UNEP

CBD

Convention on Biological Diversity

Distr.
GENERAL

UNEP/CBD/SBSTTA/14/INF/3
11 April 2010

ENGLISH ONLY

SUBSIDIARY BODY ON SCIENTIFIC, TECHNICAL AND TECHNOLOGICAL ADVICE
Fourteenth meeting
Nairobi, 10-21 May, 2010
Item 3.1.2 of the provisional agenda*

IN-DEPTH REVIEW OF THE PROGRAMME OF WORK ON THE BIOLOGICAL DIVERSITY OF INLAND WATER ECOSYSTEMS: SUMMARY OF BACKGROUND INFORMATION AND KEY MESSAGES

Note by the Executive Secretary

EXECUTIVE SUMMARY

This note is a summary of the detailed background document (http://www.cbd.int/waters/doc/sbstta-14/background-document) prepared for the in-depth review of the programme of work on the biological diversity of inland water ecosystems to be undertaken at the fourteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice. It is provided to support document UNEP/CBD/SBSTTA/14/3, which is effectively the Executive Summary of this information.

* UNEP/CBD/SBSTTA/14/1.

/…

TABLE OF CONTENTS

I. INTRODUCTION

1. This note provides a summary of, and key messages arising from, the in-depth review of the programme of work on the biological diversity of inland water ecosystems to support the considerations of this subject by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) at its fourteenth meeting (document UNEP/CBD/SBSTTA/14/3).

2. The implementation of the programme of work on the biological diversity of inland water ecosystems was last reviewed at the eighth meeting of SBSTTA, resulting in recommendation VIII/2; which led to decision VII/4 in which the Conference of the Parties adopted the revised programme of work. In annex II of decision VIII/10, the Conference of the Parties decided to undertake an in-depth review of this programme of work at its tenth meeting.

3. Guidelines for an in-depth review process were provided by the Conference of the Parties in decision VIII/15, annex III. In addition, in decision VIII/9, the Conference of the Parties decided to consider the findings of the Millennium Ecosystem Assessment (MA) in the implementation and future review of the programmes of work and cross-cutting issues under the Convention (para. 12); requested SBSTTA to take note in its deliberations of the linkages between biodiversity and relevant socio-economic issues and analysis, including economic drivers of biodiversity change, valuation of biodiversity and its components, and of the ecosystem services provided, as well as biodiversity's role in poverty alleviation and the achievement of the Millennium Development Goals (MDGs) (para. 21); and requested SBSTTA to draw upon the lessons learned from the MA process (para. 22).

4. In paragraph 11 of decision VII/29 on technology transfer, the Conference of the Parties requested SBSTTA to identify methods to increase the contribution of organizations, communities, academia and the private sector to the development and dissemination of scientific knowledge and the diffusion of technology needed for the implementation of the work programmes under review.

5. In decision IX/9, the Conference of the Parties outlined a process for the revision of the Strategic Plan, including paragraph 6(b) which requested the Executive Secretary to, *inter alia*, prepare a synthesis/analysis of issues relevant to the revision and updating of the Strategic Plan, drawing upon the results of the in-depth reviews of the Convention's programmes of work. The current review therefore included attention to relevant needs in relation to the Strategic Plan.

6. The review considered, *inter alia*, the following sources of information: extensive inputs from the Ramsar Convention on Wetlands and its Scientific and Technical Review Panel (STRP), including a detailed assessment of the status and trends of inland water biodiversity and progress towards the 2010 target using indicator data; the findings of the Third World Water Development Report (WWDR3), which includes inputs from all the 26 United Nations member organizations and programmes and the 17 partners of UN-Water; the findings of the Inter-Governmental Panel on Climate Change (IPCC) and various other regional and global assessments of climate change; the inputs of five non-governmental organizations (NGOs) working in the field (including 50 case studies of their activities); national reports to the Convention on Biological Diversity, the Ramsar Convention on Wetlands and the UNFCCC; and the findings of peer-reviewed literature and scientific assessments.

7. The full information reviewed is compiled, and its sources cited, in a detailed background document, made available for reference purposes at http://www.cbd.int/waters/doc/sbstta-14/background-document. This note summarizes this information and highlights many of the key messages derived.

II. WATER AND THE WATER CYCLE

8. ***Water is central.*** The key message of the review is that ***increased attention to water is required across the Convention on Biological Diversity*** because: ***it is an ecosystem service***, underpinned by

biodiversity; ***it is critical for ecosystem functioning***, and changes in its availability and quality affect all terrestrial, inland water and coastal ecosystems; and ***it is the strongest link between ecosystems and sustainable development***.

9. This section introduces these and some other key messages regarding water, which are elaborated further in subsequent sections. It also provides a brief introduction to the water cycle for non-specialists to help explain why it has such a high profile in the review.

10. The Earth's water cycle connects ecosystems, and those ecosystems drive the water cycle (Figure 1).

