Plan. The work of the SRSC was supported by two guideline documents: State of the Sepik Report and a Guideline on IRBM planning in the Sepik River Basin. The first document was prepared by independent consultants and contains environmental baseline information about the basin collated from existing sources. The second document was prepared by WWF as mentioned in previous paragraphs.

CHALLENGES

In its second year, project’ activities led to the declaration of three new Wildlife Management Areas within the basin. However, to date, gazettal is still pending. This is due to the time-consuming process of cross-referencing the areas for gazettal against existing logging and mineral concessions. In the second year of the project, it was clear that developing an IRBM plan for the whole Sepik basin was not achievable due to time and resource limitations. The focus was then changed to one sub-catchment within the Ambunti District or the East Sepik Province. Later on the project, the restructuring of the DEC postponed the development of the IRBM plan for this sub-catchment. Aware of the time constrains to prepare this plan; WWF secured funding for a new project (Sepik livelihoods) to extent and enhance the work started through this project.

Some Lessons Learned

- An IRBM plan can not developed within the scope of a typical three - five year project. IRBM requires long-term financial and technical investment. Time is also needed to build sufficient trust and levels of understanding on IRBM among stakeholders.
- Gaining support and commitment from a wide range of stakeholders requires significant amount of time in the field. Support is achieved by careful argument, a continued presence on the ground, and by reacting quickly and decisively when key stakeholders showed interest in integrating IRBM principles in their work.
- Flagship species, such as crocodiles in this case, can be an effective means to gain local communities participation on an IRBM project.

Partners

- Papua New Guinea (PNG) Department of Environment and Conservation (DEC)
- Ambuti Local Level Government
- Local Environment Foundation (ADLEF)
- HELP Resources Inc.
- Bauabaua Theatre Group
- Sepik Wetlands Initiative
- Project area communities

KEY PRINCIPLE(S)	*“An Integrated River Basin Management Strategy requires working at different levels simultaneously (field/site level, national level and basin level), interact with stakeholders at each level (policy-makers, regional authorities, provincial and municipal representatives, local communities, etc.), and with different approaches (public awareness campaigns, field projects, lobbying of decision makers, community outreach activities, etc.).”*
CONTACT INFORMATION	**David Peter** Freshwater Programmeme Manager - WWF Papua New Guinea Country Office E-mail: dpeter@wwfpacific.org.pg
REFERENCE WEBSITE(S)	http://www.panda.org/what_we_do/where_we_work/new_guinea_forests/conservation_new_guinea_forests/wwf_projects_new_guinea/index.cfm?uProjectID=PG0036 http://darwin.defra.gov.uk/project/13012/

Monitoring the glaciers of the Himalayas

COUNTRY: Nepal **START DATE:** July 2005 **STATUS:** Active

BACKGROUND INFORMATION
Nepal Himalayas have 3 252 glaciers with a coverage of 5 323 km^2 and an estimated ice reserved of 481 km^3. Climate change is already affecting the Himalayas glaciers in Nepal with noticeable glacial retreat and changes in freshwater flows. As a result, glacial lakes have been formed, with negative consequences for biodiversity, people and their livelihoods. In 1985, for example, a glacial lake outburst flood (GLOF) from the Dig Tsho (Langmoche) glacial lake destroyed 14 bridges and caused about USD 1.5 million damage to the nearby-completed Namche small hydropower plant. Forests, farms and people downstream were also affected. While these floods may increase in the coming years, there will be a tipping point as glacial runoff begins a decrease trend. This situation will also have negative and not well understood consequences for Nepal and the Himalayan Region.

PROPOSED SOLUTION
In order to manage the current and anticipated impacts of climate change in Nepal Himalayas, the WWF-Nepal Programmeme Office started a project to better understand these impacts and begin the process of planning an appropriate community driven management response. As part of the project, a prediction model for glacial behavior under different climatic scenarios will be developed and a freshwater vulnerability assessment for selected key sectors conducted.

IMPLEMENTATION
This project is being implemented following a four-module approach. The first module is focused on developing a model to predict future glaciers behavior. Climatic and hydrological secondary data is being collated and collected for five glaciers in Nepal and India, selected after consultations with experts. This data will be validated through primary data collection by the project team on the representative glaciers. The second module involves the development of a freshwater vulnerability assessment (FVA) for the glaciers selected. This assessment is being conducted in two steps: examination of the effects of glacier retreat on the downstream freshwater regime, and assessment of the implications of these changes for the people, economic sectors and biodiversity in the downstream areas (for only three glaciers).

Based on the results of the model and the FVA, Community Driven Management Responses (CDMRs) will be developed as part of the third module. CDMRs will focus on particular community and economic sector or ecosystem. Relevant local stakeholders, including policy-makers, will be engaged in the formulation of CDMR strategies. This will guarantee that the CDMRs are integrated into existing planning frameworks and institutions. The fourth module involves the dissemination of findings among stakeholders at local, regional and national levels, local institutions such as village committees, grass-root civil society organizations, scientific and research organizations, media (both at local, regional, national and where appropriate international), international community and donors, etc. The activities are currently being developed and will continue throughout the project lifetime.

Some Lessons Learned

- The impacts of climate change on glaciers and freshwater ecosystems are not yet fully understood. Prediction models and vulnerability assessments are two available tools that can support the development of appropriated adaptation strategies.
- Because changes in freshwater ecosystems directly affect people and their livelihoods, the formulation of adaptation strategies must be completed with full participation of stakeholders at all levels (local, regional and national).

KEY PRINCIPLE(S)	*“Glacial retreat due to climate change is already affecting freshwater flows with dramatic adverse effects on biodiversity, people and their livelihoods. These impacts need to be understood in order to proceed to the next stage of quantifying research, mitigation and adaptation.”*
CONTACT INFORMATION	**Sandeep Chamling Rai** Programme Manager - Climate Change & Energy - WWF Nepal Programmeme Office E-mail: sandeep.rai@wwfnepal.org
REFERENCE WEBSITE(S)	http://www.panda.org/who_we_are/wwf_offices/nepal/index.cfm?uProjectID=NP0898

Wetland and livelihoods in the Sand River Catchment

WWF

COUNTRY: South Africa **START DATE:** Jan 2007 **STATUS:** Completed (Dec 2008) **ECOSYSTEM SERVICE(S):** Food and freshwater provision

BACKGROUND INFORMATION

Wetlands are important ecosystem components for catchment water security because of their role in water regulation and water quality moderation. Additionally, they possess unique biodiversity and offer important livelihood benefits. However, in many areas the use of wetlands for small-scale farming is eroding the wetland integrity, and associated ecosystem services, through unsustainable practices. This is the case of the Sand River's upper catchment wetlands in South Africa's Limpopo Province. These wetlands are within densely-populated communal lands used for harvesting and cropping. The wetland farmers, 90% of whom are woman and are among the poorest of the country, depend on these freshwater ecosystems as their only source of food. But their farming practices, pass generation to generation, are causing increased erosion, increased desiccation, poor fertility and low productivity.

PROPOSED SOLUTION

In partnership with the Association for Water and Rural Development (AWARD), the WWF South Africa Programmeme Office started a project to recovery the ecological functions of the Sand River's wetlands while improving the livelihoods of the communities living in this area. The project aims to promote awareness of the value of wetlands goods and services in providing livelihood security to poor rural communities, and to develop good agricultural practices among wetlands' farmers and harvesters in the Sand River Basin.

IMPLEMENTATION

The project started by evaluating the nature and intensity of farming practice in the wetlands. Detailed and rapid appraisals on 60 plots were completed. Detailed appraisals (DA) included an in-depth interview with the farmer, an assessment of the field according to environmental criteria and documentary photographs. Rapid appraisals were similar to DA but did not include an interview. The analysis of the data from Das and RAs confirm erosion, desiccation and poor fertility as the main negative outcomes from farming practices. Based on this information, all 60 farmers were grouped on the basis of shared issues and engaged in a series of 4 workshops (01 introductory and 03 cluster meetings) and 3 field visits, whereby they were introduced to basic wetland concepts, conservation tillage methods and good wetland practices. During these workshops, farmers were asked to design actions that were implemented as Action Projects in the wetlands. A set of indicators to assess whether these projects were having and impact on their agricultural practices and the state of the wetlands were also developed in collaboration with the farmers.

CHALLENGES

Because wetlands farmers highly relied on the wetlands for their livelihoods, it was assumed that they understood their value. However, this was not true and getting farmers to change their practices and think about long term management of the wetlands was a challenge. During the workshops, discussions about the need for change were carried out so that farmers could understand the connection between their livelihoods and long term wetland security and functioning. Another challenge was the poor communication and lack of self-organization amongst farmers. Poor trust hampered knowledge exchange from the action projects. However, with the support of the project team, farmers understood with time the importance of working together to attain wetlands sustainable used. They also became aware that a number of the problems they faced have their origins in the micro-catchment (i.e. livestock damaging crops, gully erosion and large quantities of water entering the wetland form the surrounding villages) and that working with other stakeholders was needed.

Some Lessons Learned

- Wetland farmers have a desire and need for ways to resolve the problems they face; however, they do not identify themselves as farmers with a long term interest in and concern for the land and natural resources. Their active participation in the design of sustainable wetland management practices and related monitoring activities is therefore important to attain substantiate improved wetland integrity.
- While working with the farmers to rehabilitate the Sand Rivers' wetlands, communities became stronger as they realized the need of working together to stop wetlands' degradation. It also became clear to them that working with other wetland's users upstream and beyond their communities was needed to fully attain the sustainable use of the wetlands.

Partners

- NeedBank
- Association for Water and Rural Development (AWARD)

KEY PRINCIPLE(S)	*"Sustainable use of communal resources such as wetlands can be accomplished when communities are involved in the design of the solutions.'"*
CONTACT INFORMATION	**Rodney February** Water Neutral Programmeme Manager - WWF South Africa Programmeme Office E-mail: rfebruary@wwf.org.za
REFERENCE WEBSITE(S)	http://www.panda.org/who_we_are/wwf_offices/south_africa/index.cfm?uProjectID=ZA0313

Freshwater Conservation in the Peruvian Amazon

COUNTRY: Peru **START DATE:** July 1998 **STATUS:** Active **ECOSYSTEM SERVICE(S):** Water and food provision

BACKGROUND INFORMATION

The Abanico del Pastaza Wetlands Complex in Northeastern Peru is extremely rich in biological and cultural diversity. It comprises various types of wetlands only found in tropical regions and the largest lake in the Peruvian Amazon, Lake Rimachi. Endemic, endangered, and migratory species can be found in these ecosystems, as well as commercial species that are the main source of food and income for five indigenous communities: the Candoshi, the Achuar, the Quechua, the Urarinas and the Cocama-Cocamilla. But the Abanico del Pastaza Wetlands Complex, a Ramsar site since 2002, also holds important oil reserves that started to be exploited in the early sixties. Decades of petroleum production have affected water quality and commercial over-fishing has reduced fish populations.

PROPOSED SOLUTION

The WWF Freshwater Conservation Programme in the Peruvian Amazon is providing indigenous communities with skills and tools to conserve the Abanico del Pastaza Wetlands Complex's biodiversity and ecosystem services. WWF believes that by building local communities' capacity for sustainable management of ecosystems, an improvement of water quality and a reduction of over-fishing can be accomplished along with a controlled use of the Wetlands Complex's natural resources by other stakeholders.

IMPLEMENTATION

Legal and environmental capacity building activities with indigenous communities' members and leaders started in 2001 in partnership with two local NGOs, Racimos de Ungarahui and Amazonia Fund. The training focused on strengthening negotiation and decision-making skills, so that indigenous communities' leaders can better defend the communities' right to the sustainable use of natural resources in their territories by oil and commercial fishing companies. Capacity building activities also include training on how to use their legal system more effectively and how to conduct water monitoring.

Drawing on this training, Achuar's' leaders started negotiations with oil companies' managers and governmental representatives (e.g. Ministers, Congress' members, governmental organizations' directors) to improve environmental standards and prevent further damage from petroleum extraction. Where the environment had already been harmed, they negotiated for plans to repair or lessen the damage. In parallel, Candoshi's leaders started developing a fisheries co-managed plan for Lake Rimachi. The scientific and legal support from local NGOs' experts and external advisors was fundamental in this stage to further strengthen the management skills of local communities and their leaders.

In 2006, FECONACO, the indigenous federation that groups the Achuar, Quechuas and Urarinas people of the Corrientes River, Pluspetrol, an oil company, and the Government of Peru signed a historical agreement that requires Pluspetrol to re-inject 100% of production waters into old oil pits and clean contaminated wetlands. In previous years more than 1 million barrels a day of salty and hot waters were released into freshwater rivers and streams, causing severe damage to the Abanico del Pastaza Wetlands. Now, with WWF's support, Achuar people are monitoring water quality in the Corrientes River to ensure that the clean-up process is taking place.

The development of Lake Rimachi Fisheries Management Plan started in 2002 with an analysis of the legal and institutional frameworks that would support the Candoshi's rights to fisheries resources in the lake. The creation of a Candoshi Association of Artisanal Fishermen was proposed as a result. The association, known as Yungani, was officially constituted in 2004 following Peru's General Fishing Law process. This association prepared the management plan with support of WWF-Peru and partners, which was legally approved in 2007. This plan provides regulations on fishing and gives Yungani the authority to enforce them directly addressing over-fishing. It also puts the Candoshi in a better position for negotiation over resources rights and for making claims in the case of petroleum contamination events. This is particularly important because the Abanico del Pastaza has been divided into lots that are being considered for exploration by multinational petroleum companies.

CHALLENGES

To accomplish successful negotiations with governmental and oil companies, it was very important that communities' leaders have the support of their people. This was challenging because some communities did not recognized existing indigenous federations as true representatives. A strong awareness campaign about the environmental issues in the Abanico del Pastaza was fundamental to overcome this situation. In the case of Lake Rimachi Fisheries Management Plan, building communities' trust in the Ministry of Fisheries was a challenge. During the 1970s and 1980s the Ministry did not control appropriately commercial fishermen activities in Lake Rimachi, and communities force Ministry's authorities out of the region. However, through training activities focused on sustainable use and legal issues communities understood the role of the Ministry in their request for community' rights to fisheries resources in Lake Rimachi.

Some Lessons Learned

- By strengthening indigenous communities' federations and leaders, policy-makers and civil society involvement can be promoted and compliance of environmental regulations accomplished.
- Legal and environmental capacity building activities with indigenous communities can support fisheries co-management plans development. Once implemented, these plans can reduce over-fishing and increase economic benefits for indigenous communities that depend on aquatic resources for their livelihoods.

Partners

- Racimos de Ungarahui (local NGO)
- Amazonia Fund (local NGO)
- Indigenous Federations
- Coordinadora Regional de Pueblos Indígenas (CORPI)

KEY PRINCIPLE(S)	*"Empowered indigenous communities are driving forces to secure sustainable use of inland waters ecosystems and their services"*
CONTACT INFORMATION	**Aldo Soto** Northwestern Amazon Programme Manager - WWF Peru E-mail: aldo.soto@wwfperu.org.pe
REFERENCE WEBSITES	http://www.worldwildlife.org/what/wherewework/amazon/people.html http://www.panda.org/about_our_earth/teacher_resources/webfieldtrips/toxics/news/?uNewsID=85520 http://abanicodelpastaza.net/index.php?option=com_remository&Itemid=27&func=select&id=10

Managing community resources in the Peruvian Amazon

COUNTRY: Peru | **START DATE:** May 2006 | **STATUS:** Completed (Jun 2007) | **ECOSYSTEM SERVICE(S):** Forest related services

BACKGROUND INFORMATION

The Peruvian Amazon is home to many indigenous communities that rely on the forest and the ecosystems services it provides for their livelihoods. These services include food supply (e.g. bush meat), wood and non-wood products (e.g. fodder, medicinal plants), as well as spiritual and recreational services. Forested areas along riversides also prevent erosion and maintain water quality in the rivers, which are used by local communities as sources of water and food. Indigenous communities living in Peru's Amazon are among the poorest of the world, a situation that could be changed through the sustainable management of the natural resources in the forest they live in.

PROPOSED SOLUTION

To reduce poverty levels of indigenous communities in the Peruvian Amazon, WWF-Peru has developed the Managing Community Resources Project. Indigenous communities have unique mechanisms to manage their environment. Based on this notion, the project aims to strength these mechanisms by providing communities with techniques to improve land use and family productive systems. Indigenous communities' socio-organizational capacities are also expected to become stronger through the activities of the project.

IMPLEMENTATION

The project was implemented from November 2005 to June 2007. During this period, Awajun and Wampis native communities of the Condorcanqui Province received technical assistance on productive activities, such as cacao production, fish-farm management, and rubber production. The indigenous federations that represent these communities also benefited from capacity building activities, which focused on land use planning and titling. Through the project, 20 communities and their representative organizations (03) learned how to better manage their forests, freshwater ecosystems and agricultural units. In addition, 600 families within the project area improved their income through family-based productive systems, in particular family-owned fish-farms and agro-forestry systems. Landscape and conservation plans were also prepared for the Tunta Nain Conservation Area and 16 communities around it.

CHALLENGES

Activities planned for the project were delayed in many cases because the organization of native communities and their federations was not completely stable. To overcome this situation, two types of strategies were developed. First, communities were permanently consulted about the project. This action resulted in their permanent cooperation and acceptance of the project. Second, well-known communities' leaders were sensitized about the project, gaining their support as well. As consequence, the project obtained massive acceptance from the communities. At the inception phase of the project, strategic alliances with local NGOs and federal governmental organizations were sought. However, a competitive attitude from their side stopped this action. New partners were then solicited with local and regional governments. They were more receptive and an agreement for inter-institutional cooperation with the Municipality of the Rio Santiago District was signed to implement the project's activities.

Some Lessons Learned

- An adaptive approach is important when working with native communities and their organizations. Project's activities need to be synchronized with those of the communities to achieve success.
- Ancestral communities' practices on land use and natural resources' management are deeply ingrained. Thus, it is important to take them into account when proposing enhanced and long-term ways for managing forest and inland waters' ecosystem services.
- Socialization of the project's methodologies and technology transfer activities was compatible with the Awajún and Wampis communities' culture. Massive support from the communities, federations and beneficiaries was gained through this approach.

Partners

- Organization for the Development of Communities in the Cenepa Border (ODECOFROC)
- Aguaruna Huambisa Council (CAH)
- Sub-Headquarters Aguaruna Huambisa Council (Subsede CAH)
- Regional Organization of Indigenous Amazonian Peoples of Peru (ORPIAN-P)

KEY PRINCIPLE(S)	*"Strengthening indigenous communities' organizations and traditional mechanisms to manage their environment can support the conservation of forest and its ecosystems services, including those related to inland waters ecosystems."*
CONTACT INFORMATION	**Aldo Soto** Northwestern Amazon Programme Manager - WWF Peru E-mail: aldo.soto@wwfperu.org.pe
REFERENCE WEBSITE(S)	http://www.panda.org/es/sala_redaccion/proyectos/index.cfm?uProjectID=PE0867

Freshwater conservation Programmeme for Brazil

COUNTRY: Brazil **START DATE:** July 2006 **STATUS:** Active

BACKGROUND INFORMATION

Freshwater systems are experiencing the fastest rate of destruction of all the biomes in the world. This is a combined result of poor management, over extraction and inefficient and unsustainable use of water. Climate change is increasingly exacerbating this situation leading to increased flooding and run-off, drought and salinisation in estuaries and coasts (due to sea level rise). This poses real threats, not just to the inland water ecosystems, but to the hundreds of millions of people who rely on them and their services.

PROPOSED SOLUTION

To support Brazil's response to the impacts of climate change on inland water ecosystems, WWF- Brazil has developed a freshwater conservation programme focused on climate change. This initiative has the support of HSBC, Brazilian scientific institutions and governmental organizations at the federal and provincial levels. The projects within this programme aim to build river basins' resilience to climate change and/or tackle the root causes of climate change. These projects include a basin vulnerability assessment, a sustainable river flow assessment, a project to strengthen Brazil's basin governance, planning and policy, and projects to influence the activities on the hydropower and forestry sectors. An information campaign directed to the general public is also part of the programme.

IMPLEMENTATION

A basin vulnerability assessment evaluates the impacts of climate change, including weather extreme events, as related to water availability within priority river basins and big cities. It also provides decision makers and authorities with information on risks and alternatives. Currently, this assessment is being conducted for a demonstrative basin, the Alto Paraguay Basin. In partnership with the Centro de Pesquisas do Pantanal (CPP), baseline data is being collated and collected in the field. This assessment is expected to be completed by 2010.

The development of a river flow assessment is still in its inception phase. Partnership agreements with federal agencies (Environment Ministry's Water Secretariat (SRH/MMA), National Water Agency (ANA)) and other strategic water users (hydropower companies) are under negotiation. Mechanisms to assure the functioning of the aquatic ecosystems on priority hydrographic basins would be the main result of this project. Moreover, knowledge and expertise on sustainable river flows will be acquired by local researchers.

The results of the vulnerability assessment and the river flow assessment, expected by 2009-2010, will support further activities related to basin governance, planning and policy. These include: adaptation of public policies to freshwater and its vulnerability to climate change, creation of an institutional basis for water management in the Amazon, and development and implementation of financing mechanisms that harmonize good productive practices with conservation of natural resources (e.g. payment for environmental services).

In Brazil, the main sources of energy are the hydroelectric plants. Currently, only 40% of the hydroelectric potential of the country is being used, which demonstrated the expansion capacity of this kind of energy production. Energy infrastructure has significant economic, social and environmental impacts, in particular on freshwater ecosystems. The WWF-Brazil freshwater programme expects to influence the National Energy Plan so as to increase financial resources and goals for energy efficiency, influence the electric sector so as to incorporate the World Dams Council's recommendations for building dams, and influence the Ministries of Environment, Energy, National Water Resources Council and National Water Agency to enforce the use of river basin protection when constructing new hydroelectric plants.

Mechanisms to reduce deforestation and GHG emissions in the Amazon by encouraging sustainable business with forest resources will be used developed as part of the programme. Work will also be done with financial institutions to encourage the adoption of sustainable credit lines and Environmental Licensing System for Rural Properties as a pre-condition for loans. Work with HSBC's business groups in the Corporate and Investment Banking Markets (CIBM), Local Large Companies (LLC) and Middle Marketing Enterprises (MME) will be also completed. An annual event involving executive directors will be carried out in order to identify risks and opportunities of sustainable business.

To raise awareness on how climate change will affect water resources and Brazilians' lives, a communication campaign is currently under development. By 2012, 11 million Brazilians will be informed about the threats of climate change and their impacts over water.

Some Lessons Learned

- To tackle the effects of climate change on freshwater ecosystems, country's responses need to be developed at all levels of organization (federal, regional, local) and in various sectors, but in particular the hydropower and forestry ones.
- Vulnerability basin assessments and river flow assessments are two tools available to understand how climate change will affect freshwaters. These could be developed at basins' scales, and the results obtained could later be replicated country-wide.

Partners

- HSBC
- Centro de Pesquisas do Pantanal (CPP)
- Environment Ministry's Water Secretariat (SRH/MMA)
- National Water Agency (ANA)

KEY PRINCIPLE(S)	*"Climate change poses great challenges to the conservation of freshwater ecosystems and their services. Integrated responses are needed to build the resilience of these natural systems at the country level."*
CONTACT INFORMATION	**Samuel Barreto** WWF-Brazil's Water for Life Programmeme Coordinator E-mail: Samuel@wwf.org.br
REFERENCE WEBSITE(S)	http://www.panda.org/who_we_are/wwf_offices/brazil/index.cfm?uProjectID=BR0939

Seeking Alternative Energy along the Mekong

REGIONS: East and Southeast Asia **START DATE:** July 2006 **STATUS:** Active **ECOSYSTEM SERVICE(S):** hydropower generation

BACKGROUND INFORMATION

The Mekong River flows for some 4 500 km through China, Myanmar, Laos, Thailand, Cambodia and Vietnam before discharging into the South China Sea. The Mekong River basin is home to more than 60 million people with a growing demand for electricity. For many, hydropower dams along the river are regarded as the ideal solution, especially because climate change mitigation urges for new "clean" sources of energy. Currently, there are 149 planned large hydroelectric dams in the river. However, large-scale infrastructure, particularly dams, poses great threats to freshwater biodiversity, which could become even more significant under climate change conditions.

PROPOSED SOLUTION

As part of its Greater Mekong Programmeme, WWF has developed a project to find the best ways to develop any necessary hydropower project with the least environmental and social impacts, and/or explore alternative options, such as natural gas and wind and solar power. The main tool to assess hydropower needs in the region will be Strategic Environmental Assessment (SEA). Decision V/18 of the Convention on Biological Diversity (CBD) encourages the use of this type of assessment by Parties of the Convention to mainstream biodiversity in countries' policies, plans and programmes.

IMPLEMENTATION

Project's activities started in 2006. Since then, WWF is actively working with the Mekong River Commission (MRC) and the Asian Development Bank (ADB) to find best solutions to energetic needs in the Mekong Region. In September 2007, an *Environmental Criteria for Hydropower Development* report was issued. This report seeks to ensure that any real needs for additional hydropower energy can be met with the least environmental and social impacts. The use of Strategic Environmental Assessment to evaluate current and proposed hydropower projects in the six countries within the Mekong River Basin is proposed as a key tool to mainstream biodiversity in the energy policies, programmes and plans of these countries.

Some Lessons Learned	Partners
• Strategic Environmental Assessment is a tool to evaluate not only the impact of individual projects, but also their cumulative and regional effects, incorporating biological diversity considerations at the decision-making and/or environmental planning level.	• Mekong River Commission (MRC) • Asian Development Bank (ADB) • SENSA-SIDA

KEY PRINCIPLE(S)	*"In a changing climate, hydropower is seen as a clean energy; however, medium and large hydropower stations can cause severe impacts on freshwater biodiversity. Thus, countries' energy policies must take this into account when deciding on new hydropower projects".*
CONTACT INFORMATION	**Marc Goichot** WWF–Living Mekong Programmeme E-mail: marc.goichot@wwfgreatermekong.org
REFERENCE WEBSITE(S)	http://www.panda.org/who_we_are/wwf_offices/cambodia/index.cfm?uProjectID=9S0781

VI. CLIMATE CHANGE

1226. Climate change is a cross-cutting subject. Almost all of the other sections of this review make reference to it, and many should pay it more. This section of this review attempts to synthesise the findings presented elsewhere, supplemented where appropriate with additional specific information (as referenced below).

1227. Additional main sources of information for this section include: (i) the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and the IPCC Technical Paper on Climate Change and Water (2008); (ii) The Third World Water Development Report (WWDR3), which places a strong emphasis on climate change, its impact on the hydrological cycle and consequently on water availability and likely outcomes in terms of human development (information on the technical aspects of climate change in the WWDR3 is based largely on the findings of the IPCC, and other peer reviewed sources, with perspectives added on implications for water related human and ecosystem considerations from all of the 26 UN agencies dealing with water); (iii) Technical Series No. 10 and No. 25 of the CBD; (iv) the global Assessment on Peatlands, Biodiversity and Climate Change; (v) a review of fourth national reports under the CBD and second, third and fourth national communications under the United Nations Framework Convention on Climate Change; (vi) the outcomes of a CBD-Ramsar Scientific and Technical Review Panel expert workshop held in Gland Switzerland, 23-24 March 2007, which reviewed available scientific information and focussed on key messages for policy makers and communication purposes, (vii) Ramsar STRP on considerations currently ongoing; and (viii) other sources as referenced.

1228. Drawing from these sources there are very clear headline messages to be derived. These are:

- The impacts of climate change are expressed on ecosystems (and biodiversity) largely through changes in the hydrological cycle (including most changes observed or predicted for terrestrial ecosystems, and many in coastal areas).

- The impacts of climate change on humans are due to ecosystem changes – these are largely driven by water-related changes;

- Water is central to human development.

- Adaptation to climate change, therefore, requires mainly water-related responses.

- Everything is inter-connected through water (and therefore wetlands).

> The role of water (and the hydrological cycle) in how freshwater, terrestrial and to a large extent coastal, ecosystems function, the intimate relationships between water and most aspects of human development (including food, drinking water, sanitation, tourism, trade, energy and poverty reduction/livelihoods), and the central role of inland water ecosystems (wetlands) in these, lead to complex inter-connectivity between all these subjects. It is futile, counterproductive and out of context to consider one aspect in isolation from the others. The problem revolves around ecosystems – and the role of water is paramount in this.

- Unsustainable water use and degradation driven by increasing human demand is the main driver of adverse water-related ecosystem changes and subsequent impacts on both humans and biodiversity (including in many cases associated changes to terrestrial areas). Climate change is an additional driver which, by and large, simply exacerbates problems which are patently obvious already.

- The solutions begin by recognising these realities.

A. Overview of the findings of the IPCC

1229. The findings of the IPCC in its latest (fourth) assessment, and its (2008) technical report specifically on climate change and water, building on earlier assessments, confirm that water (the changing hydrological cycle) is central to many, if not most, of the climate change related shifts in ecosystems and human well-being. Some specific scientific findings reflecting this are provided below.

1230. This reality is evidenced through projected impacts, although rarely articulated as such. For example, the IPCC fourth assessment "Summary for Policy Makers" lists 32 examples of major projected impacts of climate change amongst 8 regions (covering the whole earth). Of these, 25 include primary links to hydrological changes and for most – explicitly so (for example direct reference to precipitation, droughts, floods, and changes in ice etc.) and for the others by implication (e.g., sea-level rise is due to the changing hydrological cycle). Of the other seven, water is implicated in four and two are general (not listing a specific impact)[70]. Only one refers to impacts not obviously linked to the hydrological cycle – erosion of coastal beaches and coral bleaching[71].

1231. Notably, a clear perspective on the findings is that most of the impacts on terrestrial vegetation (and therefore also fauna) are also driven largely by hydrological shifts (changes in humidity, permafrost/snow/ice cover, rainfall patterns and groundwater). This is particularly so for agriculture (shifts in water availability cause many of the major projected impacts).

1232. The impact of changing air temperature (directly), e.g., causing direct heat stress on biodiversity and humans, can be an additional impact, as is the increasing occurrence of more violent winds (although the main damage done by most storms in land areas is through flooding). But in general it is not the heat (or wind) which causes the problem – it is what the heat does to water.

B. Acceleration of the hydrological cycle

1233. There is a consensus among climate scientists that climate warming will result in an intensification, acceleration, or enhancement of the global hydrologic cycle. The intensification could be, indeed arguably is, evidenced and/or caused by changing rates of evaporation, evapo-transpiration (ET), precipitation, and changes in stream-flow (in some areas). Associated changes in atmospheric water content, soil moisture, ocean salinity, and in seasonal changes in glacier mass balance are also implicated. The strength of the intensification response to future warming, indeed any delayed responses to current warming, is hence unresolved and remains a critical question in assessing the hydrologic response to climate warming.

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[70] : one refers to wildfires (caused by both increasing air temperature directly, and increasing dryness – a hydrological factor); one refers to impacts on infrastructure and indigenous lives in the arctic (again, driven essentially by changes in snow/ice conditions – a hydrological factor); two refer to the increasing range of invasive alien species (in which changing water related habitat conditions is very probably a major factor); two are very generic (one referring to unspecified system wide changes on natural resources, the second to general biodiversity loss);

[71] even here, the erosion impact is exacerbated by sea-level rise and changes in sediment transport by rivers - leaving only coral bleaching as the only impact not linked to hydrology.

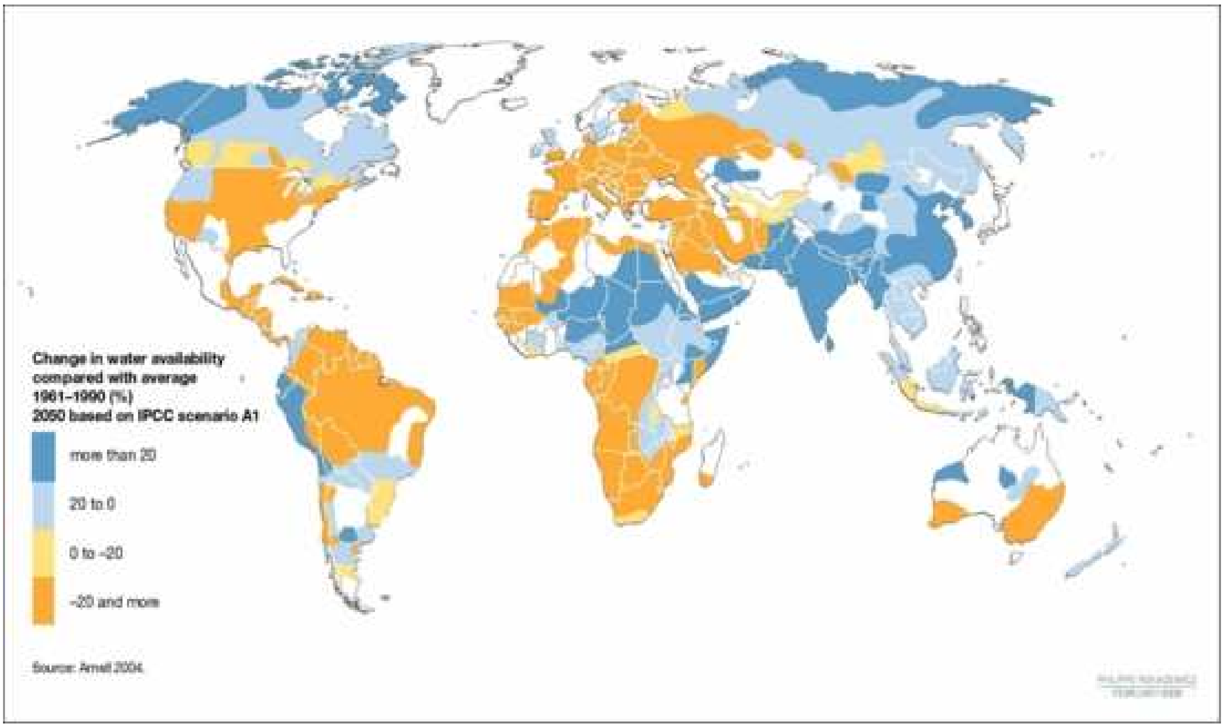
1234. Trends in precipitation have been more variable spatially and temporally compared with trends in temperature; however, regionally, increases during 1901 to 2005 have been noted in most of North America, southern South America, northern Eurasia and western Australia and decreases in western Africa and the Sahel and Chile. Current estimates of global average long-term trends in precipitation do not show significantly increasing precipitation over the period of observational record as was reported in earlier IPCC assessments possibly due to decreases in recent years and the use of different methodologies and observations. There is also some evidence that snowfall has increased in northern high latitudes and over mountain and sub-polar glaciers. Responses to warming in terms of glacier mass and permafrost are more equivocal, whereas streamflow is difficult to assess since it is already changing globally due to water management (further details below).

C. Assessment of potential impacts of climate change on biodiversity and inland water ecosystems - observed and predicted impacts on ecosystems and species

1235. The latest assessment of climate change by the Intergovernmental Panel on Climate Change describes water cycle effects associated with warming that range from a warmer atmosphere that holds more water vapour to more severe regional water shortages in semiarid and arid regions. Changes are expected in the means, standard deviations and extremes of many hydrological variables and fluxes such as precipitation, soil moisture, and evapotranspiration. These possible changes in the global water cycle will be far-reaching, increasing water stress with implications for water-borne disease rates, contributing to poorer water quality and increasing the impacts of floods and droughts. Uncertainties are very significant for the water cycle projections because many hydrologic processes are highly non-linear. Furthermore, projected changes in general are thought to be more accurate at very large (e.g., global and continental) scales, and much less so at regional scales, whereas it is at regional scales that mitigation and adaptation takes place.

1236. Changes in water resource availability will be global (Figure 95).

Figure 95**: Projected Changes in Water Availability** (http://maps.grida.no/go/graphic/the-contribution-of-climate-change-to-declining-water-availability)



1237. Due to the localized response of water resources to large scale forcing, global projections from climate models are of limited value for water resource applications unless they are accompanied by additional analysis.

1238. Irrigation influences the hydrological cycle on a regional scale, although there is strong spatial variability. In contrast, in some areas where groundwater levels are dropping due to abstractions, growing water usage is creating situations where prolonged periods of drought could further lower levels and cause rivers that are fully dependent on groundwater input during droughts to dry up.

1239. There is now increasing recognition that future climate change is likely to cause further changes in soil erosion rates, with the increased variability of rainfall and an increase in the frequency of high magnitude storm events resulting in increased erosion rates in many areas of the world. This is of significant relevance to the functioning of both terrestrial and inland water ecosystems (which are interconnected) through, for example, loss of soil functions (including water retention), decreased water quality and sedimentation in wetlands. The impacts of this, including in coastal zones, will vary locally because soil transport by rivers has already been interrupted globally by water management interventions (e.g., dam construction).

1240. Observed increases in air temperature have already caused wetland habitat to increase in some regions due to changes in hydrology stimulated by atmospheric warming. For example, some new wetland areas have emerged in Alaska and central Yakutia (in Russia) as a result of the thawing of permafrost. On the other hand, some Arctic wetlands are being lost as permafrost thaws allowing surface waters to drain into groundwater systems. In particular, increased air temperatures have been linked to the loss of wetland area as lakes on the Yukon Delta and Siberia contract. Furthermore, with a temperature increase of 2 – 3 degrees Celsius, many Arctic lakes will dry out completely.

1241. Changes in temperature, precipitation and freeze-thaw cycles will also alter the chemistry of many inland water ecosystems.

1242. General projected impacts of water-based systems under temperature and precipitation changes were identified relatively early in the considerations of the IPCCC and some of these are summarised in Table 34.

Table 34: **Projected impacts in some key water-based systems and water resources under temperature and precipitation changes approximating those of the SRES scenarios (modified from IPCC 2001c).**

Indicators	**2025**	**2100**
Coastal Wetlands and Shorelines	Loss of some coastal wetlands to sea level rise Increased erosion of shorelines	More extensive loss of coastal wetlands Further erosion of shorelines
Ice environments	Retreat of glaciers, decreased sea ice extent, thawing of some permafrost, longer ice free seasons on rivers and lakes	Extensive Arctic sea ice reduction, benefiting shipping but harming wildlife (e.g. seals, polar bears, walrus) Ground subsidence leading to changes in some ecosystems. Substantial loss of ice volume from glaciers, particularly tropical glaciers
Water supply	Peak river flow shifts from spring toward winter in basins where snowfall is an important source of water	Water supply decreased in many water-stressed countries, increased in some other water-stressed countries
Water quality	Water quality degraded by higher temperatures Water quality changes modified by changes in water flow volume Increase in salt-water intrusion into coastal aquifers due to sea level rise.	Water quality effects amplified
Water demand	Water demand for irrigation will respond to changes in climate; higher temperatures will tend to increase demand	Water demand effects amplified.

Indicators	**2025**	**2100**
Floods and droughts	Increased flood damage due to more intense precipitation events Increased drought frequency	Flood damage several fold higher than "no climate change scenarios" Further increase in drought events and their impacts

1. The most vulnerable components of biodiversity[72]

1243. Inland water ecosystems that have been identified as being particularly vulnerable to the negative impacts of climate change include:

- monsoonal wetlands (especially in India and Australia),
- boreal peatlands,
- wetlands in drylands,
- high altitude freshwater systems,
- isolated inland waters (such as pothole wetlands in North America’s prairies),
- African Great Lakes,
- low-lying coastal wetlands,
- Arctic lakes and rivers, and
- seasonal wetlands.

1244. In terms of species, less mobile aquatic species such as molluscs will be more at risk because they are unable to keep up with the rate of change in freshwater habitats. Other vulnerable species include those with restricted ranges and those with a high reliance on seasonal patterns in inland water systems.

2. Increased water temperature

1245. Rising water temperatures are likely to increase stratification, particularly in deep lakes. Reduced water movement across the thermo cline is projected to inhibit upwelling and mixing, which provide essential nutrient recycling. This also reduces water quality in inland waters through increased thermal stability and altered mixing patterns resulting in reductions in the amount of dissolved oxygen in deep waters. This is likely to affect chemical and biological processes. For example, increases in the concentration of chlorophyll (an indicator of overall ecosystem production) have occurred at an alarming magnitude in Arctic areas (e.g. Baffin Island lakes). Such changes to inland water ecosystems are likely to exacerbate many forms of water pollution, promote algal blooms and increase the bacterial and fungal content. Blooms of harmful cynaobacteria are already on the rise globally and climate change is implicated (see section – Status and Trends).

[72] The UNFCCC, in its glossary of terms, defines vulnerability in the context of climate change as: “The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.”

1246. Increased water temperatures will restrict cold-water fish range and expand warm-water fish range. Cold-water species such as salmonids are likely to decline while warm-water species such as cyprinids to become more abundant. As a result of this shift, lakes, surface water and rivers in Europe, North America and Asia are experiencing changes in species composition, abundance and productivity.

1247. Increased water temperatures are also expected to affect the growth rates and reproduction of organisms and species. For example, some species are achieving sexual maturity faster during warmer spells (e.g. painted turtles). Fish species also respond to higher temperatures by showing more rapid growth. On the other hand, increased winter water temperatures are negatively impacts egg viability of certain coldwater species (e.g. yellow perch).

3. Trends in permafrost, snow and glaciers

1248. Permafrost regions occupy approximately 22.8 x 10^6 km^2 or 23.9% of the exposed land area of the Northern Hemisphere, while the long-term average maximum area extent, usually in January, of seasonally frozen ground (including the active layer over permafrost) is about 48.1 x 10^6 km^2 or 50.5% of the Northern Hemisphere land area. Permafrost exists mainly in high latitudes and high elevation regions. Permafrost in Eurasia occurs over the entire Arctic and boreal forest areas and includes the mountainous regions of central Asia (Tien Shan and Pamir), the Tibetan Plateau and high elevated areas of the Himalayas. Over North America, permafrost is mainly distributed over Alaska and the Canadian Arctic with the southern boundary of the latitudinal permafrost varying from 50^oN to 57^oN. Due to the effect of the Rocky Mountains, mountain permafrost can extend as far south as 37^oN.

1249. Changes in the regime of ground ice in permafrost directly regulates the hydrological cycle of cold regions both in the short- and long-term. Based on information from the Circum-Arctic Map of Permafrost and Ground Ice Conditions, estimates are that the volume of excess ground ice in the Northern Hemisphere ranges from 10 800 to 35 460 km^3 or about 2.7 to 8.8 m sea-level equivalent. Assuming the average porosity of permafrost soil to be about 40%, the total volume of ground ice (including both pore and excess ground ice) varies from 54 000 to 177 000 km^3. Under global warming scenarios, permafrost is expected to degrade rapidly in the 21st century. As a result, melt-water of excess ground ice may directly participate in the hydrological cycle, while melt-water of pore ground ice may become a significant ground water resource in cold regions. Seasonal and inter-annual variations of soil water storage within the active layer and seasonally frozen layer in non-permafrost regions can be substantial and have a significant impact on the hydrological cycle in cold seasons/cold regions.

1250. There is a great deal of evidence that glaciers have retreated globally since the middle of the 19th century. As a response to rapid increases in air temperature, changes in precipitation amount and precipitation partition (rain/snow) are accelerating from the mid-1970s. Tropical glaciers are more sensitive than glaciers at higher latitudes. The Andes contain 99% of the world’s tropical glaciers, most of which are undergoing considerable recession, with many having reduced their volume by 30% since 1980. In the tropical Andes, runoff during the dry season (May-September) is often solely fed by glaciers, and therefore glacier retreat has major implications for water supplies seasonally. Changes in air temperatures and precipitation may have different impacts in different mountain regions at macro- and meso- scales and even in small catchments. In arid regions of central and northern Chile, much of western Peru and western Argentina climate change has resulted in warming and decreasing precipitation during the twentieth century and the glaciers in South America retreated much faster than in central Asia. The extent and the duration of ice cover are projected to decrease in some high latitude lakes in Europe[73].

1251. Changes in global and regional air temperatures and the frequency of major atmospheric circulation processes regulating moisture flow over central Asia are the major driving forces of glacier mass balance and river discharge variability. Glaciological observations conducted on the Tibetan Plateau revealed that between the 1950s and 1960s, 50% of glaciers retreated while 30% advanced and 20% were stable. During the next decade glaciers were relatively stable but since the 1970s recessions have accelerated and in the 1990s up to 95% of 620 glaciers studied were in recession. The recession rate was 4 m yr^{-1} at the north Tibetan Plateau intensifying up to 65 m yr^{-1} to the southeast.

1252. Glacial lake outburst floods (GLOFs) are catastrophic discharges of water resulting primarily from melting glaciers. An accelerated retreat of the glaciers in recent times has led to an enlargement of several glacial lakes. As the glaciers retreat they leave a large void behind. The ponds occupy the depression earlier occupied by glacier ice. These dams are structurally weak and unstable and undergo constant changes due to slope failures, slumping, etc. and run the risk of causing GLOFs. Principally, a moraine dam (formed of glacial debris of ice and rock) may break by the action of some external trigger or self-destruction. Characterized by sudden releases of huge amounts of lake water, which in turn would rush down along the stream channel downstream in the form of dangerous flood waves, GLOF waves comprise water mixed with morainic (ice/rock) materials and cause devastation for downstream riparian communities, hydropower stations and other infrastructure and ecosystems.

1253. In South Asia, particularly in the Himalayan region, the frequency of the occurrence of GLOF events has increased in the second half of the 20th century. GLOFs have cost lives, property and infrastructure in India, Nepal and China. GLOFs are the main natural hazards in the mountain areas of this region. A 1964 GLOF in China destroyed many kilometres of highway and washed 12 timber trucks 71 km from the scene. An outburst of Zhangzangbo Lake in 1981 killed four people and damaged the China-Nepal Friendship Bridge in the northern border, seven other bridges, a hydropower plant, Arniko highway and 51 houses. The damage was estimated to be USD 3 million. The 1985 GLOF at Dig Tsho was triggered by a large avalanche. A hydroelectricity project, 14 bridges, 30 houses and farmlands worth USD 4 million were destroyed. In 1998, the outburst of Tam Pokhari in Nepal killed two people, destroyed more than six bridges and washed away arable land. Losses worth over 150 million rupees have been estimated. A high water level was observed even after 19 hours in the Koshi barrage near the Indo-Nepal border. The river reverted to its original flow only after three days (Dwivedi 2000). There are about 159 glacier lakes in Koshi basin. Nearly 229 glacier lakes were identified in Tibet's Arun basin, out of which 24 are potentially dangerous. Since 1935 more than 16 GLOFs have been reported which either occurred or extended into Nepal.

4. Sensitivity of climate regions to various changes

1254. Different regions of the world are experiencing different degrees of change related to both climate variations and population and development pressures. In a related way, different regions also respond differently to changes in hydrological extremes:

[73] Christensen J.H. and Christensen O.B. (2003). Climate Modelling: Severe summertime flooding in Europe.Nature 421: 805-806.

(a) Deserts face conflicting influences under climate change: potentially seeing more vegetation with higher CO_2 levels, but overall facing increases in drought and warmer temperatures. As ecosystems in deserts are already fragile, impacts could be severe;

(b) Grasslands are influenced by precipitation and even when increased, changing seasonal variability is important, and declining summer rainfall could damage grassland fauna;

(c) Mediterranean ecosystems are diverse and vulnerable, susceptible to changes in water conditions. Even in the range of 2 degree warming, 60-80% of species may be lost in the Southern Mediterranean, while the Cape Fynbos in South Africa may lose 65% of its species;

(d) Tundra/arctic: with greater warming at the poles, the loss of permafrost and the potential for methane release is a major concern;

(e) Mountains are seeing shortened and earlier snow and ice melt and related changes in flooding. At higher altitudes, increased winter snow can lead to the opposite problem of delayed snow melt;

(f) Wetlands will be negatively affected where there is decreasing water volume, higher temperatures and higher-intensity rainfall; and

(g) The Himalayan region is highly vulnerable to anticipated climate change because the major river systems consist of substantial contributions from the melting of snow and glaciers.

1255. Specific impacts on wetlands are projected to include[74]:

Initially increased productivity in some mid-latitude regions and a reduction in the tropics and sub-tropics, even with warming of a few degrees;

Adverse affects on coastal wetlands and coastal fisheries, e.g. coral bleaching events are expected to increase and mangroves are expected to decline in many coastal zones;

Decreased water availability in many arid- and semi-arid regions; and

Increased forest productivity, including that of forested wetlands, although forest management will become more difficult because of an increase in disturbances (pest outbreaks and forest fires).

1256. Overall, it is projected that there will be more adverse than beneficial impacts on wetlands. Inland and coastal systems are likely to experience large and early impacts. These include identifiable changes in coastal wetlands:

Increased levels of inundation, storm flooding, accelerated coastal erosion, seawater intrusion into fresh groundwater, encroachment of tidal waters into

[74] Waterbirds around the world. A global overview of the conservation, management and research of the world's waterbird flyways, Climate variability and change and other pressures on wetlands and waterbirds: impacts and adaptation, C. Max Finlayson , Habiba Gitay , Maria Bellio , Rick van Dam & Iain Taylor, Edinburgh, U.K. The Stationery Office. 2006.

estuaries and river systems, and elevated sea surface temperatures and ground temperatures; and

Adverse impacts on marine mammal and bird species, especially migratory and nomadic bird populations that depend on coastal habitats.

1257. The Millennium Ecosystem Assessment demonstrated that freshwater ecosystem services are particularly in trouble. It found that the degradation of lakes, rivers, marshes and groundwater systems is more rapid than that of other ecosystems. Similarly it found that the status of freshwater species is deteriorating faster than those of other ecosystems. The loss of species and genetic diversity decreases the resilience of ecosystems – their ability to maintain particular ecosystem services as conditions change. Ecosystem degradation hits the poor hardest: degradation of ecosystem services hits the poor disproportionately. It is also sometimes the principal factor causing poverty. This situation is the result of non-climate change factors. Climate change will exacerbate the problems.

1258. The 15th Session of the Commission on Sustainable Development considered climate change based on the findings of an expert scientific group[75] which concluded:

(a) Avoiding the unmanageable and managing the unavoidable will require an immediate and major acceleration of efforts to both mitigate and adapt to climate change (including efforts to maintain biodiversity and water resources).

(b) Impacts by region were identified as including:

(c) *Europe:* More intense winter precipitation;

(d) *Arctic:* Significant retreat of ice; disrupted habitats by polar flooding, and other hazards; increased summer heat; loss of mega fauna (e.g. Polar Bears); accelerated loss of ice from the Greenland Ice Sheet (with major implications for sea-level rise);

(e) *North America*: Reduced springtime snowpack; melting of mountain glaciers; shifting of fisheries; replacement of most tundra changing river flows; shifting ecosystems, with stress in southern regions; intensifying regional climate by boreal forest; greater exposure to UV-radiation; loss of niche environments; rising sea level; greater biotic stress, causing shifts in flora; increased intensity and energy of Atlantic storms; loss and fragmentation of Arctic ice sheets (impacts on Polar Bears already observed);

(f) *Mediterranean region:* Tourism shifts; increasing coastal flooding and storm damage; more frequent and intense heat waves;

(g) *Central and Northern Asia*: Widespread melting glaciers; wildfires; improved agriculture and but loss of forest permafrost, disrupting transportation and buildings; productivity for a few decades increase but then declines; ecosystem stress from warming; increased release of methane; coastal erosion due to sea ice retreat;

(h) *Central America and West Indies*: Greater likelihood of intense rainfall; storms; sea-level rise; increased coastal vulnerability.

[75] Confronting climate change: Avoiding the unmanageable and managing the unavoidable. February 2007, Full Report, Scientific Expert Group Report on Climate Change and Sustainable Development. Prepared for the 15th Session of the Commission on Sustainable Development. Scientific Expert Group on Climate Change (SEG), 2007.

(i) *Southern Asia*: Sea level rise and more intense cyclones; increase flooding of deltas and coastal plains; major increased coral bleaching; some loss of mangroves and coral reefs; melting of mountain glaciers reduces vital river lows; inundation from sea level rise; increased pressure, biodiversity loss, stress on water resources with rising population and need for irrigation; possible monsoon perturbation;

(j) *Pacific and Small Islands*: Inundation of low-lying coral islands as sea level rises; salinization; storm damage.

(k) *Africa:* Declining agricultural yields and diminished food supplies; depleted aquifers; widespread coral bleaching;

(l) *Global Oceans:* Made more acidic by increasing CO^2; increased occurrence of drought and stresses; powerful typhoons and possible intensification of deep overturning circulation possibly impacting on freshwater water supplies; disruption of ecosystems and loss of biodiversity, including some major species; ENSC extremes reduced by warming and freshening in the North Atlantic;

(m) *South America*: Disruption of tropical forests and significant loss of biodiversity; melting glaciers;

(n) *Australia and New Zealand*: Substantial loss of coral along Great Barrier Reef; reduced water supplies - significant diminishment of water in agricultural regions; increased moisture stress; and

(o) *Antarctica and Southern Ocean*: Increasing risk of significant ice loss from West Antarctic Ice Sheet, risking much higher sea level, and disrupting marine life and penguins particularly at risk.

1259. Furthermore, increased water demand for consumption and irrigation as a result of climate change will place increased pressure on inland water systems. When considering that 54% of accessible runoff is already appropriated for anthropogenic use[76], declining water availability in desert margins and dryland areas, such as North Africa, the Mediterranean and South-eastern Australia (see Figure 95), will likely result in the increased exploitation of aquifers, inland waters and oases. This increased exploitation will have further negative impacts on some riparian systems. As one example, increased irrigation water demand due to climate change in India and China are estimated to range from 1–3% by the 2020s and 2–7% by the 2070s. The number of people living in water-stressed river basins would also increase significantly in the same period.

1260. Sea-level rise will affect a range of freshwater systems in low-lying coastal regions which may be displaced by salt-water habitats due to the combined actions of sea-level rise and larger tidal or storm surges. Plant species not tolerant to increased salinity or inundation could be eliminated, while salt-tolerant mangrove species could expand from nearby coastal habitats.

1261. Many inland water species will also be impacted by changes to the marine environment. For example, increased ocean temperatures are projected to cause population declines in high-Arctic breeding water birds due to fish species shifting toward the poles with cold-water fish being more restricted in their range.

1262. At this juncture it worth revisiting the relevance of many of the above phenomena to the topic of this review - inland waters (wetlands). In the above list, most impacts are related

[76] Threats to Rivers, Lakes and Wetlands. WWF, http://www.panda.org/about_our_earth/about_freshwater/freshwater_problems/

to changes to the hydrological cycle. The "ice" (and glaciers) referred to are made up of freshwater. Melting permafrost causes major shifts in wetlands (in fact, most permafrost areas are technically already defined as inland wetlands). Changing grassland functions have significant implications for soil erosion and soil water retention and groundwater (and therefore surface water) recharge and water quality; likewise for forests. Polar bears and penguins are, by recognised definitions, inland wetland dependent species (one problem they face being the freshwater on which they stand is melting). These examples are a reminder of the inter-connected nature of the issues in question. And the awareness issue is illustrated well by the polar bear – now an "icon" of climate change induced biodiversity loss, where few see the water/wetland link.

5. Hazards associated with changes in average streamflow

1263. Although considerable attention has been given to trends in discharge of unregulated rivers, most studies find that the number of rivers for which statistically significant trends (that might be attributable to long-term climate variations and change) are detected is considerably less than the number for which no significant trend is detected. On the other hand, the discharge of many large rivers have indisputably been affected by water management, especially dam construction, but also within-basin diversions for uses such as irrigation and municipal and industrial water supply, as well as trans-basin diversions. Although the projected effects of climate change are substantial, they are much less than the observed effects of water management.

1264. While hazards are normally experienced with hydrological extremes, there could be substantial risks to human activities caused by changes in average streamflow, especially in those areas that are already water-stressed. The IPCC (2007) report suggests that by 2050 the annual average runoff will have increased by 10-40% at high latitudes, and decreased by 10-30% over some dry regions at mid-latitudes and semi-arid low latitudes. However, in many water scarce regions, land use change and increasing levels of water resource development and use could hide the effects of climate change.

1265. There is evidence of increased annual runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, indicating a regime shift for some rivers. This trend is projected to continue in response to increasing temperatures, causing initially increased, but eventually reduced summer stream-flow in downstream regions receiving melt water from major mountain ranges.

1266. The response of different sections of river ecosystems to climate change will depend on their location within the river basin. Longitudinal linkages play an important role in the river functioning as an ecosystem. Upper sections of rivers are influenced more by abiotic factors and the biotic structures are better adapted to high abiotic (hydrological) variability, resistant to rapid and unexpected changes, and have a better ability to recover from stress. Down the river course, with stabilizing abiotic characteristics, biotic processes determine ecosystem dynamics, thus the lower reaches of these ecosystems will be more vulnerable to global warming.

1267. These processes will contribute to an intensification of eutrophication, a common problem already in lakes and rivers all over the world and a serious hazard for both human activities (drinking water, aquaculture, recreation etc.) and ecosystem functioning/biodiversity.

1268. The expected overall lowering of water levels in rivers and lakes will lead to amplification of already ongoing decreases in water quality. Water reserves will become more turbid through the re-suspension of bottom sediments and the decrease in water supply will decrease the dilution of pollutants in water resources. Salinity levels will increase with decreasing streamflow in semi-arid and arid areas; salt concentrations are predicted to increase by 13-19% by 2050 in the upper Murray-Darling Basin in Australia. Salinisation of water resources is also predicted to be a major hazard for island nations where coastal seawater intrusion is expected with rising sea levels.

1269. For a landlocked country like Nepal, which relies on hydropower generation as a vital source of national income, the prospect of an eventual decrease in the discharge of rivers spells doom. For an energy-constrained economy like India, the prospect of diminishing river flows in the future and the possibility that energy potential from hydropower may not be achieved has serious economic implications. The implications for industry extend beyond the ‘energy’ argument: chemical, steel, paper and mining industries in the region that rely directly on river/stream water supply would be seriously affected. Reduced irrigation for agriculture would have ramifications for crop production leading to impacts on basic human development indices like available food supplies and malnutrition.

6. Species

1270. The loss of aquatic biodiversity through global warming will be mostly caused by shifts of the physical characteristics of ecosystems and shrinking of suitable habitats. Other species will not be able to reach suitable habitats due to increasing disconnections and disintegration of climate and landscape. Rising water temperatures and related changes in ice cover, salinity, oxygen levels and water circulation have already contributed to global shifts in the range and abundance of algae, zooplankton and fish in high-latitude and high-altitude lakes, as well as to earlier migrations of fish in rivers.

1271. There are many cases studies showing that climate change is already having an impact on wetland species. We already know that climate change can significantly affect certain groups of species particularly sensitive to changes of temperature such as fishes, reptiles and amphibians[77]. There remains limited robust data on these changes, with a clear bias towards birds – and in particular birds in the Artic region. This information bias is due largely to information availability – birds in particular being a well studied group where good data are available. They are not necessarily more vulnerable to climate change and trends in bird populations are likely a warning sign for many other species groups.

1272. Climate change scenarios indicate the potential for widespread changes in populations of Arctic breeding water birds. The level of the impact varies from species to species, and will be affected by direct and indirect effects of changes in the climate, particularly through

[77] *El Cambio Climático y los Humedales en Centroamérica: Implicaciones de la variación climática para los ecosistemas acuáticos y su manejo en la región*, Junio 2003, Área Temática de Humedales, Agua y Zonas Costeras. Oficina Regional para Mesoamérica (ORMA), Unión Mundial para la Naturaleza (UICN), p.19.

habitats. The Arctic is of major importance for many water birds. More than two thirds of all geese and almost 95% of all Calidrid sandpipers breed in the Arctic[78].

1273. Changes to waterbird populations should also be expected in less severely affected areas. Increased temperatures will advance breeding seasons and possibly reduce winter mortality. The vegetation structure of wetlands can be expected to change, altering the physical aspects of habitats and plant productivity. There will almost certainly be great regional variation, with some areas experiencing increases in waterbird populations and others, decrease[79]. Relationships between the geographical distributions of birds and present climate have been modeled for species breeding in both Europe and Africa. The resulting models have very high goodness-of-fit and provide a basis for assessing the potential impacts of anthropogenic climatic changes upon avian species richness in the two continents.

1274. Simulations made for a range of general circulation model projections of late 21st century climate lead to the conclusion that the impacts upon birds are likely to be substantial. The boundaries of many species' potential geographical distributions are likely to be shifted ≥ 1000 km. There is likely to be a general decline in avian species richness, with the mean extent of species' potential geographical distributions likely to decrease. Species with restricted distributions and specialized species of particular biomes are likely to suffer the greatest impacts. Migrant species are likely to suffer especially large impacts as climatic change alters both their breeding and wintering areas, as well as critical stopover sites, and also potentially increases the distances they must migrate seasonally. Many inland species also depend upon coastal wetland sites, either as areas of non-breeding or as critical stopover sites; these wetlands are likely to be at risk from projected sea-level rise, as well as other projected climatic change impacts, adding further to the future threats to birds species.

1275. Without implementation of new conservation measures, these impacts will be severe and are likely to exacerbated ongoing threats from land-use change, water use and associated habitat fragmentation. Unless strenuous efforts are made to address the root causes of anthropogenic climatic change, much current effort to conserve biodiversity will be in vain.

1276. Coniferous trees are invading the tundra (much of it peatlands), a consequence of the changing climate. The shift will have adverse impacts on tundra species such as caribou and wild sheep, which will also be forced upwards as tundra habitats fragment and disappear[80].

1277. Major changes in planktonic communities and their food webs in lakes are predicted in response to increasing water temperature and other shifts in ecology[81].

1278. However, more information is required concerning impacts of climate change on wetland species and areas. The results available are ambiguous. Some species will clearly be adversely affected whilst others may benefit. Much emphasis is placed on climate change disruptions of migrations. We may not be able to predict for which particular species these

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[78] WCMC Biodiversity Series No. 11 Water Birds on the Edge. First circumpolar assessment of climate change impact on Arctic breeding water birds World Conservation Monitoring Centre prepared by Christoph Zöckler and Igor Lysenko

[79] *Waterbirds around the world. A global overview of the conservation, management and research of the world's waterbird flyways.* Climate variability and change and other pressures on wetlands and waterbirds: impacts and adaptation, C. Max Finlayson , Habiba Gitay , Maria Bellio , Rick van Dam & Iain Taylor Edinburgh, U.K. The Stationery Office. 2006.

[80] "Canadian Tundra Turning Green", Edmonton, Canada, March 6, 2007, Environment news service (ENS)

[81] Fischlin, A., G.F. Midgley, J.T. Price, R. Leemans, B. Gopal, C. Turley, M.D.A. Rounsevell, O.P. Dube, J. Tarazona, A.A. Velichko (2007). Ecosystems, their properties, goods, and services. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, 211-272.

changes will prove to be important, but the inherent diversity of the changes increases the probability that they will be of importance for at least some rare or threatened species. Of course, we also must ensure that less common physical habitat types, especially wetlands, continue to be protected, and should aim to increase the number of such sites within the protected area network. Nevertheless, the majority of wetland protected areas are already under threat, and many degrading, due to land and water use (see section Status and Trends). It will become increasingly difficult to sustain such protected areas in the face of the additional pressures of climate change.

7. Wetlands and invasive alien species

1279. Of the various types of ecosystems, wetlands are particularly susceptible to invasions by non indigenous species due to their location at the land-water interface. The fact that wetlands can contain purely aquatic habitats and terrestrial habitats, as well as a range of intermediate habitats, alone increases the potential for invasions by alien species which can invade through the terrestrial or aquatic component of the wetland. Although < 6% of the earth land mass is wetland, 24% of the world most invasive species are wetland species. Alien species already comprise 13.7% of the vascular flora of the St. Lawrence River wetlands (Canada). Climate change is likely to exacerbate invasive species problems by broadening climatic ranges and degrading wetlands, stressing native species and thereby opening up expanded opportunities for invasions.

D. Links between the terrestrial carbon and water cycles

1280. Strong evidence exists to indicate potential impacts of hydrologic trends on the "terrestrial" carbon cycle. Interactions between various stages of the carbon and water cycles can yield positive feedbacks to climate change. The rate of carbon uptake depends on hydrologic and climate conditions, as well as land use.

1281. Water plays different roles in each stage of the terrestrial carbon cycle. Soil moisture determines the proportions of carbon released to the atmosphere as carbon dioxide (CO_2) and methane (CH_4). Some hydrologic trends are expected to have serious implications for soil respiration. In the zone of continuous permafrost, many lakes have expanded over the last few decades, actively thawing the surrounding and underlying *yedoma* (an organic rich form of permafost with 50-90% ice content). Because the newly thawed soil around and under the lakes is saturated with water; respiration of the carbon produces CH_4, a much stronger greenhouse gas than CO_2. There is concern that permafrost degradation may cause some of these wetlands to drain and be replaced by grasslands, with important overall negative implications for the global carbon cycle and possible feedbacks to global climate change. The recent expansion of thaw lakes (14.7% increase in area between 1974 and 2000) may have resulted in a 58% increase in lake CH_4 emissions.

1282. Several studies have observed marked increases in the annual fluxes of dissolved organic carbon (DOC) in many temperate and boreal streams around the world. It has been difficult to attribute all of the observed trends to any single cause, but hydrology appears to play a role in some cases through changes in groundwater drainage. For example, in the Arctic, several studies have found strong correlations between daily river discharge and DOC concentrations. The increases in the annual discharge of the six major rivers of the Russian Arctic and especially the recently discovered increase in minimum flows across Northern Eurasian pan-Arctic may have important consequences for the carbon cycle. Because minimum flows generally reflect the influence of groundwater, the cause of these trends could be a reduction in the intensity of seasonal soil freezing, allowing more connectivity in subsurface drainage networks. It is conceivable that the increased flushing of the soils through groundwater, accompanied by longer growing seasons and greater microbial activity during seasons in which the soils historically have been frozen, could lead to greater mobility and loss of soil carbon. There is some indication that the thawing of permafrost in Siberia may release large amounts of soil carbon into streams in the future.

E. Impacts of Multiple Nutrient Loading

1283. The impacts of climate change on multiple nutrient loading are varied depending on initial local conditions, projected climate change impacts and seasonal variability. Furthermore, the assessment of projected links between climate change and multiple nutrient loading are still based on a high degree of uncertainty associated with the need to downscale climate models and on the complexity of modeling multiple stressors.

1284. Based on the studies that have been conducted, overall, increased flows are correlated with increased nutrient loading, via increased spring runoff as a result of glacial melting or early snowmelt, and enhanced evapotranspiration may actually reduce nutrient loading the late summer[82]. As such, some studies have demonstrated that the annual changes in nutrient loading are, in fact, minimal despite significant changes in seasonal nutrient loading profiles[83]. But in intensively cultivated watersheds, nutrient loading has been shown to decrease as flows increase.

1285. Where climate change is acting as a stressor on inland water ecosystems and multiple nutrient loading is increasing, experimental evidence suggests that the two factors will act as synergistic pressures driving algal processes[84]. There is also evidence that increased water temperatures decrease the threshold at which nutrient loads become critical in terms of affecting the health of inland water ecosystems[85]. As such, many studies suggest that increased attention should be paid to reducing multiple nutrient loading if environmental targets are to be met in inland waters under changing climatic conditions[86].

F. Impacts on transboundary water resources

1286. Countries that share water resources may face additional challenges under conditions of changing hazards. There will be great variations in how nations mitigate the hazards that affect international waters. In broad terms, OECD-member countries in Europe, North America and South East Asia, would be able to mobilise their institutional and financial resources to invent new cooperative efforts, while developing nations that have limited resources and hazard mitigating experience would be the most exposed. Examples include the Mekong basin and some of the major basins in West and Central Africa. Changes in transboundary water resources (either through engineered developments or climate change) represent opportunities for further cooperation, given that there is the political will to engage in such cooperation. However, it is important to recognise that cooperation must be based on a

[82] Heejun Chang , Barry M. Evans and David R. Easterling. The Effects of Climate Change on Stream Flow and Nutrient Loading. JAWRA Journal of the American Water Resources Association. Volume 37 Issue 4, Pages 973 – 985.
[83] Moore, Karen, Donald Pierson, Kurt Pettersson, Elliot Schneiderman and Patrick Samuelsson. Effects of warmer world scenarios on hydrologic inputs to Lake Mälaren, Sweden and implications for nutrient loads. The European Large Lakes Symposium (ELLS) 2006, Tartu , Estonia 2008, vol. 599 , Pages 191-199
[84] Lisette N. De Senerpont Domis, Wolf M. Mooij, and Mathew Leibol. Nutrient loading and climate warming: Two synergetic drivers of freshwater algal dynamics? Proceedings of the ESA/SER Joint Meeting (August 5 -- August 10, 2007)
[85] Sebastiaan A. Schep, Gerard N.J. Ter Heerdt, Jan H. Janse, Maarten Ouboter. Possible effects of climate change on ecological functioning of shallow lakes, Lake Loenderveen as a case study. Annals of Warsaw University of Life Sciences - SGGW. Land Reclamation. Volume 38, Volume 38 / 2007, Pages 95-104
[86] Reilly J., Tubiello F, McCarl B, Abler D, Darwin R, Fuglie K, Hollinger S, Izaurralde C, Jagtap S, Jones J, Mearns L., Ojima D., Paul E., Paustian K., Riha S., Rosenberg N, and Rosenzweig C. U.S. Agriculture and Climate Change: New Results. Climatic Change, Volume 57, Numbers 1-2, 200303 , Pages. 43-67(25)

common understanding of the nature of the resource as well as its value to the countries who share it.

G. Related socio-economic considerations - the risks and consequences for ecosystem services and human well-being

1287. The Stern Review (The economics of Climate Change) recognised that climate change presents very serious global risks - often mediated through water.

1288. Wetlands provide a disproportionate amount of production of the ecological goods and services upon which humans depend. Because wetlands are dependent on a single major driver, hydrology, they may experience greater rates of change than terrestrial systems under climate change scenarios.

1289. The impacts of climate change on inland waters will have varied effects on ecosystem services and human well-being but overall with a predominately negative trend. For example, a trend towards wetter conditions in parts of southern South America has increased the area affected by floods, but has also improved crop yields in the Pampas region of Argentina. China, Finland and the USA are also projected to experience increases in annual runoff. In other areas flooding will increase, not only because of changing precipitation but also as a result of the impacts of increased temperatures on ice jams. Currently, floods affect 140 million people per year on average.

1290. In very pragmatic and economic terms, functions, values and ecosystem services provided to humans from the vast boreal ecosystem exert a large influence over millions of more southerly humans by altering climatic conditions, affecting atmospheric gas balances, capturing and delivering water for hydro-power, producing habitat for billions of migratory birds, partially regulating precipitation and storm patterns, producing forest products, and maintaining recreational opportunities for people. The magnitude of the influence on boreal carbon and water supplies may overshadow direct use biodiversity contributions in terms of global repercussions[87].

1291. In addition to increasing floods, climate change may increase periods of drought. In fact drying trends have already been observed in much of Eurasia, northern Africa, Canada and Alaska. Such droughts will place increasing pressure on the water cycling services provided by inland waters and may, in fact, cause some wetlands to cease to perform these functions, at least seasonally. This is especially of concern for seasonal flows in savannah regions in sub-Saharan Africa.

1292. Reduced river flows, projected for West Africa, Southern Europe and Southern Latin America, may also result in disruptions to inland navigation, irrigation and power plant cooling. Groundwater flow and levels in shallow aquifers are also decreasing, affected through recharge processes.

1293. In general, changes to the timing and amount of precipitation may result in periods of increased turbidity and nutrient and pathogen loadings within surface water sources with negative impacts on freshwater access. Freshwater access is also being negatively impacted by less snow at low altitudes and earlier spring runoff as well as mountain glacier decline globally. For example, even though China is projected to experience increased annual runoff as a result of climate change, in western China, earlier spring snowmelt and declining glaciers are likely to reduce water availability for irrigated agriculture.

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[87] Wetlands in Canada's western boreal forest: Agents of Change by Lee Foote and Naomi Krogman, November/December 2006, VOL. 82, No. 6 — The Forestry Chronicle.

1294. Changes are projected to result in decreased potential travel days of vehicles over frozen roads in Alaska and increased flood periods disrupting inland water navigation and low flow restricting the loading of ships.

1295. A recent report to the IPCC[88] states that coastal areas are particularly at-risk, where millions of people in densely-populated low-lying areas are at increasing risk of exposure to flooding by storm surges over the 21st century. The IPCC expects sea level rise to exacerbate inundation, storm surges, erosion and other coastal hazards. Global warming can expand the endemic zones of several water related infectious diseases like dengue, malaria or bilharzias.

1296. Scarcity as measured by available water per capita is forecast to get worse through non-climate change trends where the population is still growing significantly – in Sub-Saharan Africa, South Asia and some countries in South America and the Middle East. Notably, climate models show that extremes of rainfall are probably going to get worse resulting in heavier floods and more frequent droughts in regions already affected by these.

1297. Projections from climate scientists and modellers warn that changes in water availability and quality may have disastrous consequences. Because water is the principal medium through which changes in climate will impact upon economic, social and environmental conditions, changing water availability translates into economy-wide impacts.

1298. Over one sixth of the world's population lives in areas where surface water is dominantly derived from snowmelt, either seasonally ephemeral snowpacks, or perennial glaciers (Barnett et al., 2005). This area also accounts for over one-quarter of the global gross domestic product. Therefore, changes in the seasonal patterns of runoff, and/or permanent changes in runoff volume that result from changes in snow cover are of great concern. In the Indian context, the importance of the river systems originating from the Himalayas, namely the Indus, Ganga and Brahmaputra River systems, can be understood from the fact that they contribute more than 60% to the total annual runoff for all the rivers of India. These river systems hold immense potential as a future freshwater source and drain the major plains of the country. Some Himalayan rivers obtain more than a 50% contribution from snow and glacier melt runoff to the annual streamflow near the foothills of Himalayas. Melting of glaciers and a reduction in solid precipitation in mountain regions would have a direct impact on water resources affecting domestic supplies, irrigated agriculture, hydropower generation and other water-dependent activities.

1299. Among the recent extreme high-impact water-related events are: floods in Europe in 1997 and 2002, floods in China in 1996 (26 billion US$ in material damage) and 1998 (30 billion US$ in material damage). Destructive floods observed in the last decade all over the world have led to record high material damage. The costs of extreme weather events have exhibited a rapid upward trend and yearly economic losses from large events increased ten-fold between the 1950s and 1990s, in inflation-adjusted dollars. Disaster losses, mostly weather and water related, have grown much more rapidly than population or economic growth suggesting a climate change factor. Water Sensitive Planning (WSP) dictates that water considerations must be incorporated in land use and land cover planning from the very outset. The relevance of this in the context this in-depth review is that almost universally such losses arise, at least in part if not often in whole, from the degradation of inland water ecosystems and subsequent loss of the disaster mitigation services that they naturally provide.

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[88] Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe, 2007: Coastal systems and low-lying areas. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 315-356.

1300. Progressive modification in catchments due to the impacts of other, powerful, non-climatic agents of global change, may both enhance or mitigate the expected effects of climate change. The socio-economic drivers superimposed upon the ecological and hydrological processes include changing demography, technology development, dynamics of economic markets and resource demands, political and social institutions, culture, knowledge and information exchange. A chain of causal links transformed though 'pressures' (emissions, waste, resource use and land use) creates pressure on nature and the environment, including climate change, to 'states' (physical, chemical and biological) and to 'impacts' on ecosystems, human health and functions. These eventually may lead to political 'responses' such as prioritisation, target setting and indicators, policies, regulations or possibly socio-economic constraints and losses.

1301. Anthropogenic climate change is a fundamental driver of changes in water resources and an additional stressor over and above other external driving forces. Policies and practice aimed at adaptation to, or mitigating of, climate change can have direct and indirect implications on water resources – and shifts in related ecosystem service provision. Remarkably, this is hardly ever considered.

1302. Adaptation to climate change adds a critical challenge for all countries, particularly for cities in coastal zones and for developing countries that will be hit hardest and earliest, with low capacity to adapt and for almost all business sectors. The importance of water is paramount in these challenges.

1303. What advocacy on climate change has done is to bring to the fore a dire projection of a worsening water situation – a different cause, but the same end result. It is an unfathomable paradox that the world is motivated to respond to the impacts of climate change of the future, yet has remained disinterested in taking the actions needed to meet the rising water crisis that is upon us today.

H. Economic growth

1304. Estimates indicate that some 40% of development investment is currently at risk to climate related changes.[89] The costs of climate change will likely affect different donor countries in different ways, but would potentially lead to an overall drop in official development assistance (ODA), exacerbating the vulnerability of poor people and countries to adapt and develop their water resources.

1305. The costs of adapting to climate change are considerable. The World Bank[90] estimates of the additional costs to adapt or climate-proof new investments range from US$ 9 to 41 billion each year; a recent update by UNDP[91] put the mid-range of the costs of adaptation at about US$ 37 billion/year in 2015; UNFCCC[92] estimated that additional investments needed for adaptation to climate change as US$ 28- 67 billion, and could be as high as US$ 100 billion per year several decades from now; the *additional* investment needed in water supply infrastructure in 2030 is estimated at USD 11 billion, 85 per cent of which will be needed in

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[89] OECD (Organization for Economic Cooperation and Development) (2005) Bridge over Troubled Waters. Linking Climate Change and Development. OECD, Paris.

[90] World Bank 2006. Clean Energy and Development: Towards an Investment Framework. DC2006-0002, World Bank, Washington, DC, USA, x+146 pp.

[91] UNDP (2007): Human Development Report 2007/2008: Fighting climate change. Human solidarity in a divided world. http://hdr.undp.org/en/reports/global/hdr2007-2008/

[92] UNFCCC (2007): Investment and financial flows to address climate change. Background paper. http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/background_paper.pdf

developing countries. Oxfam[93] estimated that the current costs of adaptation to climate change for all developing countries to be greater than US$ 50 billion per annum. Clearly, current GEF funds (~US$ 160 million) are several orders of magnitude too low to meet these projected needs. Much of such costs are environment and water-related.

1306. However, it should be noted that these levels of investment requirements are an increment to the much larger overall (non climate change) water-related investment requirements for meeting human needs (including the MDGs) factoring in population growth and changes in consumption patterns. Some of these estimate investment requirements for water infrastructure to meet drinking water and sanitation objectives alone at $ 22 trillion by 2030 (see section: Drivers of Change – Water use for further information).

1307. There is clear evidence supporting a relationship between climate variability and economic performance in countries heavily dependent upon agriculture for their GDP – and the major linkages occur through water related stresses on crops.

1308. Across many parts of the developing world, losses associated with disasters are of a sufficient scale to undermine development and poverty reduction goals. Elsewhere this review (see section: Drivers – Water use) notes that most disasters are water related (droughts/floods) and that their existence causes a 14% reduction in GDP of low-income countries; whereas a single catastrophic event can cause even higher national economic losses sustained beyond a decade. These disasters are already occurring. Few doubt that climate change will increase their frequency and severity. While infrastructure designs, agriculture investments and water management plans currently incorporate some awareness of (natural) climate variability, actual climate risks are seldom properly considered.

1309. Whilst re-emphasising that climate change is not the main driver of global water problems, nor overall of loss of inland water biodiversity, there is clearly an urgent need to "climate proof" existing policies, investments and management.

I. Mitigation

1310. There is growing evidence of the significant importance of wetlands for Greenhouse Gas mitigation. Wetlands, in particular peatlands, are significant carbon stores, and so their conservation needs to be properly considered in climate change mitigation strategies. The primary mitigation response at present continues to be avoiding the degradation of carbon rich wetlands and where feasible restoring these. A clear mitigation strategy is to avoid deforestation on wetlands. An additional mitigation strategy is the restoration of degraded wetlands and creation of human-made wetland ecosystems. Restoration and creation can compensate to some extent for the loss natural wetland functions, such as flood storage and water quality buffering and provide opportunities to store carbon.

1311. The geographical distribution of wetlands is likely to shift with changes in temperature and precipitation, with uncertain implications for net greenhouse gas emissions from non-tidal wetlands (Ramsar STRP).

1312. The most detailed information on the carbon mitigation aspects of wetlands remains in relation to peatlands. Peatlands are a critical area of focus for mitigation due to their large carbon stores and current and potential carbon emissions. This is particularly so for tropical (usually forested) peatlands, and to some extent likewise for temperate peatlands, because

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[93] Oxfam (2007): Adapting to climate change - What's needed in poor countries, and who should pay. Oxfam briefing paper 104. http://www.oxfam.org.uk/resources/policy/climate_change/downloads/bp104_adapting_to_climate_change.pdf

improved management options are quite feasible. Exposure of higher latitude peatlands, due largely to permafrost melt, is not necessarily of less concern regarding emissions but there are limited management options since the degradation generally is not due to direct human intervention in these wetlands.

1313. The ninth meeting of the Conference of the Parties to the CBD already considered the Global Assessment of Peatlands, Biodiversity and Climate Change (decision IX/16, section D) in these regards and invited the tenth meeting of the Contracting Parties to the Ramsar Convention to consider appropriate action in relation to wetlands, water, biodiversity and climate change. Responses of the Ramsar Convention to this and related climate change matters are detailed further below. The Ramsar STRP is already paying increased attention to the mitigation aspects of wetlands, in particular attempting to fill the gaps in knowledge on non-peat wetlands.

J. Assessment of the positive and negative impacts of climate change mitigation and adaptation activities on biodiversity and inland water ecosystems

1. Mitigation and wetland conservation/restoration

1314. Interventions aimed at mitigating further release of GHG from wetlands centre on conservation and rehabilitation. This aspect of mitigation is therefore by-and-large positive for inland waters biodiversity.

1315. The danger lies in lack of attention to the mitigation options for wetlands and the relative benefits of doing so (which can include very attractive cost effective returns in terms of reduced carbon emissions). Where benefits are less than those from wetland related investments, investment in alternative mitigation activities is an indirect driver not only of further wetland degradation (and loss of other wetland services besides carbon storage) but also a potential inefficient use of financing as measured against its primary objective (reduced GHG levels). Tropical peatlands provide the clearest example. The GHG mitigation, biodiversity, poverty and ecosystem services benefits of investments in sustaining or rehabilitating them are relatively clear (the Global Assessment of Peatlands, Biodiversity and Climate Change provides further information). Yet these ecosystems still struggle to obtain adequate financing, in part through competition from more popular activities.

2. Water and climate change mitigation

1316. Some roles of water (the hydrological cycle) and wetlands in GHG fluxes are outlined above. These imply significant linkages between water use, carbon and mitigation efforts, as detailed above.

1317. The relationship between climate change mitigation measures and the direct use of water is a reciprocal one because of the significant linkages between water and energy. Energy related mitigation measures can influence the quantity and condition of water resources and their management. It is important to recognize this reality when developing and evaluating mitigation options. For example: utilizing hydropower as an alternative to fossil fuel power plants would lead to more dam construction (and subsequent losses of water through evaporation, particularly in dry areas), the impacts of dams on biodiversity are already widely known; a significant amount of water is required to grow biofuels (see section: Drivers – Water use for further details).

1318. Historically, most of the discussions and subsequent efforts, including those initiated under the Kyoto Protocol on the reduction of GHG emissions, have focused on mitigation strategies. This approach will continue to have serious implications for energy policy (a major water use sector), as well as other key sectors such as international trade and transportation. The net result will be an escalation of drivers of water use and consequently inland waters biodiversity loss.

1319. WWDR3 concludes that for truly effective adaptation and mitigation measures to take effect, it will become increasingly necessary to shift the climate change portfolio into the authority of the ministries of finance and planning, especially with the emergence of regional carbon trading markets and an eventual carbon-constrained economy. It will become ever more important that investment decision making is aware of the ecosystem context of carbon and water and the role of ecosystem infrastructure.

1320. There is obviously increasing world attention to carbon mitigation through improved forest management (in particular REDD), and interest in wetlands is growing. Despite this progress, Ramsar STRP has noted that there does not appear to be any scientific basis on which the integrity of forests and wetland systems as carbon stores can be guaranteed for decades let alone centuries. For example, there is very limited attention to the implications of changing water availability (due to direct human use, let alone climate change) on the sustainability of forests. There is already evidence (presented elsewhere in this review – see Status and Trends) that unsustainable groundwater use is lowering water tables in many areas and at the continental scale. So far, it appears that dialogue has missed the fact that terrestrial vegetation (including forests) depends on the same groundwater. Likewise, localised, even regional, deforestation coupled with the over use of water are widely considered a potential driver of local/regional climate shifts (particularly reduced rainfall). Reforestation with water intensive species can also further deplete water resources – in particular reducing blue water supplies in some critical areas. The implication is that in such areas feedback mechanisms will increase the vulnerability of those forest resources which are supposed to be conserved as carbon stores. In view of the projected expanding area under increased water stress (not even considering climate change) this is a substantial potential problem regarding current mitigation efforts.

1321. The conclusion is that mitigation efforts must pay more attention to wetlands and their role in both the water and carbon cycles – in order to sustain both wetland *and* land (forest) mitigation benefits.

3. Adaptation responses

1322. Managing water has always been about managing naturally-occurring variability. Climate change threatens to make this variability greater, and to shift and intensify the extremes. Climate change introduces greater uncertainty into the picture. The decisions and policies put in place today regarding mitigation and adaptation can have profound consequences on the water resource (supply and demands) both today and over the long term.[94]

1323. Overall, the adaptation response to risk will be to increase water storage – to cater for the increased frequency and severity of both droughts and floods. This presents both significant dangers and opportunities. Many response measures to adapt to climate change, particularly physical infrastructure approaches, have significant implications for wetlands and further disruptions in the water cycle. A whole-scale business as usual engineering approach to the problem (dam, levee construction etc.) brings significant further threats of increased biodiversity loss and deteriorating ecosystem functioning – which would likely, in many

[94] IPCC, 2008, Technical Paper on Climate Change and Water http://www.ipcc.ch/meetings/session28/doc13.pdf

cases, undermine the objective of risk reduction itself. Dams, for example, increase evaporation particularly in dry areas, increase ecosystem fragmentation and further stress water cycles downstream. They also retain large quantities of sediments essential to the maintenance of deltas and coastal wetlands.

1324. On the other hand, there are significant opportunities to use natural ecosystem infrastructure (including not only wetlands but related considerations for soil moisture and groundwater) more wisely in order to reduce risk and achieve more sustainable water supplies, and other advantages of improved ecosystem functioning. There are strong arguments, and a solid case-study evidence base, that this can be feasible and that the main reasons for doing so are to meet human needs – biodiversity being a co-beneficiary. This conclusion has already been noted elsewhere in this review – climate change considerations provide additional weight to the need to think more intuitively regarding responses taken.

1325. It is absolutely critical that climate change adaptation strategies fully recognise the central role of water, are aware of hydrological cycle and consider the problem and solutions from an ecosystem perspective. In this, natural ecosystem infrastructure is a considerable ally in achieving cost-effective and sustainable solutions. Where adaptation by infrastructure development includes the maintenance or restoration of protective ecosystem services through, for example, improved river basin management, positive outcomes can be expected for inland waters biodiversity. Where it is absent it is difficult not to foresee further substantial biodiversity loss.

1326. In terms of adaptation to climate change, effective funding mechanisms for developing countries, where the needs are broadly about development, are woefully lacking (WWDR3). This is especially true for Africa, where the impacts of climate change will range from energy shortages, reduced agricultural production, worsening food security and growing malnutrition, to spreading disease, more humanitarian emergencies, growing human migratory pressures and increased risks of conflict over scarce land and water resources. The financial mechanisms providing support to developing countries need to be aware of the nature of the problems and solutions as outlined in this review. In particular, "natural infrastructure" solutions to the problems faced in such countries may be particularly promising – if for no other reason than the fact that financial resources are unavailable for capital intensive fixes.

1327. A major area of concern for inland waters (including coastal wetlands) relates to adaptation to sea-level rise. There are two basic response options – let it happen and allow wetlands to adapt and move inland, or build stronger coastal defences (to some extent both are already happening worldwide). But most coastal wetlands are now surrounded by physical infrastructure and have limited room to move – or rather they will not be allowed to; even if they do move there is a danger it will be unmanaged (leading to increasing catastrophy). The development of coastal protection infrastructure is already a major direct driver of coastal wetland change. The scale of the problem is alarming. For example, in the U.S.A, due to this constraint, a 0.3m sea level rise could eliminate up to 43% of coastal wetlands (National Academy of Sciences, http://www.koshlandscience.org/exhibitgcc/index.jsp); projected sea-level rise already exceeds this.

1328. The picture emerges, in many places, of coastal wetlands being "sandwiched" in an unsustainable location. Clearly, responses to sea-level rise (and increasing severity of coastal storms) more than ever requires a more holistic ecosystem based approach. Where feasible, the flood and storm adaptation services provided by coastal wetlands need to be rehabilitated.

1329. Adaptation activities in the agriculture sector may have positive or negative impacts on inland waters. Where adaptation activities focus on increasing the efficiency of water use, such as through repairing irrigation networks or adopting low-water requirement crops or livestock breeds, the rate of increase of pressures on inland waters may be reduced. However, if adaptation activities include the expansion of irrigation networks such that fresh water withdrawal increases, pressure on inland waters can be expected to escalate. Furthermore, if adaptation activities in the agriculture sector involve the expansion of agricultural areas into wetlands (including through the draining of wetlands), further negative impacts can be expected for inland waters biodiversity[95].

1330. Given the projected impacts of climate change on increased river transport, adaptation responses may include adjustments to flow, management of channels, river maintenance and expanded canal construction. This could include, increasing water flow controls, the stabilization of banks and dredging[96]. Such adaptation activities could potentially have negative impacts on inland waters biodiversity if they are carried out without due consideration for the needs of species and ecosystems.

1331. Within the forest sector, a number of adaptation approaches are being proposed with the aim of protecting existing forest stocks and ensuring the continued provision of ecosystem goods and services. Some approaches, such as the expansion of protected areas or the adoption of measures to combat invasive alien species will likely have positive impacts on inland waters biodiversity through the maintenance of water flows. Adaptation approaches that may have negative impacts on inland waters biodiversity include afforestation and reforestation where wetlands are converted to forests, or tree species that have a high water need are used.

1332. Climate change is projected to increase the instances of water borne diseases (such as malaria). In some cases, adaptation activities include the draining of wetlands in order to eliminate breeding grounds, or the spraying of wetlands with pesticides[97] – despite the fact that it is usually artificial and poorly maintained water (e.g., ditches, water tubs) that are the main culprit, not healthy wetlands. These approaches can be expected to have negative impacts on inland waters biodiversity if not implemented appropriately. On the other hand, where adaptation activities to control disease vectors in inland water ecosystems include the restoration of natural flow regimes, or the adoption of integrated pest management, inland waters biodiversity could be expected to benefit from adaptation activities.

K. Reports of Parties (CBD fourth national reports and the second, third and fourth national communications under the United Nations Framework Convention on Climate Change UNFCCC)

1. Climate Change Impact and Response Activities in the Inland Waters Programme of Work

1333. In the annex to decision VII/4 a revised programme of work on inland waters biodiversity is set out. Paragraph 7 of this annex states that the programme of work should pay particular attention to the impacts of climate change and the role of inland waters in mitigation of and adaptation to climate change. This should include the consideration, support and collaboration with other relevant initiatives, in particular those related to the conservation and sustainable use of peatlands.

1334. The same annex, in programme element 1, sets as an objective, the integration into land-and water-use management approaches appropriate adaptive management and mitigation

95 http://www.springerlink.com/content/v664175713l238n0/

96 http://74.125.95.132/search?q=cache:_cLbXw6forkJ:www.pianc.org/downloads/envicom/envicom-free-tg3.pdf+climate+change+adaptation+waterways&cd=4&hl=en&ct=clnk&gl=ca&client=firefox-a

97 http://www.sdnetwork.net/briefing_papers/malaria_climatechange.pdf

responses to combat, and prevent where possible, the negative impacts of climate change on the biodiversity of inland water ecosystems. To achieve this objective Parties are called on to:

- Develop effective management strategies to maintain or improve the sustainability of inland water ecosystems and facilitate a minimum water allocations to the environment to maintain ecosystem functioning and integrity while giving due consideration to the likely impacts of climate change.

- Provide to the Executive Secretary advice on national experiences and approaches to promoting and implementing adaptive management and mitigation strategies for combating the impacts of climate change.

- Assess the linkages between inland water ecosystems and climate change and the management options for mitigation of and adaptation to climate change.

Assessment of implementation

1335. The extent to which Parties have implemented the climate change elements of the inland waters programme of work has been assessed based on an analysis of fourth national reports to the CBD and second, third and fourth national communications to the UNFCCC.

1336. Based on an analysis of the 51 Parties who submitted their 4th National Reports as of 13 August, 2009, 23 Parties have reported on climate change activities specifically targeted at inland waters biodiversity[98]. An additional 17 Parties reported on activities related to climate change and inland waters biodiversity through their National Communications to the UNFCCC[99].

1337. Examples of activities reported by Parties (see below for additional details) include:

- Assessments of the vulnerability of inland waters to the negative impacts of climate change (including the establishment of long-term monitoring programmes);
- Programmes for the restoration of degraded wetlands;
- Halting development in flood plains;
- Improved fisheries management;
- The development of water resource management plans for threatened wetlands;
- Improved water management including the establishment of catchment or river basin management plans;
- Reducing threats to people and livelihoods from the negative impacts of climate change on inland water ecosystems;
- The expansion of protected areas networks for inland water ecosystems; and
- Analysing the role of inland water ecosystems in climate change mitigation.

1338. The vast majority of Parties reported on adaptation activities and vulnerability and impact assessments with only 4 Parties reporting on activities linking climate change mitigation to inland waters biodiversity[100] although a number of additional Parties did recognize the need to enhance this link.

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[98] Afghanistan, Armenia, Australia, Bhutan, Botswana, Canada, China, Comoros, Cuba, Czech Republic, Djibouti, European Commission, Finland, Hungary, Mexico, Mongolia, Morocco, Norway, Philippines, South Africa, Sweden, United Kingdom and Uganda

[99] Austria, Belarus, Belgium, Denmark, Estonia, Former Yugoslav Republic of Macedonia, Germany, Iceland, Ireland, Italy, Kazakhstan, Netherlands, New Zealand, Republic of Korea, Switzerland, Tajikistan and Uzbekistan.

[100] Belarus, Canada, Iceland and the United Kingdom.

Gaps in the integration of climate change impact and response activities in the programme of work

1339. In reporting on activities, Parties also identified a number of barriers that are preventing the further implementation of the climate change elements of the inland waters programme of work. These include:

- The need for enhanced international cooperation in inland waters management, especially when considering trans-boundary water ways and migratory pathways;
- The need for further financial and technical resources, including capacity building;
- The need for better information on the projected impacts of climate change on inland waters biodiversity; and
- The need for a better understanding of the links between inland waters biodiversity and climate change mitigation.

2. The contribution of inland waters biodiversity to climate-change adaptation

1340. The above assessment, together with conclusions from other sections of this review, stress that the main linkages between climate change adaptation and inland waters biodiversity centre on the role of biodiversity in sustaining ecosystem functioning. This contribution is considerable. Inland waters biodiversity has an important role to play in maintaining both access to and supply of fresh water under changing climate conditions. The maintenance of wetlands can regulate water flows and provide storage and slow release. In areas that are facing an increased intensity but decreased frequency of precipitation events, such measures can significantly contribute to the continued provision of fresh water. Likewise, in the face of sea level rise and increased storm surges, inland water ecosystems offer considerable scope to adapt to these increasing risks.

1341. At the species/genetic level opportunities also exist. For example, species with high salt tolerance are being exploited to provide alternative livelihood options; in Bangladesh, the salt tolerant reed species, *Cyperus tagetiformus* is being used by local communities as a source of income when salt water inundations cause crop loss[101].

1342. Some ancillary and related considerations include:

Agricultural sector and food production

1343. Inland waters biodiversity is providing an important source of protein that is helping to support food security in agricultural systems negatively affected by climate change. For example, in Lao PDR increased flooding during the rice cultivation season is causing lost production. In an adaptation programme to address such losses, local communities are turning to wetland species to supplement their diet. As such, the sustainable management of crabs, fish, frogs and toads and the conservation of the wetlands that support them is an important element of local adaptation strategies[102].

[101] ITDG-B (2003) An Attempt on Application of Alternative Strategies for Community Based Flood Preparedness in South-Asia, Bangladesh and Hossen and Roy (2005) Local Contributions to Operationalising the UNFCCC, CBD and UNCCD. Reducing Vulnerability to Climate Change in the Southwest Coastal Region of Bangladesh

[102] Meusch, E., Yhoung-Aree, J., Friend, R. & Funge-Smith, S.J. (2003) The role and nutritional value of aquatic resources in the livelihoods of rural people – a participatory assessment in Attapeu Province, Lao PDR. FAO Regional Office Asia and the Pacific, Bangkok, Thailand, Publication No. 2003/11

1344. Other adaptation activities that are supported by inland waters biodiversity include the sustainable management of wetlands as an integral part of irrigation systems and flood control mechanisms, and the capture of fish for sustainable aquaculture.

Health sector

1345. Biodiversity is already being used to halt or slow the spread of disease vectors which are expected to increase as a result of climate change. For example, in the Sudan, berries from the drought-resistant *Balanite*s *aegyptiaca* tree are being applied to rivers and waterways to kill schistosome parasite hosts[103].

Infrastructure

1346. Many adaptation strategies to counter the negative impacts of floods and storm surges on infrastructure are already including elements for the conservation or restoration of wetlands. For example, a programme for the restoration of mangroves in Thailand provides protection against storm surges while also delivering benefits for biodiversity and local livelihoods[104]. Likewise the conservation and restoration of floodplains is an integral component of the European Union flood management strategy. Many other case studies reflecting such approaches are provided throughout this review (see in particular the sections on Activities of relevant NGOs and VII Responses and challenges).

L. Measures that enhance the adaptive potential of components of inland waters biodiversity

1347. Climate change is an additional driver of all existing drivers of inland waters biodiversity loss. Conservation measures, as already being implemented widely to varying degrees, have a continuing and probably increasing role in relation to climate change. But for most of the world the prominence of water in development makes it certain that globally "conservation" approaches will be challenged to make a significant impact on the rate of biodiversity loss. As a generality, in most regions, including the developed world, the most promising strategy is to enhance the adaptive potential of inland waters biodiversity in order to achieve better human development outcomes. There is a clear opportunity to switch to a more positive dialogue – to seek and implement biodiversity (ecosystem) solutions to water resources problems, including with respect to climate change.

1348. Some specific measures to would enhance the adaptive capacity of inland waters biodiversity include:

- Identifying those species and ecosystems that are particularly vulnerable to the negative impacts of climate change;
- Enhancing and/or restoring the connectivity of inland water ecosystems to allow for natural migration of species;
- Consider, under extreme circumstances and appropriate risk analysis, assisted migration;
- Restoring the functions and services of degraded inland water ecosystems, many of which are required for meeting climate challenges; and
- Expanding the network of protected areas incorporating better inland water ecosystem coverage and incorporating improved attention to inland water ecosystems within terrestrial protected areas.

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[103] Archibald, R.G. 1933: The Use of the Fruit of the Tree *Balanites aegyptiaca* in the Control of Schistosomiasis in the Sudan. In: Transactions of the Royal Society of Tropical Medicine and Hygiene 27:2, 207-210.

[104] http://maindb.unfccc.int/public/adaptation/adaptation_casestudy.pl?id_project=154

1349. Further general approaches and guidelines for enhancing the adaptive capacity of biodiversity are included in the draft report of the Second Ad hoc Technical Expert Group on biodiversity and climate change.

Opportunities from climate change mitigation and adaptation activities for the conservation and sustainable use of biodiversity

Adaptation

1350. A number of Parties have already integrated the conservation and sustainable use of inland waters as a part of national adaptation programmes. For example, within the UNFCCC's National Adaptation Programmes of Action the following priority activities have been identified:

- Lake restoration (Burkina Faso);
- Protection of Lake Tanganyika from agriculture and overgrazing on lake bed during the dry season (Burundi);
- Community-based wetland management and rehabilitation of wetlands (Ethiopia; Lesotho; Sierra Leone);
- River basin management and restoration (Haiti; Malawi).

1351. Such adaptation activities present opportunities for the further conservation and sustainable use of inland waters biodiversity by raising the awareness of the ecosystem goods and services provided by inland waters and by mobilizing additional financial and technical resources for the activities already included in the programme of work.

1352. In particular, with additional attention turning to climate change risks and vulnerabilities, a greater incentive is in place for valuation studies concerning inland water ecosystems. For example, in Malaysia, the value of existing mangroves for coastal protection is estimated at US$ 300,000 per km of coast based on the cost of installing artificial structures that would provide the same coastal protection[105]. Furthermore, in the United States, coastal wetlands reduce the damaging effects of hurricanes on coastal communities by acting as "horizontal levees." An economic analysis of wetland losses and hurricane damage since 1980 in the United States suggests that a one hectare loss of wetland resulted in an average increase of US$ 33,000 in damage from a single storm 106/.

Mitigation

1353. The links between greenhouse gas emissions and the destruction and degradation of inland water ecosystems have been well established and are continuing to be better elaborated. This is particularly the case for peatlands (see above).

1354. The rate of climate change will also impact whether wetlands act as a sink or a source of emissions. Slow increases in sea-level rise probably increases the carbon sequestration rate by coastal wetlands whereas a rapid sea-level rise would generate net CO_2 emissions through plant inundation and sediment disturbance. In northern latitudes, vegetation changes plus water drawdown should increase the primary production and biomass, which with slower decomposition of litter will possibly generate net carbon accumulation, possibly even increasing it. However, longer and more frequent droughts plus thawing of permafrost, are expected to have negative effects on the carbon balance in boreal peatlands.

[105] In the Front Line: Shoreline Protection and other Ecosystem Services from Mangroves and Coral Reefs. United Nations Environment Programme, 2006

[106]/ Costanza et al (2008) The Value of Wetlands for Hurricane Protection, Ambio 37:241-248

1355. As such, while some Annex 1 countries are already reporting on emissions from land use change in inland waters, there are also proposals on ways and means to promote the conservation and restoration of inland waters in developing countries as a contribution to climate change mitigation.

M. Enhancing the Integration of Climate Change within the Programme of Work on Inland Waters Biodiversity

1356. This review concludes that climate change causes changes to the existing indirect and direct drivers of change of inland waters biodiversity, brought about mainly by changing water resources availability (both quantity and quality) driven by fundamental changes in the earth's hydrological cycle[107].

1357. The programme of work is already designed to address these direct drivers (threats, pressures) and includes necessary responses. "Integrating climate change" into the programme of work therefore centres on recognising that climate change increases:

(h) existing risks and vulnerability for biodiversity, ecosystem services and the humans that depend on these; and

(i) the urgency of taking action in an already critical area.

1358. It is not fruitful to list "priority actions" within the programme of work in relation to climate change adaptation since these are largely the same as required without climate change. Critical needs centre on sustaining ecosystem services and managing ecosystem infrastructure more wisely in order to meet both biodiversity and human development objectives. Water is central to this.

1359. It is also clear, and as concluded throughout this entire review, that the central role of water in climate change, in both the ecosystem and socio-economic contexts, means that the priority requirement is to integrate relevant water related considerations into all other programme areas.

Appropriate monitoring and evaluation techniques, related technology transfer and capacity-building support within the programmes of work

Monitoring and evaluation techniques

1360. The Third World Water Development Report has already drawn the pertinent conclusion that whilst we are experiencing ever increasing uncertainty, risk and scarcity of water, the monitoring network for this is in decline (for both water quantity and quality). We face increasing risks but decreasing ability to monitor and manage it. WWDR3 illustrates this point by remarking that many countries do not know how much water they have, let alone use or its purpose, nor the condition it is in when they finish with it. The relevant water-related management agencies are already lobbying for improved monitoring and data availability.

1361. Likewise, a similar conclusion has been drawn regarding climate change – that is, our limited ability to observe and monitor global change in the hydrological cycle is a major problem in terms of preparing ourselves better for it. Increased investment in monitoring in this regard is already promoted by the World Meteorological Organisation, amongst others.

[107] Increasing water temperature in inland waters, an issue mainly with high altitude/latitude lakes, is the only identified impact that is not caused directly by a shift in hydrological conditions. This aspect is not emphasised here as globally it is of incidental importance relative to hydrological change, although locally it can be significant.

Improvements in such monitoring can only lead to improvements in our ability to manage inland waters biodiversity better. Some relevant monitoring programmes in existence are mentioned below. However, it should be noted that most commentaries remark that these are currently unable to generate robust projections of climate induced trends that are useful for management at the local level. In most circumstances, therefore, the most appropriate response is to manage adaptively for increasing uncertainty.

1362. Further information on indicators of trends in both biodiversity and direct and indirect drivers of change is included elsewhere in this review (in the section Status and Trends) and in document UNEP/CBD/SBSTTA/14/INF/1.

1363. Guidance on cost effective tools and methods to assess the threats and likely impacts of climate change faced by biodiversity in the identified vulnerable areas was compiled from a literature review conducted by the Secretariat, as well as from the Technical Series No. 10 and No. 25; and the Intergovernmental Panel on Climate Change Technical Guidelines for Assessing Climate Change Impacts and Adaptations[108].

1364. The Intergovernmental Panel on Climate Change technical guidelines for assessing climate change impacts identifies six steps for analysing vulnerability:

1. Definition of the problem;
2. Selection of the methods;
3. Testing the methods;
4. Selection of scenarios;
5. Assessment of biophysical and socio-economic impacts; and
6. Assessment of autonomous adjustments.

1365. Tools identified in the technical guidelines include: experimentation, impact projections, empirical analogue studies, and expert judgement. To evaluate current impacts, observations and literature reviews are also useful tools.

1366. For inland waters biodiversity, tools and methods assessing the impacts of climate change on water flows are especially relevant. As such, one of the main tools available is the Global Terrestrial Network – Hydrology, which is a joint project of the Global Climate Observing System (GCOS), the World Meteorological Organization / Climate and Water Department (WMO/CLW), and the Global Terrestrial Observing System (GTOS) established as a network of networks to monitor the global hydrological cycle[109].

1367. Additional tools and networks listed in Table 35 provide examples of some of the more commonly implemented tools and methods to assess the impacts of climate change on inland waters biodiversity.

Table 35**: Examples of tools and methods to assess vulnerability**

[108]/ T.R.Carter, M.L.Parry, H.Harasawa, and S.Nishioka. Technical Guidelines for Assessing Climate Change Impacts and Adaptations. 1994

[109] http://gtn-h.unh.edu/about.shtml

Tools	Elements Monitored or Evaluated
International Satellite Land Surface Climatology Project [110]/	Precipitation levels
Sea level Fine Resolution Acoustic Measuring Equipment (SEAFRAME) [111]/	Sea level rise
Wetland Simulation Model (WETSIM)[112]	Projected impacts of changing precipitation on wetlands
Coastal Vulnerability Index (CVI) [113]/	Vulnerability of coastlines and coastal ecosystems to the impacts of sea level rise
Networks	**Elements Monitored or Evaluated**
GCOS Baseline River Discharge Network[114]	River flows and discharge rates
GCOS Baseline Lake Level Network[115]	Lake levels, area and temperature
GCOS Glacier monitoring network[116]	Glaciers mass balance and length, also Ice sheet mass balance

Technology Transfer

1368. Under the cross-cutting issue on technology transfer, Parties to the CBD undertake to provide and/or facilitate access for and transfer to other Contracting Parties of technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment.

1369. With regards to enhancing the integration of climate change considerations within the programme of work on inland waters biodiversity, such technologies could apply to adaptation and mitigation. With regards to adaptation based on the needs stated by Parties, relevant technologies may include techniques for the restoration of degraded inland waters, tools for monitoring impacts and vulnerability, and technologies for information exchange and awareness raising. With regards to mitigation, technologies may include tools for monitoring carbon sinks and emission rates.

Capacity Building

1370. With regards to climate change and capacity building, Parties identified two main needs (i) improved knowledge and (ii) institutional capacity building for enhanced international cooperation.

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[110]/ http://www.gewex.org/islscp.html

[111]/ http://www.icsm.gov.au/icsm/tides/SP9/PDF/IOCVIII_acoustic_errors.pdf

[112] http://library.wolfram.com/infocenter/Articles/5946/

[113]/ http://cdiac.ornl.gov/epubs/ndp/ndp043c/sec9.htm

[114] http://gtn-r.bafg.de/servlet/is/Entry.2492.Display/

[115] http://gtn-h.unh.edu/

[116] http://www.geo.unizh.ch/wgms/monitoring.html

1371. The need for capacity building to enhance knowledge has also been expressed under the UNFCCC Nairobi work programme on impacts, vulnerability and adaptation to climate change, which has called for capacity building to improve bioclimatic modelling as noted above. Such models consider not only the physical impacts of climate change but also the affects of such impacts on biological processes and the functioning of ecosystems. Additional capacity building has been requested to improve the down-scaling of climate models which is especially relevant for inland waters biodiversity given the high level of local variability in climatology surrounding water basins, wetlands and water and land use activities.

1372. Institutional capacity building needs to facilitate international cooperation arises due to the complexity of climate change, and its interrelationship with other drivers of loss as well as the trans-national nature of many inland waters management needs.

N. Critical knowledge needed to support implementation

1373. The fourth assessment report of the IPCC and the IPCC Technical Report on Water and Climate Change identify several uncertainties concerning the links between climate change and inland waters biodiversity including:

<u>Gaps in observational data</u>

- Precipitation data over oceans;
- Stream and river flow data;
- Soil moisture and actual evapotranspiration;
- Ground water;
- Water quality and use; and
- Snow, ice and frozen ground inventories;

<u>Gaps in Knowledge Concerning Impacts and Vulnerability</u>

- Isolation of the causal relationship between observed impacts and anthropogenic climate change;
- Projected impacts on fine scale hydrological processes driven by topography (e.g. cloud forests);
- Catchment scale projections;
- Impacts on seasonal water needs;
- Feedbacks between land use change and climate change;
- Water-related consequences of different climate change policy options; and
- Impacts of climate change on aquatic ecosystems.

1374. Parties also identified knowledge gaps preventing implementation of the existing climate change elements of the inland waters programme of work including:

- Lack of information on impacts and vulnerability of specific species or inland water systems; and
- Lack of knowledge on the interrelationship between different impacts projected as a result of climate change (e.g. between reduced dissolved oxygen content and changing precipitation patterns);

1375. Technical Series No. 10 and No. 25 also identify key research needs although these are not specific to inland waters biodiversity. Knowledge needs identified by the Technical Series include additional research on:

- The relationship between biodiversity and ecosystem structure and the delivery of ecosystem services;
- Which ecosystem functions are most vulnerable to species loss;
- Projected climate change impacts on soil biodiversity;
- The effects of energy activities on biodiversity; and

- Indicators.

O. The ecosystem-approach principles and guidance and the precautionary approach;

1376. Since the ecosystem approach takes a broad perspective to management, it has been identified as a potential methodology through which the multiple impacts from climate change, including on biodiversity, can be reflected in comprehensive and responsive adaptation planning.

1377. With regards to inland waters biodiversity, and water resources, the major need is to achieve more widespread and inclusive Integrated Water Resources Management (IWRM)[117]. Progress in implementation of IWRM is discussed in more detail in section VII.B. Regarding climate change, the need is better integration of climate change considerations into these processes.

1378. There is progress. The Netherlands, for example, has published a strategy on Integrated River Basin Management and Climate Change Adaptation[118], which highlights the importance of ‘building with nature’ while also managing river basins for multiple ecosystem services and in collaboration with a broad set of stakeholders. As another example, the Government of China has identified basin-wide implementation of climate change adaptation as an important priority for achieving a better balance between humans and nature in water resource management[119].

1379. Throughout this review note is made of the need to manage water in an "ecosystem context", to promote "ecosystem based management approaches" or to manage "ecosystem infrastructure" (etc.). These deal with the same concept (holistic approaches) but in practice differ in context and approach. The Ecosystem Approach has a similar ultimate objective and includes not only attention to ecosystem interactions at the ecological level but also social needs and prescribes management approaches (e.g., participation, consultation, information exchange etc.). IWRM, for example, if implemented properly, would be implementation of the Ecosystem Approach. But in practice implementation is not at this level yet universally (see section VII). All of these concepts and approaches are evolving, based on experience.

1380. The risk management approach to the management of inland waters biodiversity in the face of climate change is being increasingly recognized, including the need to adopt the precautionary approach. The Word Bank Group, for example, published a guide for applying the risk management approach for incorporating climate change within World Bank Operations[120]. The guide suggests that all projects should be screened for climate risks, with those that are identified as posing possible risks subjected to a more detailed and complete risk analysis. The guide also suggests that a precautionary approach should be adopted to better manage risk where possible threats and vulnerabilities have been identified.

1381. At this juncture it is useful to reflect that the realities of water resource management necessitate that "precaution" be taken in context. In many circumstances use of resources has already passed the point at which "precaution" in the sense of "doing nothing" is now not an

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[117] integrated watershed, river basin or catchment management/planning are related approaches but IWRM is the terminology in most consistent use amongst relevant practitioners

[118] http://www.riob.org/wwf-5/eu_china/08_JosVanAlphen.pdf

[119] http://www.china.org.cn/english/environment/213624.htm#16

[120] http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2004/10/06/000160016_20041006165241/Rendered/PDF/300650PAPER0Look0Before0You0Leap.pdf

option. Precaution is now largely about *reinstating* resilience. A particular concern in relation to ecosystems is the issue of thresholds, or tipping points, beyond which damage would be inevitable and possibly irreversible. There is a great deal of uncertainty with regards to when these will be reached. For example, elsewhere this review notes that changing terrestrial vegetation (e.g. forest) patterns can cause abrupt shifts in local climate (in particular rainfall – and usually promoting shifts towards increasingly arid/desert conditions). There is already evidence suggesting that this is happening in some areas (although not necessarily attributable only to climate change). The net result will be not only major shifts in aquatic biodiversity, wetlands and their functions, but also related increases water stress on both terrestrial vegetation and people – both leading through feedback to a rapid downward spiral of ecosystem collapse. This is an existing threat to ecosystems and climate change will increase its probability because it results in greater extremes (tipping thresholds).

P. Progress under the Ramsar Convention

1382. Decision IX/16 of the CBD, section D para. 3, welcomed the initiative of the Scientific and Technical Review Panel (STRP) of the Ramsar Convention to consider wetlands and climate change as an important emerging issue, invited the Secretariat and the STRP, subject to available resources, to further assess the contribution of biodiversity to climate-change mitigation and adaptation in peatlands and other wetlands and further invited the Secretariat and the STRP to make the reports on these assessments available, for example through its website. Para. 6 of the same section of this decision invited the Conference of the Parties to the Ramsar Convention, at its tenth meeting, to consider appropriate action in relation to wetlands, water, biodiversity and climate change in view of the importance of this subject for the conservation and sustainable use of biodiversity and human welfare.

1383. In response, climate change was considered in detail at the tenth meeting of the Contracting Parties to the Ramsar Convention. Ramsar COP resolution X.24 deals specifically with climate change and the entire resolution is relevant to the in-depth review of the programme of work on inland waters (as well as many other CBD programme areas). Some points made include, *inter alia*:

(a) that almost all of the world's consumption of freshwater is drawn either directly or indirectly from wetlands and wetland ecosystems are important in protecting freshwater supplies (para. 3);

(b) Parties need to manage their wetlands in such a way as to increase their resilience to climate change and extreme climatic events and to ensure that in their climate change responses (such as revegetation, forest management, afforestation and reforestation) such implementation does not lead to serious damage to the ecological character of wetlands (para. 4); and

(c) the increasing evidence that some types of wetlands play important roles as carbon stores, and there is concern that this is not yet fully recognized by international and national climate change response strategies, processes, and mechanisms (para. 8).

1384. In relation to scientific, technical and technological matters, Resolution X.24: noted the Scientific and Technical Review Panel's renewed attention to wetlands and climate change issues during the 2006-2008 triennium, including *inter alia*, on developing simple methods for assessing the vulnerability of different wetland types to climate-driven changes in water regimes, on the role of and opportunities for wetland restoration as a tool for climate responses, on the role and importance of different wetland types in the global carbon cycle, on assessing vulnerability of wetlands to hydro-ecological impacts, wetland restoration and climate change, and on recent key messages and recommendations concerning wetlands, water and climate change from relevant intergovernmental and international processes and initiatives; instructed the STRP, in its more comprehensive examination of climate change and wetland issues, to review emerging information on the ways in which, *inter alia*, changes in wetland thermal and chemical regimes, hydro-patterns, and increases in water storage and conveyance infrastructure, including impoundments, potentially alter the pathways by which non-native species invade wetlands, and influence their spread, persistence and ecological impacts on native species, and to liaise with the Arctic Council on an assessment of the vulnerability of Arctic wetlands to climate change and the development of guidelines for wise use while taking account of the ongoing Arctic Biodiversity Assessment; requested the Ramsar Secretariat, the STRP, and CCGAP to work together with relevant international conventions and agencies, including the CBD, UNCCD, UNEP, UNDP, FAO and the World Bank, and especially UNFCCC and IPCC, to investigate the potential contribution of wetland ecosystems to climate change mitigation and adaptation, in particular for reducing vulnerability and increasing resilience to climate change; requested the Ramsar Secretariat and the STRP to use appropriate mechanisms to work with the UNFCCC and other relevant bodies to develop guidance for the development of climate change mitigation and adaptation programmes that recognize the critical role of wetlands in relation to water and food security as well as human health; and instructed the STRP to continue its work on climate change as a high priority and, in conjunction with the Ramsar Secretariat, to collaborate with relevant international conventions and agencies, including UNFCCC, CBD, UNCCD, IPCC, UNEP, UNDP, FAO and World Bank, in the development of a multi-institutional coordinated programme of work to investigate the potential contribution of wetland ecosystems to climate change mitigation and adaptation, in particular for reducing vulnerability and increasing resilience to climate change, and in addition to:

i) establish ways and means of collaborating with the UNFCCC and other relevant bodies to develop guidance for the development of mutually supportive adaptation and mitigation programmes that recognize the critical role of wetlands in relation to water and food security as well as human health;
ii) bring scientific issues and information on wetlands and climate change to the attention of the Chairs of the Scientific Advisory Bodies of the Biodiversity-related Conventions (CSAB) at the next available opportunity, and use this forum to encourage enhanced scientific collaboration on issues related to wetlands and climate change; and
iii) establish ways of collaborating with the IPCC on scientific issues specifically related to wetlands and climate change, and contribute to its future work in order to raise the awareness of the climate change community of the importance of wetlands, including through the preparation and publication of relevant scientific reports on wetlands and climate change.

Q. Responses

1385. Because the impacts of climate change are expressed mainly through additional influences on existing direct and indirect drivers of change, responses to it largely centre on incorporating climate change into existing responses and recognising that it adds further urgency for action. Responses being taken to the current challenges facing the conservation and sustainable use of inland waters biodiversity are noted, from varying perspectives, throughout this in-depth review. Case studies of good practice are also included throughout other sections of this review and many of these incorporate climate change relevant approaches, whether explicit or not (see in particular sections on: National Reports; The Work of Selected Non-Governmental Organisations, which lists 50 cases studies; and Drivers of Change – Water Resources Use). These responses are summarised in sections VII.which incorporates some climate change aspects.

1386. One challenge to addressing climate change impacts for inland waters is that there is evidence that change has occurred already; in most cases not due directly to climate change (e.g., reduced water flows due to abstraction), whereas for a few climate change alone is implicated (e.g., increasing lake water temperatures), but for most it is probably a combination of both (e.g., combined pressures of abstraction and reduced rainfall). Climate projections indicate that substantial future change may occur, but for most considerations, but not all, these impacts are likely to be secondary to impacts already arising and projected through increasing demand on, and the over- and mis- use of, water. Without some modifications, current inland water management plans and practices are likely to have difficulty coping with the full range of future climate impacts on water supply reliability, flood risk, health, energy, and aquatic ecosystems. Society needs to build its capacity to both respond to existing needs and adapt to the additional challenges that climate change will bring.

1387. There is much scope for improved outcomes for biodiversity, water resources and human well-being. Many promising solutions to the problems exist and many centre on using "biodiversity" to solve water related needs – including in response to climate change. Much is known about how water resources can be managed under conditions of change. Indeed the Millennium Ecosystem Assessment itself reviewed a wide catalogue of ‘response options’, and highlighted many viable ways forward. Key fields in which good work lies include poverty-oriented surface and groundwater management and provision, integrated water resource management and payments and negotiation for watershed (ecosystem) services.

1388. Recognition of the importance of water, and understanding of how it links climate change, ecosystems, and human well-being, and the role of biodiversity in this, is variable as judged by dialogue in the international arena. Many fora acknowledge these links but fewer appear to recognise their full importance. It is insufficient to acknowledge the subject as just "important". This needs to be the lens through which climate change is studied, considered and addressed. Putting things more simply – the climate change adaptation dialogue needs to refocus from "what to do about the world getting warmer?" to "what is happening with water?".

1389. For example, WWDR3 notes the absence of recognition of water in major forums (Box 1).

<u>Box 62: Extracts from Declaration of G-8 Leaders Toyako, Hokkaido, Japan, 9 July, 2008</u>

Climate change is one of the great global challenges of our time. Conscious of our leadership role in meeting such challenges, we, the leaders of the world’s major economies, both developed and developing, commit to combat climate change in accordance with our common but differentiated responsibilities and respective capabilities and confront the ***interlinked challenges of sustainable development, including energy and food security, and human health***.

We will work together in accordance with our Convention commitments to strengthen the ability of developing countries, particularly the most vulnerable ones, to adapt to climate change.

1390. Based on collective experience and thorough assessments, UN-Water[121] articulated the situation and needs in a concise message to the Fifteenth Meeting of the Conference of the Parties to the UNFCCC (Box 63). This captures many of the fundamental points made in this in-depth review including, *inter alia*: that water is the primary medium through which climate change influences the earth's ecosystem and therefore people; that adaptation is mainly about water; and that a sense of urgency for adaptation and recognition of the centrality of water have not yet permeated the political world and are not adequately reflected in national or international plans and strategies.

[121] UN-Water is composed of representatives of 26 United Nations organizations. United Nations organizations include those responsible for major funds and programs, specialised agencies, regional commissions, United Nations conventions and other entities within the UN system. Other organizations outside of the United Nations are partners in UN-Water.

Box 63: Message delivered from UN-Water to COP-15 of the UNFCCC

Climate change adaptation is mainly about water …

Water is the primary medium through which climate change influences the Earth's ecosystems and therefore people's livelihoods and well-being. Already, water-related climate change impacts are being experienced in the form of more severe and more frequent droughts and floods. Higher average temperatures and changes in precipitation and temperature extremes are projected to affect the availability of water resources through changes in rainfall distribution, soil moisture, glacier and ice/snow melt, and river and groundwater flows; these factors are expected to lead to further deterioration of water quality as well. The poor, who are the most vulnerable, are also likely to be affected the most.

Water resources and how they are managed impact almost all aspects of society and the economy, in particular health, food production and security, domestic water supply and sanitation, energy, industry, and the functioning of ecosystems. Under present climate variability, water stress is already high, particularly in many developing countries, and climate change adds even more urgency for action. Without improved water resources management, the progress towards poverty reduction targets, the Millennium Development Goals, and sustainable development in all its economic, social and environmental dimensions, will be jeopardized.

Adaptation to climate change is mainly about better water management. Recognizing this and responding to it appropriately present development opportunities. Appropriate adaptation measures build upon known land and water management practices to foster resilience to future climate change, thereby enhancing water security. Innovative technologies and integrated solutions are needed at the appropriate scales, for adaptation as well as mitigation. Any adaptation measures, however, need to be assessed for inadvertent adverse effects, in particular on the environment and on human health.

Adapting to increasing climate variability and change through better water management requires significant investments and policy shifts that should be guided by the following principles:

1. Mainstreaming adaptation within the broader development context;
2. Strengthening governance of water resources management and improving integration of land and water management;
3. Improving and sharing knowledge and information on climate, water and adaptation measures, and investing in comprehensive and sustainable data collection and monitoring systems;
4. Building long-term resilience through stronger institutions and water infrastructure, including well-functioning ecosystems;
5. Investing in cost-effective adaptive water management and technology transfer;
6. Releasing additional funds through increased national budgetary allocations and innovative funding mechanisms for adaptation through improved water management.

The sense of urgency for climate change adaptation and recognition of the centrality of water therein have not yet permeated the political world and are not systematically reflected in national plans or international investment portfolios for adaptation.

It is imperative for the Parties to the UNFCCC to recognize the pivotal role of water in adapting to climate change in order to increase resilience and achieve sustainable development

1391. There are however compelling examples of where dialogue has grasped the nature of the issues and identified necessary responses. Some example include:

The *European symposium: Dresden communication on Flood Risk Management Research*, Dresden (Germany), 7th February 2007

> The symposium statement: urges the inclusion of climate change assessment in all actions under the proposed EU directive on the assessment and management of flood risks; notes that flood risks are dynamic, driven by climate change and growing vulnerability; and notes Integrated Water resources Management is a key to cope with effects of climate change;

The conference *Time to adapt: Climate change and the European water dimension (vulnerability-impacts-adaptation)*, Berlin, 12-14 February 2007, Berlin. http://climate-water-adaptation-berlin2007.org/

> Which noted: climate change is of critical importance to the water industry everywhere; adaptation starts with using water more efficiently in all sectors and water dependant sectors need to be involved; needs to be taken into full account by everybody in water planning and investment; it affects all aspects of water services and the quality of water in the environment will also be affected; water and climate change legislation needs to recognise the possible conflict between ever higher environmental standards and the impact of using more energy to meet these standards; water makes the wider debate on climate change more relevant; adaptation will require much more efficient use of water; the need to prepare for potential changes in wastewater infrastructure, in agricultural practice, in the impact of new infrastructure on biodiversity and wetlands; regulation and policy must reflect the broad social implications of climate change; international communication is need – "**if we don't get water right, we will not be able to get right any other sector; the need for action is more urgent than ever before"**.

The Economics of Ecosystems and Biodiversity (TEEB) prepared a brief for UNFCCC COP 15 which concludes:

> "There is a compelling cost-benefit case for public investment in **ecological infrastructure** (especially restoring and conserving forests, mangroves, river basins, wetlands, etc.), particularly because of its significant potential as a means of adaptation to climate change".
>
> "The carbon cycle and the water cycle are perhaps the two most important large-scale bio-geological processes for life on Earth".
>
> It also presented a table listing, as an example, the value of ecosystem services provided by tropical forests. The water related services listed include: water provisioning, regulation of water flows, waste treatment/water purification and erosion prevention. These collectively account for more than 44% of the value of forests (not including climate regulation, which has a strong hydrological cycle element).

The *Ministerial Statement at the Fifth World Water Forum*, 16 – 22 March, 2009, Istanbul, Turkey, *inter alia*: acknowledges that water is a cross-cutting issue and recognises the need to achieve water security, and to this end it is vital to increase adaptation of water management to all global changes;

VII. RESPONSES AND CHALLENGES

1392. Based on the findings elsewhere in this review, it is very difficult to paint a positive picture for the future of inland waters biodiversity. The current situation with water, and the biodiversity that not only relies upon it but underpins its continued availability, is dire. Projections for increasing pressures upon inland waters mean the situation will get much worse, even with improved management. Climate change, overall, simply amplifies existing problems and increases the urgency of solutions which are patently already needed. Whilst the situation in these regards differs significantly between countries, and regions within them, no countries are exempt from needing strengthened approaches. For many, this is critical; for quite a few, past critical. The scenarios for water and their implications for terrestrial biodiversity and human development, to put it mildly, present considerable challenges; arguably the main challenge to a sustainable planet.

1393. The scenarios tell us not so much that better management approaches are needed (something known for decades), but rather that they are becoming unavoidable. The history of water shows that significant and intelligent improvements tend to arise from crisis. Increasing crisis, therefore, brings hope of increasingly intelligent approaches.

1394. A further conclusion of this review is that water, and the biodiversity associated with it, cannot be managed effectively solely through managing the direct drivers of change (pressures/threats). The indirect drivers, in the social, economic, political and development arena, are what largely influence outcomes for resource use and must be addressed alongside more direct policy and management interventions. Hence, this review devotes much space to looking beyond what lives in freshwater and what directly affects it. Sustaining inland waters biodiversity requires an approach which captures this reality.

1395. Many solutions to the problems exist. Much is known about how water resources can be managed under conditions of change. Indeed the Millennium Ecosystem Assessment itself reviewed a wide catalogue of 'response options', and highlighted many viable ways forward. Key fields in which good work lies include poverty-oriented surface and groundwater management and provision, integrated water resource management and payments and negotiation for watershed services. Good solutions have been identified to make agricultural land and water use move towards sustainability. Increases in efficiency are also being achieved with industrial, energy and urban uses of resources. Business is setting the example of best practice in many areas, often voluntarily.

1396. Clearly, the status and trends information tells us that collectively these good practices and approaches are not yet enough. But they are a platform upon which to build. The biggest factor in all is the extent to which stakeholders at all levels and across all sectors and interests recognise how important it is to get things right with this subject.

1397. The following is an overview of some of the approaches identified. The list is far from complete.

A. The effectiveness of good wetland policies

1398. Rasmar STRP is undertaking some interesting analysis of Party responses, policies and outcomes for wetlands based largely on an analysis of Ramsar National Reports. Recent work by the STRP indicates that better overall status of a country's wetlands, as evaluated by Indicator A(ii) (trends in conservation status of wetlands) appears to be associated with:

- having a National Wetland Policy/equivalent;
- applying Strategic Environmental Assessment practices;
- applying Ramsar's guidance on wetland restoration;
- implementing programmes for raising awareness about wetland services;

- having greater financial resources; and
- providing opportunities for wetland site manager training.

1399. These results are encouraging and demonstrate on a number of fronts the value of implementing relevant guidance and strategies for the wise use of wetlands. It also supports the continued encouragement for countries without a National Wetland Policy or equivalent to adopt and implement one, whether they are a Party to the Ramsar Convention or not.

B. Integrated Water Resources Management (IWRM)

1400. The relevance of IWRM, or similar integrated resource management approaches, and progress towards it is mentioned throughout this review (see in particular "Drivers of change – water resource use" and the extended summary for a specific section on this topic). Progress towards targets for IWRM and water efficiency plans made at the World Summit on Sustainable Development (and its Johannesburg Plan of Implementation) were conspicuously lacking by the target date. In the past few years progress and experience with implementation has accelerated.

1401. The fifteenth meeting of the Commission on Sustainable Development encouraged, where appropriate and within their mandates, the use of the MEAs to leverage additional resources for IWRM by: enhancing the sustainability of ecosystems that provide essential resources and services for human well being and economic activity in water-related decision making; facilitating information exchange and knowledge sharing, including indigenous and local knowledge; developing preventive and preparedness measures, as well as risk mitigation and disaster reduction, including early warning systems; protecting and rehabilitating catchment areas for regulating water flows and improving water quality, taking into account the critical role of ecosystems.

1402. External drivers and policies - those that deal with sectors and issues such as agriculture, trade, energy, housing and real-estate, disaster preparedness, security, finance and social protection, and those that affect overall economic diversification - have more impact on water management than many policies championed and implemented by water-related ministries, the private sector and civil society leaders of the water domain. These leaders acting alone and in isolation may end up making uninformed and sub-optimal development decisions. They also run the risk of being overlooked or even ignored in the broader decision-making frameworks.

1403. The most valuable evolution of IWRM could be the extension into dialogue and partnerships with water-using sectors, whose policies and strategies are governed by many other factors beyond water alone.

C. Financing and payments for environmental services

1404. One of the most persistent problems in the water resources decision-making arena (as with other sectors) is the availability (or lack) of sustainable financing. Direct "biodiversity conservation" financing needs improving but in reality is negligible compared to needs. Biodiversity outcomes need to be built more on integrating relevant approaches within broader financial approaches. That is, into financing development. In this context, "incremental costs" for biodiversity conservation and sustainable use (*sensu* the GEF approach) also needs better financing, but again, will be negligible (globally) compared to needs. The real opportunity lies in solutions to development problems which are not only biodiversity based but also contribute to increased sustainability and cost reduction. "Biodiversity" does not always have to cost more. Notably, the arena of inland waters (wetlands) presents some of the clearest examples of how this is being achieved. The subject is, generally, actually at the forefront of moves in this direction.

1405. Ultimately, the main sources of financing sustainable water management more broadly are tariffs, support from the national budget and external aid for development related interventions. Several key initiatives have arisen over the past five years to help shape the agenda of water financing. These initiatives include the Camdessus Panel, Gurria Task Force, and UN Secretary General's Advisory Board on Water and Sanitation (UNSGAB). There are examples of how some countries are tackling the identified problems and implementing the recommendations in these reports.

1406. Additionally, elsewhere this review notes the astounding projections, indeed realities, of investments that are or will be made in the water arena to reach related MDGs, let alone resolving water problems in developed countries. Requirements to adapt water related infrastructure to climate change are also substantial, if incremental in terms of overall investment. Biodiversity needs mainstreaming into this source of financing. To achieve such eclipses any even optimistic resources available through other means (including the GEF).

1407. One of the best documented case studies refers to improving water supply to New York from the Catskill watershed. The plan included payments for both on-farm capital costs and pollution reducing agricultural measures. It was implemented at a cost estimated to be only 20 per cent of the cost of solving the problem through physical (artificial) water treatment infrastructure. It also protected the other environmental goods and services the watershed provided (e.g., recreation; biodiversity conservation). Financing was achieved through payments to water providers coming directly from the revenues collected from water users in New York City. A similar approach was utilized in Heredia, Costa Rica, which established a system that taxed its approximately 50,000 connected water users to pay farmers in the watershed to undertake improved conservation measures.

1408. This "payment for environmental services" (PES) approach is increasingly recognized for financing environmental protection and conservation. With the market for these services often poorly developed or nonexistent, ecosystem managers have little economic incentive to improve their management efforts. The PES concept attempts to address this problem by creating markets for environmental services, in the same manner as for other commodities. For water, often money is collected from water users, for example, and payments directly made to those providing the resource, encouraging efficient and sustainable delivery of watershed services.

1409. Water related PES schemes work well (although not always) because: (i) the related services are valuable and visible; and (ii) there is often already a financial mechanism in place (e.g., water supply costs) from which finances can be re-allocated. Notably, a major outcome is improved terrestrial, not just aquatic, environments. Solutions to water related problems are usually more to do with better management of land activities and outcomes for terrestrial ecosystems than for inland waters directly.

1410. The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Watercourses Convention) in 2006 adopted guidelines on payments for ecosystem services (PES) in integrated water resources management (IWRM) (see CBD Technical Series 40 for further information). This illustrates the importance of PES in relation to water. It also demonstrates, in the context of MEAs, a far advanced approach to PES than currently exists under the CBD.

1411. Throughout this review, many further examples are provided of how inland waters biodiversity can help solve water, and climate change, related problems. In a fashion that is attractive for Ministries of Finance.

D. Valuations of ecosystem services

1412. Because of the inter-connectivity of freshwater ecosystems and their services, developing one service (e.g. food production through increased irrigation) automatically has impacts on other services. The management objective, therefore, is generally to balance the delivery of all these services collectively so that ecosystems are used optimally and development becomes sustainable. Nature has to be recognized as a water stakeholder because it performs important services to society. Understanding its functioning and value is essential. The provisioning services (goods) provided by ecosystems have been the main focus of development. But this interest is not necessarily incompatible with sustaining other services. There are pastures in the Alps, oases in Morocco, and irrigation systems in the Philippines that have been used for centuries with no diminution of their productive capacities or beauty.

1413. However, valuing ecosystem services remains a problematic area. Values generated can be controversial. But comparative values of services are more important that absolute values. Canada, in its third national report, recognises the inherent difficulties with valuations. But Canada also noted that valuations of water related ecosystem services provide good comparative indicators of where priorities might lie and have led to increased national attention to inland waters.

1414. With additional attention turning to climate change risks and vulnerabilities, a greater incentive is in place for valuation studies concerning inland water ecosystems. For example, in Malaysia, the value of existing mangroves for coastal protection is estimated at US$ 300,000 per km of coast based on the cost of installing artificial structures that would provide the same coastal protection. In the United States, an economic analysis of wetland losses and hurricane damage since 1980 suggests that a one hectare loss of wetland resulted in an average increase of US$ 33,000 in damage from a single storm.

E. Water quality – mitigating pollution: progress in urban and rural areas

1415. In the developed world, many pollution issues, especially those pertaining to point sources, have been addressed and ameliorated over the last 40 years. In developing countries pollution issues remain among the most important water resource problems. In the developed world, non-point source pollution often remains an important issue, in part because management requires whole landscape, multi-jurisdictional approaches that do not lend themselves to easy implementation. Successful policies addressing acidification of surface water by atmospheric deposition in North America and Europe provide a hopeful model for landscape management that is beginning to lead to recovery of many surface waters from acidification.

1416. There are signs of progress in the way pollution and risks are addressed in and across different sectors. The ‘polluter pays’ principle has stimulated changes in attitudes towards the pollution problem. There is well-documented evidence that the costs of inaction are high (high rehabilitation costs of polluted rivers, health-related costs, etc.) and that some impacts are nearly irreversible (contamination of groundwater drinking water, ecosystem collapse).

1417. In many areas of the developing world, high physical infrastructure waterborne sanitation systems and pollution mitigation facilities may not be the most sustainable option. Other approaches may be more suitable (e.g. using lagoons – a simpler and cheaper option for collective units). By-and-large, this is already happening. Where human wastes are not already being treated artificially, ecosystems are already dealing with it, although not always sustainably. Increasingly, sewage is being seen as a resource. It is already reused in water-stressed countries and for different purposes when actively enforced. Farmers in peri-urban areas use their streams for agriculture and aquaculture as in the past, but now increasingly alongside wastewater and the nutrients in it – often because it is the only water they can access. Wastewater flows are typically more reliable than freshwater sources and nutrient-rich for the cultivation of high-value crops.

1418. In Phnom Phenh, Hanoi and Ho Chi Minh City, the most important health problem perceived by farmers themselves as being related to wastewater exposure was skin disease. Water spinach cultivated in the wetlands that receive wastewater from Phnom Penh, was highly contaminated with faeces, as indicated by high concentrations of indicator bacteria and the presence of protozoan parasites. However, a reduction in bacterial numbers almost to WHO guideline levels for irrigation water occurred through using the natural biological and physical processes of nearby wetlands.

1419. The OECD (2008) reports evidence of larger investments in "Change in Production Process" technologies (CPP). There is a steady growth of companies seeking certification through ISO; Japan and China have the largest number of certified companies. The globalisation of the economy can contribute to cleaner production even with the delocalisation of polluting activities to countries with lower environmental standards. Many multinational enterprises apply high environmental standards to their activities worldwide, introducing environmental management systems to increase environmental performance, thus contributing to the globalisation of better corporate practices.

1420. In the industrial sector, a combination of subsidies, higher water prices and environmental regulations have encouraged industries to improve processes and reduce withdrawals. There are clear indications that the global business community is devoting growing attention to water – and solving problems. In emerging and agricultural economies the scope for progress through the introduction of clean processes is even greater, since production processes are generally poor compared with worldwide standards. The international competitiveness of a company and its products in the global market is enhanced by its commitment to Best Environmental Practices. This contributes to pollution reduction and improved efficiency of the water used.

1421. At the national level, there are now a growing number of companies introducing clean production processes – often for pollution reduction – that result in significant water savings, with return-on-investment times seldom exceeding two years.

1422. Progress is also being made in many places in reducing soil erosion. For example, in recent years soil conservation and related measures promoted by the Food Security Act of 1985 have reduced the total annual erosion from US cropland by about 40%. Likewise the successful implementation of erosion control measures in the Middle Yellow River Basin in China after 1978 played a major role in reducing the annual sediment load of the Middle Yellow River from ca. 1.6 Gt/y in mid 20thcentury to ca. 0.7 Gt/y at the end of the 20th century. Elsewhere in the world, the progressive introduction of no-till and minimum till practices will also have reduced erosion rates on cultivated land. Such measures typically reduce erosion rates by more than an order of magnitude. To date, no-till and minimum till practices have been implemented on about 5% of the world’s cropland – leaving much scope for further expansion.

1423. Multiple frameworks (often born after a major crisis) support the protection of freshwater systems and the mitigation of impacts. The OECD monitors the level of commitment to these instruments by its member countries. Some of the most important instruments for pollution mitigation and water resources conservation are:

- Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1972), which obliges parties to prevent, control and reduce water pollution from point and non-point sources;
- Ramsar Convention for wetlands protection and the CBD for all ecosystems;
- Convention to Promote Environmental Impact Assessment (ESPOO Convention, 1991);
- Convention for the Reduction of Pesticides (Rotterdam, 1998);
- Conventions or agreements focused on pollution in shared receiving bodies, such as regional conventions (Barcelona Convention on the Protection of the Mediterranean Sea Against Pollution set in 1976; Baltic in 1992) and basin agreements (Rhine Cooperation); and
- Processes such as the CSD process, the outcomes of the Rio and Johannesburg Summits including Agenda 21 (Chapter 18), which support ‘sustainable use’, or IWRM plans that promote integrated water resource management and monitoring.

1424. The International Commission for the Protection of the Rhine (ICPR) gathered together nine States in the 1950s. It stimulated major improvements in river quality by setting quantified pollution reduction targets for some key parameters in its Rhine Action Programme, together with a monitoring programme to control performance.

1425. In Europe, member states have to comply with various European legislations focused on water issues including the Water Framework Directive and the Urban Waste Treatment Directive (1991). Subsequently, there has been good progress in improving water quality in Europe, although outcomes vary considerably between regions and the criteria considered. Generally, point-source pollution has been well addressed and although non-point source pollution is more difficult to manage progress has been made (particularly the slowing of nitrate and phosphate contamination of surface waters.

F. Progress in achieving environmental sustainability

1426. Ensuring ecosystem integrity while meeting the demands of a growing and increasingly affluent population has emerged as one of the world's primary resource issues. Human utilization and control of water resources enables managers to convert natural riverine flows into dependable ecological services (e.g., water supply, hydropower generation, flood control, recreation, and navigation), yet this also results in considerable ecological damage and the loss of important ecosystem services that are valued by society. In response to the intensifying competition for water, scientists are becoming increasingly engaged in the development of environmental flow recommendations needed to sustain river ecosystems. Environmental flows are typically discussed in the context of water releases from dams, where there is general agreement that managed flows need to exhibit patterns of natural variability necessary to support a functioning riverine ecosystem.

1427. Our capacity to achieve environmental sustainability has improved but remains constrained by several factors including a lack of full understanding of the impact of pollution and the resilience of ecosystems; a lack of monitoring of negative impacts of water use on the environment; and in many developing countries, the institutional weaknesses that prevent effective implementation of legal instruments. Some promising developments, however, exist.

1428. The concept of environmental services is now widely acknowledged as a way to recognise the services provided by nature, although economic valuation of these services, estimates of environmental flows, and benefits remain problematic. Successful processes are based upon multi-stakeholder dialogue and negotiation where ecosystem services are valued and recognized.

1429. The e-flows concept is targeted at reversing trends that disconnect ecosystems from livelihoods, instead placing emphasis on how water management strategies may impact water. There has been much progress in e-flow approaches in recent years. Research in Asia and the Pacific shows that 23 out of 48 countries are currently undertaking some activity on environmental flows (funded by Australia, Japan and New Zealand). These countries are moving towards integrating and implementing an e-flows approach into local, regional and state planning processes and national legislation and policies. China, Korea, India, Nepal, Pakistan, Cambodia, Lao PDR, Malaysia, Thailand and Viet Nam have all adopted the approach and, in some cases, may incorporate e-flows within national legislation and policies. Explicit consideration of e-flows in the national water accounts is a further step towards recognition of environmental water demands. Interest in adopting e-flows is also growing roots in Bangladesh, Iran, Sri Lanka, Indonesia and the Philippines, as well as a number of Central Asian countries.

1430. However, evidence of effective implementation of environmental flows is still limited. Lessons drawn from where e-flows have gained ground indicate political support is perhaps the most crucial element. Strong community interest, pressures from a river basin critically degraded due to over-allocation, and donor-driven or instigated concerns over development projects have each played important roles in the operationalization of the concept. E-flow adoption and implementation has been particularly strong where national legislation and policies placed e-flows as a priority within an IWRM framework, and where it was also integrated into natural resource management plans at the basin scale.

1431. Inversely, examples abound where interest in e-flows has failed to be converted into legislative implementation. Chief among these is lack of understanding of the socioeconomic benefits of e-flows, of political will to support implementation, and a lack of proper legal, institutional and monitoring arrangements.

1432. Increasing attention to ecosystem services provides an opportunity to emphasize multi-functionality within agro-ecosystems and the connectivity between and within agro-ecosystems and other ecosystems. Paddy fields are a well-documented example of the multi-functionalities of agriculture. Urban wastewater use for agriculture production could be an example whereby farmers act as environmental stewards re-using the water, avoiding pollution directly discharged into nature, and safeguarding quality water for domestic uses. This multiple role played by the farmer should be recognized and valued through economic incentives from other sectors[122]. This is the aim of programmes such as Green Water Credits in Kenya.

1433. Direct water related hazards could be the result of too much (floods, erosion, landslides, etc.) or too little (droughts, loss of wetlands or habitat, etc.) water. The natural variability of water resources and changes in the hydrological regime, whatever the cause, can also provide additional opportunities. For example, the approach of Integrated Flood Management (IFM) considers the positive as well as the negative aspects of flood waters and considers the valuable resource that is represented by the flood plains that these waters, on occasions, occupy and re-invigorate.

1434. The Madhumalla community in Nepal embarked on a remarkable mission some 14 years ago to address the threats posed by unpredictable and devastating floods they had witnessed in the area. The community employed a bioengineering technique, which relies on planting series of stratified green belts along the river bank using native trees, shrubs and grasses in that order towards the river in conjunction with reinforcing materials, to defend undercutting and erosion of the banks and degradation of floodplains. This is considered a role model and replicated in several other communities in the region, including in the refugee camps nearby. The project area is currently serving as a training centre in-situ on bioengineering technology. The project mobilized a substantial amount of resources internally in the form of cash, labour and material assistance, besides receiving grants from several national and international donors but totalling only a modest US$ 40,000. The project is currently in the threshold of reaping benefit from sale of forestry products from the plantation area and expected to generate annually over hundreds of thousand of US dollars in a couple of years. This project is a perfect example of a success story at grass-root level towards managing and adapting to flood disasters. A community-led initiative employing bioengineering technique has been found to be most appropriate and effective in mitigating not only the annually recurring flood havocs, but also turning such “risks into rewards”.

1435. Rehabilitation of wetlands can also be a powerful force in recovery from socio-political crises. The destruction of the Iraqi Marshlands, and the consequent displacement of its indigenous Marsh Arab population, is one of the major humanitarian and environmental challenges facing Iraq. With the collapse of the former regime in mid 2003, local residents opened floodgates and breached embankments to reintroduce water back into the Marshlands. By April 2004, approximately 20% of the original Marshland area was re-inundated, compared with 5-7% in 2003.

[122] A reference to the ICID working group on Use of Poor Quality Water for Irrigation is available in the ICID Publication No.86 (September 2006 Kuala Lumpur IEC International Workshop)

1436. Win-win scenarios are also being promoted through Security and Crisis Prevention. Water is emerging as a strategic resource in that it underpins many of the other dimensions of security. Many interventions at local, regional or global level that are designed as direct responses to insecurity can have benefits for water – and potentially generate multiplied human security benefits in the long term.

1437. In addition to promoting human security at the local level, inter-regional cooperation around shared waters can help promote peace-building and trust among countries, as seen in the cases of the Nile Basin and the Senegal River. Although the causal pathways between water scarcity and conflict are still the object of much academic debate, there is no doubt that international cooperation on shared waterways is occurring, in many cases in areas where tensions existed even outside of the water issues. The creation of solid international water institutions at the very least demonstrates that cooperation is possible, and can be successful provided the rules of cooperation are transparent, and consensual. This long history of cooperation around a central waterway has been recognized as a key contribution to regional stability and integration. It is known as an example of a solid water-based institution for the promotion of collaboration on the multiple uses of water and the promotion of integrated water management. Many other examples of successful or growing transboundary cooperation exist.

1438. The Comprehensive Assessment of Water Management in Agriculture (2007) concludes that potential exists at the global level to produce enough food and other agricultural products to meet demand while reducing the negative impacts of water use in agriculture. From its scenario analysis, this assessment also noted there are significant local opportunities and options – in rainfed, irrigated, livestock and fisheries systems – for preserving, even restoring, healthy ecosystems. But gains require significant changes in the way in which water is managed. For example of China which has succeeded over the last 10 years in improving its water use efficiency by around 10% without increasing its water allocation to agriculture. China projects a need to increase, by 2020, its national food production by 200 million tons to maintain national food security, which requires increasing its irrigation area by 6.67 million ha. It is projected that newly developed water resources over the next two decades will be mainly allocated to domestic and industrial users; the agriculture sector will have to maintain food security for a larger population with the current amount of water allocation. From 1980 to 2004, while national total water diversion increased by 25%, and the proportion of irrigation water use as a percentage of total water use declined from 81% to 65%. Meanwhile, national irrigation area increased by 5.4 million ha, food production capacity increased by 20 million tons, and 200 million additional people gained food security.

G. Indirect drivers

1439. External drivers and policies have more impact on water management and biodiversity than many policies championed and implemented by water or biodiversity related ministries. Trade-offs between water and other policy sectors should be identified at an early stage to enhance policy impact in all sectors, as well as to reduce potential adverse effects on water. Governments, civil society, and individual business leaders make decisions every day that have a potential consequence for water and the biodiversity it supports; hence it is important to identify what can create win-win conditions which lead to improvements in service delivery. Examples of win-win situations abound - whether created by governments, communities, or businesses - that further point to the need to promote deliberate cooperation between water and non-water actors, and for the integration of water issues into external decisions.

1440. The devolution of decision-making powers over natural resources to publicly accountable local authorities is frequently advocated as a means of achieving social development and enhancing environmental management. The extent to which benefits occur depends on the character of the decentralization. The decentralization process has to offer the following elements: (i) decentralization has to provide adequate legislative and regulatory powers to local authorities; (ii) the devolution of executive and enforcement authority; and (iii) the provision of adequate resources.

1441. Water is often a very local issue and management certainly nearly always local. National policies need to describe broad principles and objectives and empower, or legislate for, local implementation according to local circumstances and needs.

1442. Greater impact on irrigation efficiency can be expected from external drivers influencing the evolution of irrigation than from demand management programmes. The trend and prospects for irrigation are that it will serve an increasingly market-oriented agriculture, with progressive increase in the value of production, and where precision irrigation will become increasingly important. This will lead to progressive adoption of pressurised irrigation, thus reducing losses.

1443. One solution to solving the problem of the uneven global availability of water is to increase food production in water abundant areas and trade (a process known in water terms as trading in virtual water). Water and food production are intimately linked. Policies to achieve national food security are a significant driver of water use, particularly in more arid regions. There is evidence of national policies moving away from being over-focused on food independence. Saudi Arabia, for example, in an effort to achieve food self-sufficiency, tried to produce its wheat needs domestically but this policy proved both environmentally and economically unsustainable, since production continued to rely heavily on government subsidies, and water quality and quantity was seen to decline rapidly. The Saudi Government abandoned its food independence strategy and decided instead to import the country's entire wheat needs by 2016.[123]

1444. Water allocation systems should work to balance equity and economic efficiency, with tradable water rights favouring the latter over the former and, therefore, being regulated to varying degrees. There are, however, tendencies to ignore environmental concerns from both perspectives. In Chile, for example, the environment is not granted any water licenses. A contrasting example is South Africa, where decisions-makers are debating how to put water law on environmental protection into practice.

H. Private sector responses

1445. There are many examples from the private sector illustrating how production can be increased whilst reducing environmental footprints. Mondi South Africa's expansion project, raised the mill's production capacity by 25% to 720,000 tonnes per annum, and accommodated a 40% increase in timber supply. The company achieved its expansion objectives, while realising the following benefits: SO2 – 2,177 tons representing a 50% reduction; NOx – 509 tons representing a 35% reduction; CO2 – 297,121 tons representing a 50% reduction; total sulphur (TRS) emissions were reduced by approximately 60%; total energy and water cost-savings of R 38,678,843 (approximately 4.9 million US$). Meanwhile, a reduction of water use by some 13,000 cubic meters per day was achieved. Wastewater volumes were reduced by more than 25%.

1446. Private-sector awareness of the centrality of sustainable water management is clearly increasing. Recent initiatives in the business community to support sustainable water management include the CEO Water Mandate launched at the 2007 UN Global Leadership Forum; the World Economic Forum's call for a "coalition" of businesses to engage in water management partnerships, and development by the World Business Council for Sustainable Development of a water diagnostic tool and water scenario planning supports.[124]

[123] Saudi Arabia's Agricultural Project: From Dust to Dust, by Eli El Hadj, in the Middle East Review of International Affairs; June 2008.

[124] *Business in the world of water: WBCSD water scenarios to 2025, 2006.*

1447. Diminishing quality of water supplies, increasing water purchase costs, and strict environmental effluent standards are forcing industries to target increased water-efficiency and report on their progress (Global Reporting Initiative).

1448. Swiss-based ST Microelectronics cut electricity use by 28 percent and water use by 45 percent in 2003 and reported saving $133 million. DuPont committed to a policy of keeping energy use flat no matter how much production increased, which reportedly saved over $2 billion in the past decade. The company Advanced Micro Devices tracks “kilowatt hours per manufacturing index” and reports a 60-percent reduction from 2.17 in 1999 to 0.86 in 2005.[125]

1449. Tourism is a growing sector of the economy, and one to which many developing countries are turning for diversification. Tourism depends on the availability of natural resources, landscapes, and ecosystem services, chief among them water. Tourism installations and infrastructures can also generate significant adverse impacts on ecosystems through pollution, deforestation or over-exploitation. Tourism also requires increased water supply and sanitation, which may in some cases create diversions from other uses of water. Antigua and Barbuda, whose economy is dependent on tourism, has to purchase freshwater from neighbouring island Dominica in order to satisfy demand.

1450. There is increasing evidence that win-win scenarios between tourism and water are possible, as well as between tourism and community development. With the recent rise in consumer awareness, tourism enterprises everywhere are increasingly making efforts to demonstrate corporate social and environmental responsibility. From a government perspective, much is being done to promote more integrated tourism investment planning, sustainable use of protected areas, impact assessment and certification programs. Ecotourism, provided it is more than a simple marketing strategy, can help promote conservation, poverty reduction and sustainable water management, when adequate enforcement and benefit sharing mechanisms are in place.

1451. Examples of successes in creating social marketing campaigns around water issues can be found in almost all countries. In the countries riparian to the Danube, the campaign involved educational institutions and the private sector, in the creation of the Danube Educational Toolkit, the “Danube Box”. The "Green Danube Partnership" is an alliance between the Coca-Cola Company, Coca-Cola Hellenic and the International Commission for the Protection of the Danube River (ICPDR).

I. International (and regional) Water Policy

1452. The European Union Water Framework Directive (EUWFD, 2000/60/EC) deals with management of inland surface waters, groundwater, transitional waters and coastal waters, in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems and mitigate the effects of floods and droughts. In a 2007 report (COM 2007), the European Commission mentioned the considerable risk that several EU member states will fail to meet the targets set in the EUWFD for several reasons, particularly because of the extent of the physical deterioration of aquatic ecosystems as a result of overexploitation of water resources, and the disturbing levels of pollution from diffuse sources in European water systems. The Commission also cited problems in meeting the deadlines for incorporating the Framework Directive into national law, with shortcomings in the actual transposition process in some cases.

1453. This water framework directive is often cited as a model. The lessons learned here are that achieving water and environmental sustainability, even in regions with higher capacity and well developed institutions, is not easy. Rapid improvements should not be expected. Long-term commitments, well thought out, with adequate resources and political support, are required.

[125] From State of the World Report, 2008

1454. There are many examples where regional cooperation and institutional coordination is achievable; many in developing countries. A large number of cases studies (see in particular section "Work of selected non-governmental organisations on inland waters biodiversity and wetlands"").

J. Hazards versus opportunities

1455. The increased exposure of potential climate change hazards has led to an increasing awareness of a number of issues related to the management of water resources that require solutions in the future regardless of the impacts of climate change. The revision of management strategies in response to potential climate change threats therefore represents an opportunity to implement policies and practice that will lead to more sustainable use of available resources into the future. These strategies could include, but would not be limited to, improved observation networks, increased integration in the use of groundwater and surface water supplies (including artificial recharge), improved early warning and forecasting systems for hazardous events, improved risk-based approaches to management and the raising of community awareness of sustainable water resource use and individual responses to water related hazards.

1456. Floodplain restoration was used to restore thousands of hectares of aquatic habitat in the lower Danube River Basin in Eastern Europe. The restoration of tanks in Andhra Pradesh, India, by removal of silt allows the capture of more monsoon runoff, resulting in less groundwater pumping, restoration of some dry wells, allowing an extra 900 ha of land to be irrigated. Reconnecting lakes in the Hubei Province in China to the Yangtze River, by opening sluice gates and initiating sustainable management techniques, increased wetland areas, and wildlife diversity and population, while make them more resilient to flood flows. Government agencies in China subsequently adopted the new lake management regimes into their standard operating procedures, allocating funds for ongoing implementation efforts.

K. Biotechnology and the 'Green Revolution'

1457. Biotechnology is believed to have a valuable role in addressing water scarcity and quality challenges in both developed and developing countries, particularly in regard to agricultural needs. The development of drought resistant crops or those with lower water demands is one example. Likewise, the application of nanotechnology shows particular promise in regard to water resources, especially for developing countries; namely desalinization, water purification, wastewater treatment, and monitoring.

L. Reaching the Millennium Development Goals

1458. One critical need is to recognise that water is the key mechanism linking the various MDGs (Figure 96).

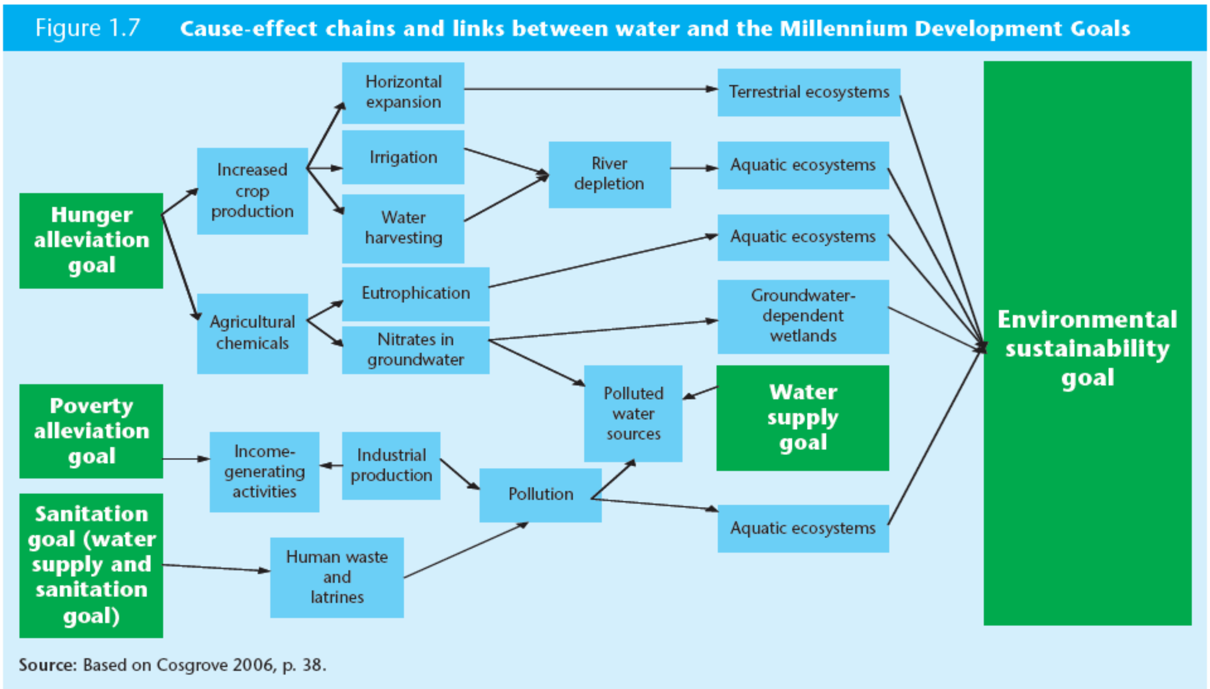

Figure 96: Cause-effect chains and links between water and the MDGs (Source: W.J. Cosgrove Water for growth and security in Water Crisis: Myth or Reality. Fundacion Marcelino Botin. Taylor and Francis London 2006; from WWDR3 2008).

1459. Water is a primary reason why "environmental sustainability" targets were incorporated into the MDGs originally. This is why (somewhat oddly) the environmental sustainability target (#1) is included under MDG7 together with the target (#3) for drinking water and sanitation. This opened the door for the latter incorporation of the 2010 biodiversity target itself under the same MDG7 (as target 2). The importance of water, therefore, is historically why the 2010 target was recognised as relevant.

1460. But history seems to have been somewhat forgotten. The MDGs too often are looked at independently. They are a package. More so, we need to recall that the primary reason they are connected is through water. "Water" is a lens through which the MDGs should be viewed. Managing water better helps us manage the MDGs better. And in this context it is absolutely critical to understand and recognise the biodiversity link. Water delivery is an ecosystem service, and biodiversity underpins this. Achieving the MDGs sustainably and collectively is not possible without sustaining "inland waters biodiversity" and the services it provides; nor is it possible without trading, balancing and compromising on those various services.

Climate change

1461. Climate change is cross-cutting. Because the impacts of climate change are expressed mainly through additional influences on existing direct and indirect drivers of change, responses to it largely centre on incorporating climate change into existing responses and recognising that it adds further urgency for action. Responses being taken to the current challenges facing the conservation and sustainable use of inland waters biodiversity are noted, from varying perspectives, throughout this in-depth review. Case studies of good practice are also included throughout other sections of this review and many of these incorporate climate change relevant approaches, whether explicit or not (see in particular sections on: National Reports; The Work of Selected Non-Governmental Organisations, which lists 50 cases studies; and Drivers of Change – Water Resources Use).

1462. One challenge to addressing climate change impacts for inland waters is that there is evidence that change has occurred already; in most cases not due directly to climate change (e.g., reduced water flows due to abstraction), whereas for a few climate change alone is implicated (e.g., increasing lake water temperatures), but for most it is probably a combination of both (e.g., combined pressures of abstraction and changing rainfall). Climate projections indicate that substantial future change may occur, but for most considerations, but not all, these impacts are likely to be secondary to impacts already arising and projected through increasing demand on, and the over- and mis- use of, water. Without some modifications, current inland water management plans and practices are likely to have difficulty coping with the full range of future climate impacts on water supply reliability, flood risk, health, energy, and aquatic ecosystems. Society needs to build its capacity to both respond to existing needs and adapt to the additional challenges that climate change will bring.

1463. There is much scope for improved outcomes for biodiversity, water resources and human well-being. Many promising solutions to the problems exist and many centre on using "biodiversity" to solve water related needs – including in response to climate change. Much is known about how water resources can be managed under conditions of change. Indeed the Millennium Ecosystem Assessment itself reviewed a wide catalogue of 'response options', and highlighted many viable ways forward.

1464. There are a growing number of countries and cities where water-related adaptations to climate change are being incorporated into planning and policy efforts, as are institutional and technological adaptation measures to mitigate such predicted impacts as sea-level rise, more frequent droughts and increased precipitation.

1465. For developing countries, technology development and transfer will be key to adapting to and mitigating climate change.

1466. Recognition of the importance of water, and understanding of how it links climate change, ecosystems, and human well-being, and the role of biodiversity in this, is variable as judged by dialogue in the international arena. Many fora acknowledge these links but fewer appear to recognise their full importance. It is insufficient to acknowledge the subject as just "important". This needs to be the lens through which climate change is studied, considered and addressed. Putting things more simply – the climate change adaptation dialogue needs to refocus from "what to do about the world getting warmer?" to "what is happening with water?".

1467. For example, WWDR3 notes the absence of recognition of water in major forums (Box 1).

Box 64: Extracts from Declaration of G-8 Leaders Toyako, Hokkaido, Japan, 9 July, 2008

Climate change is one of the great global challenges of our time. Conscious of our leadership role in meeting such challenges, we, the leaders of the world's major economies, both developed and developing, commit to combat climate change in accordance with our common but differentiated responsibilities and respective capabilities and confront the ***interlinked challenges of sustainable development, including energy and food security, and human health***. [Note the absence of water]

We will work together in accordance with our Convention commitments to strengthen the ability of developing countries, particularly the most vulnerable ones, to adapt to climate change.

1468. Based on collective experience and thorough assessments, UN-Water[126] articulated the situation and needs in a concise message to the Fifteenth Meeting of the Conference of the Parties to the UNFCCC (Box 63). This captures many of the fundamental points made in this in-depth review including, *inter alia*: that water is the primary medium through which climate change influences the earth's ecosystem and therefore people; that adaptation is mainly about water; and that a sense of urgency for adaptation and recognition of the centrality of water have not yet permeated the political world and are not adequately reflected in national or international plans and strategies.

Box 65: Message delivered from UN-Water to COP-15 of the UNFCCC

Climate change adaptation is mainly about water …

Water is the primary medium through which climate change influences the Earth's ecosystems and therefore people's livelihoods and well-being. Already, water-related climate change impacts are being experienced in the form of more severe and more frequent droughts and floods. Higher average temperatures and changes in precipitation and temperature extremes are projected to affect the availability of water resources through changes in rainfall distribution, soil moisture, glacier and ice/snow melt, and river and groundwater flows; these factors are expected to lead to further deterioration of water quality as well. The poor, who are the most vulnerable, are also likely to be affected the most.

Water resources and how they are managed impact almost all aspects of society and the economy, in particular health, food production and security, domestic water supply and sanitation, energy, industry, and the functioning of ecosystems. Under present climate variability, water stress is already high, particularly in many developing countries, and climate change adds even more urgency for action. Without improved water resources management, the progress towards poverty reduction targets, the Millennium Development Goals, and sustainable development in all its economic, social and environmental dimensions, will be jeopardized.

Adaptation to climate change is mainly about better water management. Recognizing this and responding to it appropriately present development opportunities. Appropriate adaptation measures build upon known land and water management practices to foster resilience to future climate change, thereby enhancing water security. Innovative technologies and integrated solutions are needed at the appropriate scales, for adaptation as well as mitigation. Any adaptation measures, however, need to be assessed for inadvertent adverse effects, in particular on the environment and on human health.

Adapting to increasing climate variability and change through better water management requires significant investments and policy shifts that should be guided by the following principles:

7. Mainstreaming adaptation within the broader development context;
8. Strengthening governance of water resources management and improving integration of land and water management;
9. Improving and sharing knowledge and information on climate, water and adaptation measures, and investing in comprehensive and sustainable data collection and monitoring systems;
10. Building long-term resilience through stronger institutions and water infrastructure, including well-functioning ecosystems;
11. Investing in cost-effective adaptive water management and technology transfer;
12. Releasing additional funds through increased national budgetary allocations and innovative funding mechanisms for adaptation through improved water management.

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[126] UN-Water is composed of representatives of 26 United Nations organizations. United Nations organizations include those responsible for major funds and programs, specialised agencies, regional commissions, United Nations conventions and other entities within the UN system. Other organizations outside of the United Nations are partners in UN-Water.

The sense of urgency for climate change adaptation and recognition of the centrality of water therein have not yet permeated the political world and are not systematically reflected in national plans or international investment portfolios for adaptation.

It is imperative for the Parties to the UNFCCC to recognize the pivotal role of water in adapting to climate change in order to increase resilience and achieve sustainable development.

1469. There are however compelling examples of where dialogue has grasped the nature of the issues and identified necessary responses. Some examples include:

(a) The *European symposium: Dresden communication on Flood Risk Management Research,* Dresden (Germany), 7th February 2007

> The symposium statement: urges the inclusion of climate change assessment in all actions under the proposed EU directive on the assessment and management of flood risks; notes that flood risks are dynamic, driven by climate change and growing vulnerability; and notes Integrated Water resources Management is a key to cope with effects of climate change;

(b) The conference *Time to adapt: Climate change and the European water dimension (vulnerability-impacts-adaptation),* Berlin, 12-14 February 2007, Berlin. *http://climate-water-adaptation-berlin2007.org/*

> Which noted: climate change is of critical importance to the water industry everywhere; adaptation starts with using water more efficiently in all sectors and water dependant sectors need to be involved; needs to be taken into full account by everybody in water planning and investment; it affects all aspects of water services and the quality of water in the environment will also be affected; water and climate change legislation needs to recognise the possible conflict between ever higher environmental standards and the impact of using more energy to meet these standards; water makes the wider debate on climate change more relevant; adaptation will require much more efficient use of water; the need to prepare for potential changes in wastewater infrastructure, in agricultural practice, in the impact of new infrastructure on biodiversity and wetlands; regulation and policy must reflect the broad social implications of climate change; international communication is needed; and "if we don't get water right, we will not be able to get right any other sector; the need for action is more urgent than ever before".

(c) *The Economics of Ecosystems and Biodiversity (TEEB)* prepared a brief for UNFCCC COP 15 which concludes:

> "There is a compelling cost-benefit case for public investment in **ecological infrastructure** (especially restoring and conserving forests, mangroves, river basins, wetlands, etc.), particularly because of its significant potential as a means of adaptation to climate change".
>
> "The carbon cycle and the water cycle are perhaps the two most important large-scale bio-geological processes for life on Earth".
>
> It also presented a table listing, as an example, the value of ecosystem services provided by tropical forests. The water related services listed include: water provisioning, regulation of water flows, waste treatment/water purification and erosion prevention. These collectively

account for a value of up to $US 7236 per hectare per year - more than 44% of the total value of forests - exceeding the combined value of climate regulation, food, raw materials, and recreation and tourism.

(d) The *Ministerial Statement at the Fifth World Water Forum*, 16 – 22 March, 2009, Istanbul, Turkey, *inter alia*: acknowledges that water is a cross-cutting issue and recognises the need to achieve water security, and to this end it is vital to increase adaptation of water management to all global changes;

(e) Following the 2008 Davos meeting, there are calls for a minimum water impact alongside a minimum carbon footprint.

1470. One way to cope with the uncertainty of climate change is to adopt management measures which are flexible and robust to uncertainty. The use of adaptive management principles, which involves a systematic process for improving management policies and practices by learning from the outcomes of implemented management strategies, is particularly relevant in the context of climate change by explicitly recognizing that management strategies and even goals may have to be adapted over time.

1471. Session 3 of the Fifth World Water Forum considered managing and protecting water resources and their supply systems to meet human and environmental needs. The outcomes brought together the recommendations from several sub-sessions that spanned issues of large scale management policies, financial mechanisms, conflicting claims, and local actions, and put forward a series of recommendations that target various sectors, including governmental organisations, NGOs and industry. Outcomes include:

(a) The preservation of ecosystems must be a central focus of water and land management if ecosystem services that provide clean water and reliable water supplies are to continue.

(b) This is relevant outside of the water "sector" because the preservation of ecosystems both requires efforts from many sectors, and will impact upon many sectors.

(c) Efforts are necessary on several political levels, and public opinion in favour of preserving natural ecosystems is necessary for a sustainable situation.

(d) Common issues are that ecosystem services describe a variety of socially-valued goods and services that society derives from natural ecosystems. However, multiple claims on ecosystems and their services, and rapid agricultural, industrial, and urban development put severe pressures on ecosystems being under threat due to water scaricity and chemical contamination.

(e) Stopping and certainly reversing degradation of important ecosystem services demands major policy changes.

(f) As governments seek to achieve the MDGs and IWRM plans, doors are open for a focus on ecosystem preservation to contribute to and benefit from theses related goals.

(g) The recent economic crisis also brings heightened attention to opportunities for stimulating economies, where the concept of payments for ecosystem services may be introduced as an option to finance adaptation/mitigation measures, while simultaneously stimulating economic activity.

(h) Governments around the world have pledged to work together to provide adequate access to clean water, sanitation, and electricity for all. The importance of ecosystems for providing basic human needs must not be forgotten while these goals are pursued.

(i) As ecosystems are critical for so many of the challenges faced today, many processes have opportunities for the inclusion of discussion on ecosystems, including the UNFCCC and CSD processes.

M. The way forward

1472. Tested approaches available to water managers that show promise lie within the fields of:

- Water policy and planning processes that are currently not fully developed, and where incremental change that secures alignment with the real-world outcomes in the use of water will be most effective;
- Institutional development, through continuing reforms which create institutions that are better attuned to today's current and future challenges, considering decentralization, stakeholder participation and transparency, increased corporatisation wherever feasible and implementable in fairness, partnerships and coordination (public-private, public-public, public-civil society), and new administrative systems based on shared benefits of water, especially when water crosses statutory boundaries or political borders;
- Water law, both formal and customary, including regulations within other sectors that bear influence upon the management of the water resource;
- Consultation with stakeholders and developing accountability in planning, implementation and management; building trust, as effective management relies more and more upon pluralistic governance and interactions among parties with different vested interests;
- Developing appropriate solutions through innovation and research; and
- Institutional and human capacity development.

1473. Economic pressure for high-quality groundwater will likely enhance regulation and protection with greater stakeholder involvement in most post-industrial economies. Some intermediate countries are also likely to follow suit if able to prioritize their efforts, but at the same time numerous opportunities for conservation of high-quality resources have already disappeared and few countries have the financial resources for wholesale remediation of aquifers.

1474. Traditional practice has it that planners locate land uses and design land cover and then hand over to engineers the task of directing water flows. Instead, water considerations should be incorporated in determining the location of land uses, their layout and topography, the distribution of pervious and impervious land cover, and the use of Best Management Practices (BMPs). This approach includes improving water quality and supply by passing it through wetlands. For the Coastal Plain of Israel, with an annual rainfall of 500 mm, it has been estimated that the aquifer recharge can be increased by about 25,000-77,000 m^3 km^{-2} of urban area by connecting roof drains to a 15% pervious area on the property and surrounding the property with a low (~20 cm) wall. Land use should be counted among the key drivers of change, either alone or in connection with urbanization. Land use and land cover should be planned to maximize the beneficial use of potable water and stormwater, while reducing the hazards associated with runoff.

1475. There are many good examples of sustainable groundwater management practices, e.g. in many European countries, where groundwater has been used for decades as a safe, high quality source for drinking water supply, without any degradation. These highly valued and well-protected groundwater resources are key factors for social and economic development, environmental sustainability and biodiversity conservation.

1476. Groundwater reservoirs add persistency and stability to the terrestrial hydrological systems and provide unique opportunities for humans, fauna and flora to bridge extended dry periods of time and survive. This underlines the potential role of groundwater in coping with increasing water scarcity due to global change. At the same time, because of strong interdependence between groundwater and surface water, the overall resource is difficult to quantify.

1477. Despite its importance for river baseflow and wetlands *(and vice versa)*, groundwater is frequently ignored in water balance calculations. For longer term evaluations such as associated with global changes, groundwater resources are of utmost importance, since groundwater has a buffer function for short term climatic variations and is at the base of important adaptation strategies.

1478. Increasing a demand-driven research capacity in developing countries is essential because a critical mass of individuals in research and development is needed to facilitate economic development (Human Development Report, 2006; Van der Zaag 2007). The Paris Declaration also stressed that developing countries must become more capable of solving their own problems, therefore requiring research capacities which also will facilitate their ability to absorb and utilize existing knowledge from other sources and countries.

1479. Reliable and accurate water resources information and data provides a means by which decision-makers can attempt to convert uncertainty regarding water resources into more reliable assessments of water risks (the latter being more manageable from a political perspective). There is considerable room for improvement and urgency for this. Many of the critical data/information needs centre of understanding and managing the water cycle (essentially – hydrological data). But this must be accompanied with better information on the role of ecosystems (wetlands). Wetland/ecosystem/environment specialists must gather, package and disseminate relevant information that is pertinent to assisting better land and water management, particularly where there are cost savings. And they need to move beyond "conservation" data. Funding agencies must recognise that investments in environment related information is investment in more sustainable development.

1480. Effective legal and political frameworks are necessary to develop, carry out and/or enforce the agreed rules and regulations that fundamentally control human water uses. Water policy operates within a context of local, domestic, regional and global policy and legal frameworks, all of which must be supportive of sound water management goals. Legitimate, transparent and participatory processes can be effective ways of gathering support for the design and implementation of water resources policy, as well as creating a major deterrent to corruption. There is no one size-fits-all approach to establishing a fair and functioning institutional framework.

1481. The bottom-up approach to water resources management was recognized in the Dublin and Rio de Janeiro processes. Such coordination is facilitated by a legislative and regulatory framework. This was recognised by the Government of Australia in adopting the Commonwealth Water Act in 2007 and subsequent regulations[127]. Processes which strengthen water (and land) governance and include more holistic approaches can be expected to have desirable outcomes for the conservation and sustainable use of inland waters biodiversity.

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127 Water Act 2007 An Act to make provision for the management of the water resources of the Murray-Darling Basin, and to make provision for other matters of national interest in relation to water and water information, and for related purposes Act - C2007A00137 Department of energy and Water, Australia 2007.

N. Information contained in CBD national reports regarding implementation of the programme of work

1482. CBD national reports continue to provide limited information by which to assess implementation of the programme of work – certainly by comparison with other sources of information, many of which include detailed assessments of many relevant activities at national level. Regarding MEA national reports, and as recognised in CBD decision VII/4, para. 2, Ramsar National reports remain a much more substantial information source. The extent of this difference can be judged by comparing, for example, the section "Status and Trends" with the section "Analysis of CBD national reports".

1483. Whilst this difference might be expected (the Ramsar Convention is more focussed on specific inland water/wetland related issues) CBD national reports provide limited information on relevant subjects in other programme areas, or information which is difficult to interpret or quantify. It is activities in these other programme areas that chiefly influence outcomes for inland waters. Some relevant cross-references are made, for example, for agricultural biodiversity, scattered measures taken include: reducing pollution from agricultural chemicals, use of organic fertilizers, promoting good agricultural practices, monitoring of hydrological change, conservation of pastoral systems, reducing persistent organic pollutants and nitrogen surplus, promoting organic agriculture. All of these are activities relevant to the inland waters programme of work. In particular, there is a conspicuous absence of systematic and organised reporting on water use and influences on the hydrological cycle (as relating to biodiversity considerations) through other programmes of work.

1484. Details of information provided in CBD national reports is provided in the section "Analysis of CBD national reports". The following synthesis is prepared on the basis of the information from all 128 Parties which submitted a third national report (as of May 2009).

1485. The level of priority accorded to the programme of work on inland waters varies significantly between Parties, but overall it is medium priority. Among the thematic programmes of work forest biodiversity is ranked as a high priority by 70% of reporting countries. The programmes of work on agricultural biodiversity and marine and coastal biodiversity are in second and third place.

1486. Regarding protected areas, 41 countries reported undertaking significant actions while 46 countries reported taking limited actions to increase representation of marine and inland ecosystems in protected areas (it is not possible to separate the two in the relevant question). Certainly, many countries have plans to increase the extent of Marine and Coastal Protected Areas (MCPAs). An under-emphasis on inland water sites would be implied.

1487. Most Parties report that they have incorporated objectives and relevant activities into their NBSAPs. However, most of those have done so partially and not all objectives and activities are implemented. Some Parties have mentioned other national environmental policies, strategies, and plans in which the biodiversity of inland waters has been considered. A few (6) of these refer to fisheries. Significantly, only 3 Parties (Belarus, Colombia, India) have integrated the programme of work into in policies, strategies, and plans related to development. It is unlikely that the majority of Parties do not recognise the role of water in development, but, according to third national reports, it is clear that the role of the programme of work is not reflected in this context.

1488. The reliance of Cities on services provided by inland water ecosystems, and their impacts upon these downstream, has been highlighted throughout this review. Canada is the only Party to mention activities in urban areas through the New Deal for Cities and Communities 2005 which targets new funding at environmentally sustainable municipal infrastructure, including water and wastewater systems, and through the Green Municipal Fund that offers grants and low-interest loans for sustainable infrastructure initiatives that generate measurable environmental, economic and social benefits.

1489. Responses regarding the extent to which the programme of work has been integrated into IWRM and water efficiency plans (which is high according to third national reports) differs significantly from other sources of information on this subject. The response that most CBD Parties have "partially or fully integrated into IWRM plans" is not consistent with findings of independent reviews that at the time reports were submitted, most Parties very likely did not have such plans. This is an important gap in knowledge in assessing progress in implementation of the programme of work from national reports (fortunately alternative sources of information shed more light on the picture, as noted elsewhere).

1490. Most Parties report that they have incorporated the objectives and relevant activities of the programme of work into enhanced coordination and cooperation between national actors – citing examples such as a committee, board, or council responsible for coordination. Few Parties mentioned coordination at the local level (county, district, or watershed committee) and in other settings. Some Parties (29) referred to a legislative framework, whether a water law, act, or code. But among these, there is a predominance of EU member states mentioning the Water Framework Directive. But another noteworthy example is Israel amending its Water Law in 2004 to include the allocation of water for nature and landscapes assets

1491. Only 39 Parties have developed national outcome oriented targets for this programme of work, with 20 of these also identifying priority activities to achieve them. India was the only Party which mentioned the organization of consultative workshops in different regions of the country to identify key issues of wetlands which would be addressed through integrated conservation and development plans. Twenty-five additional Parties have developed priority activities but not outcome-oriented targets. Regarding targets for protected areas, in the case of inland water biodiversity, only a few countries reported that such a target is in place. For example, Thailand has aimed to conserve and restore 35% of its wetlands by 2010. Overall, targets are seldom clearly defined and many countries listed measures currently in place rather than targets *per se*.

1492. The responses to target related questions are conflicting. According to the responses on the 2010 target, overall more than 60% of Parties report that they have established targets for this programme of work (although the figures vary between sub-targets). However, according to the same question in the inland waters section - only 29.7% of Parties have established outcome oriented targets for this programme of work.

1493. Only 9 Parties have taken comprehensive measures for joint implementation between the Ramsar Convention and CBD. Despite being a non-Party of the Ramsar Convention, Turkmenistan mentioned that its NBSAP provides for a range of targets and activities compatible with the principles of the Ramsar Convention and highlights the possible synergies between Ramsar and CBD.

1494. Many reporting Parties (49%) indicated that they had taken steps to improve national data on goods and services provided by inland water ecosystems, while some (29%) are taking steps towards this direction and some (22%) are yet to take any steps. However, many countries (60 to 65%) indicated that they had taken steps to improve data on the basic hydrological aspects of water supply, on species and all taxonomic levels, and on threats to inland water ecosystems. But only 38% of Parties indicated that they had taken steps to improve national data on the uses and related socioeconomic variables of goods and services provided by inland water ecosystems.

1495. Data generation for inland waters continues to be dominated by technical and biological interests whereas socioeconomic data are clearly still weak. Likewise, data generation on threats is also a weak area. There has been some uptake of the guidelines for the rapid assessment of the biological diversity of inland water ecosystems (largely focussed on biological aspects) although a few Parties, mainly developed countries, report they have not used the guidelines because they have more comprehensive guidelines available.

1496. Implementation of the programme of work is not linked linearly with economic status. The responses of Parties sub-divided by economic grouping (developed, economies in transition, developing, least developed, SIDS) is a fruitful area for analysis. As might be expected, developed countries show a generally high level of engagement (meaning more positive responses in terms of progress etc.) in the programme of work. But not always, and developing countries often "outperform" them and the total scores are only marginally different between these two groupings. That developing countries often engage well in the programme of work perhaps reflects the more pressing nature of water-biodiversity related issues to the poor, the need to manage natural resources more wisely under more harsh economic conditions and the fact that direct dependency on biodiversity is higher amongst them. But the fact that their water resources are under more rapid development could be a contributing factor. The same would apply to least developed countries but their performance is perhaps more constrained by capacity than for developing countries. Overall, least developed countries perform in fourth position out of the five groupings.

1497. Interestingly, countries with economies in transition are ranked third overall (and their total score is more aligned to least developed countries than either developed or developing countries). This supports the long held paradigm that countries experiencing more rapid economic growth (in transition) tend to give less attention to the environment, particularly freshwater related resources, despite the increasing capacity to do so.

1498. Engagement in the programme of work is consistently by far the lowest amongst Small Island Developing States (SIDS). This may be influenced by capacity considerations. But very likely a factor is that islands may focus on marine and coastal areas, climate change, and for many also forests. If a correct interpretation, this is not logical. There are no grounds to assume that inland waters are less important on islands. In fact, there are strong arguments that they can be more important. Freshwater resources availability is a critical issue in most SIDS (if not all). The smaller the island – the more important freshwater becomes. Some SIDS are currently even importing freshwater from neighbouring States. Even from the perspective of species conservation – islands are characterised by high degrees of freshwater species endemicity (probably more so than for terrestrial biota, and certainly compared to marine). Neither could a case be made that freshwater needs and issues are lower in countries with economies in transition.

1499. There are also interesting differences with regards to target setting. Least developed countries rank highest in the ideal scenario of having targets and identified activities to achieve them. They are approaching three times better on this point than developed countries. Even developing countries "out perform" developed countries in this area. Developed countries rank highest only where priorities have been identified but no targets established. LDCs are second highest (after developed) in integrating the programme of work into NBSAPs. Better progress is reported by all groups (except SIDS) than developed in enhancing cooperation between national actors (suggesting this is a continued area of weakness in developed countries). Developed countries rank highest in those areas which clearly require a high degree of technical capacity (for example, taxonomy, identifying threats and hydrological aspects of water supply as they relate to maintaining ecosystem function).

1500. Developing countries are doing "better" than developed in areas relating to attention to goods and services provided by inland water ecosystems and the uses and related socioeconomic variables of such goods and services. This may reflect the more obvious relevance of some of those goods and services to developing countries (e.g., direct use for food, disaster, e.g. flood, mitigation etc.) – although the goods and services provided by inland waters (collectively) are in reality probably of equal importance amongst country groupings.

1501. Main challenges identified by many countries for implementing this work programme include:

(a) Lack of mainstreaming inland waters ecosystem management into broader relevant policy frameworks;

(b) Limited capacities for inland waters ecosystem management;

(c) Lack of adequate information, monitoring, technical standards and practices for inland waters ecosystem management;

(d) Lack of financial, human and technical resources;

(e) Inadequate policy and legislative frameworks and weak enforcement capacities; and

(f) Lack of inter-sectoral coordination or synergies.

1502. There are a few challenges rated as high by a considerable number of countries – including weak law enforcement capacity, in particular for the programme of work on inland waters biodiversity.

1503. In the second national reports, the programme of work on biological diversity of inland water ecosystems is recognized as priority programme by a majority of responding Parties. However, two thirds of the Parties did not have adequate resources for implementation of the programme of work. Responses showed that the programme of work on biological diversity of inland water ecosystems was reviewed by only nine Parties, which identified priorities for national action in implementing the programme. However nearly half of the responding Parties reported on developing national and sectoral plans for conservation and sustainable use of inland water ecosystems. *This indicates that the majority of the national sectoral plans for conservation and sustainable use of inland water ecosystems are developed independent of the programme of work.* Assessing progress between the second and third national reports is difficult because the questions differ, as does the status of development of the programme of work, and the response rate for the second national report relatively low. Following trends through to the fourth national report is even more difficult due to its quite different format.

1504. Intuitively, the third national reports suggest much improved engagement in and attention to inland waters since the second report but this cannot clearly be attributed to the existence of the programme of work. It remains difficult to assess for particular activities whether these are (i) in response to the programme of work itself, or (ii) they are activities which would in any case be carried out but are consistent with the programme of work and therefore reported against it. There are few clear examples of Parties in the first category although the level of influence of the programme of work no doubt varies amongst these. It is highly likely that a considerable proportion of Parties fall into the second category, in particular the developed countries. This uncertainty makes it difficult to assess the impact of the implementation of the programme of work on the achievement of the 2010 target. This has to be assessed through a multitude of additional, mainly indirect, approaches.

O. Assessment of implementation of climate change elements in the inland waters programme of work by Parties

1505. The extent to which Parties have implemented the climate change elements of the inland waters programme of work has been assessed based on an analysis of fourth national reports to the CBD and second, third and fourth national communications to the UNFCCC.

1506. Based on an analysis of the 51 Parties who submitted their 4th National Reports as of 13 August, 2009, 23 Parties have reported on climate change activities specifically targeted at inland waters biodiversity. An additional 17 Parties reported on activities related to climate change and inland waters biodiversity through their National Communications to the UNFCCC.

1507. Examples of activities reported by Parties include:

- Assessments of the vulnerability of inland waters to the negative impacts of climate change (including the establishment of long-term monitoring programmes);
- Programmes for the restoration of degraded wetlands;
- Halting development in flood plains;
- Improved fisheries management;
- The development of water resource management plans for threatened wetlands;
- Improved water management including the establishment of catchment or river basin management plans;
- Reducing threats to people and livelihoods from the negative impacts of climate change on inland water ecosystems;
- The expansion of protected areas networks for inland water ecosystems; and
- Analysing the role of inland water ecosystems in climate change mitigation.

1508. The vast majority of Parties reported on adaptation activities and vulnerability and impact assessments with only 4 Parties reporting on activities linking climate change mitigation to inland waters biodiversity although a number of additional Parties did recognize the need to enhance this link.

1509. In reporting on activities, Parties also identified a number of barriers that are preventing the further implementation of the climate change elements of the inland waters programme of work. These include:

- The need for enhanced international cooperation in inland waters management, especially when considering trans-boundary water ways and migratory pathways;
- The need for further financial and technical resources, including capacity building;
- The need for better information on the projected impacts of climate change on inland waters biodiversity; and
- The need for a better understanding of the links between inland waters biodiversity and climate change mitigation.

1510. As a generality, in most regions, including the developed world, the most promising strategy is to enhance the adaptive potential of inland waters biodiversity in order to achieve better human development outcomes. There is a clear opportunity to switch to a more positive dialogue – to seek and implement biodiversity (ecosystem) solutions to water resources problems, including with respect to climate change.

1511. Some specific measures that would enhance the adaptive capacity of inland waters biodiversity include:

- Identifying those species and ecosystems that are particularly vulnerable to the negative impacts of climate change;
- Enhancing and/or restoring the connectivity of inland water ecosystems to allow for natural migration of species;
- Consider, under extreme circumstances and appropriate risk analysis, assisted migration;
- Restoring the functions and services of degraded inland water ecosystems, many of which are required for meeting climate challenges; and

- Expanding the network of protected areas incorporating better inland water ecosystem coverage and incorporating improved attention to inland water ecosystems within terrestrial protected areas.

1512. A number of Parties have already integrated the conservation and sustainable use of inland waters as a part of national adaptation programmes. For example, within the UNFCCC's National Adaptation Programmes of Action the following priority activities have been identified:

- Lake restoration (Burkina Faso);
- Protection of Lake Tanganyika from agriculture and overgrazing on lake bed during the dry season (Burundi);
- Community-based wetland management and rehabilitation of wetlands (Ethiopia; Lesotho; Sierra Leone);
- River basin management and restoration (Haiti; Malawi).

1513. Such adaptation activities present opportunities for the further conservation and sustainable use of inland waters biodiversity by raising the awareness of the ecosystem goods and services provided by inland waters and by mobilizing additional financial and technical resources for the activities already included in the programme of work.

1514. While some Annex 1 countries are already reporting on emissions from land use change in inland waters, there are also proposals on ways and means to promote the conservation and restoration of inland waters in developing countries as a contribution to climate change mitigation.

1515. The formulation of conservation plans that follow an integrated water management approach has been the target of their efforts, with special attention to the design of measures that reduce poverty of local communities. These subjects are of course inter-related; for example institution building and/or environmental flows can both be mechanisms to address an over-arching objective of poverty reduction.

1516. Through the implementation of IWRM projects, WWF, IUCN, TNC and WI are successfully influencing water policy and strengthening water governance at different levels. Positive results have been more evident in projects where governmental institutions had an active participation and where the decision for integrated water management was a result of political will (often prompted by crisis). Through their IWRM projects, these NGOs are also acting towards climate change adaptation. One aspect that requires more attention, however, is considering the impact of climate change on river flows, especially when conducting environmental flow assessments that are the base for developing IWRM plans. TNC and WWF are starting to take this into account more explicitly in their IWRM projects by including climate change vulnerability assessments. Yet, this practice needs to be further applied.

1517. Conservation International has a particular approach to deal with the impacts of climate change on freshwater ecosystems. Based on the strong relationships among climate change, forest and freshwater ecosystem services, this NGO is implementing water funds and carbon forest projects worldwide. These projects are based on payment for ecosystem services and carbon markets mechanisms, with conservation agreements as the main tool. Similar projects are being also implemented by The Nature Conservancy, which is leading the creation of an innovative water-related certification programme that is expected to have major impacts on the protection of water and freshwater ecosystems. WI is also taking advantage of carbon mechanisms to implement a Global Peatland Fund to support projects that protect peatlands and avoid the emission of large quantities of carbon dioxide from these wetlands.

1518. Notably, whilst the overview of activities of these NGOs looked specifically for outcomes for inland waters, a considerable number of highly relevant and beneficial projects are not dealing with water directly. This reflects the fact that the drivers of inland waters biodiversity (and ecosystem services) loss are driven by land-based activities. Many projects and programmes therefore deal with land-based interventions, with a strong focus on cross-sectoral and institutional coordination. This supports a related finding of this in-depth review that the major solutions to addressing the needs under this programme of work rely on building relevant approaches in and across other programme areas.

1519. Examples of such approaches are successfully demonstrated through the 50 NGO case studies included in the aforementioned section of this review.

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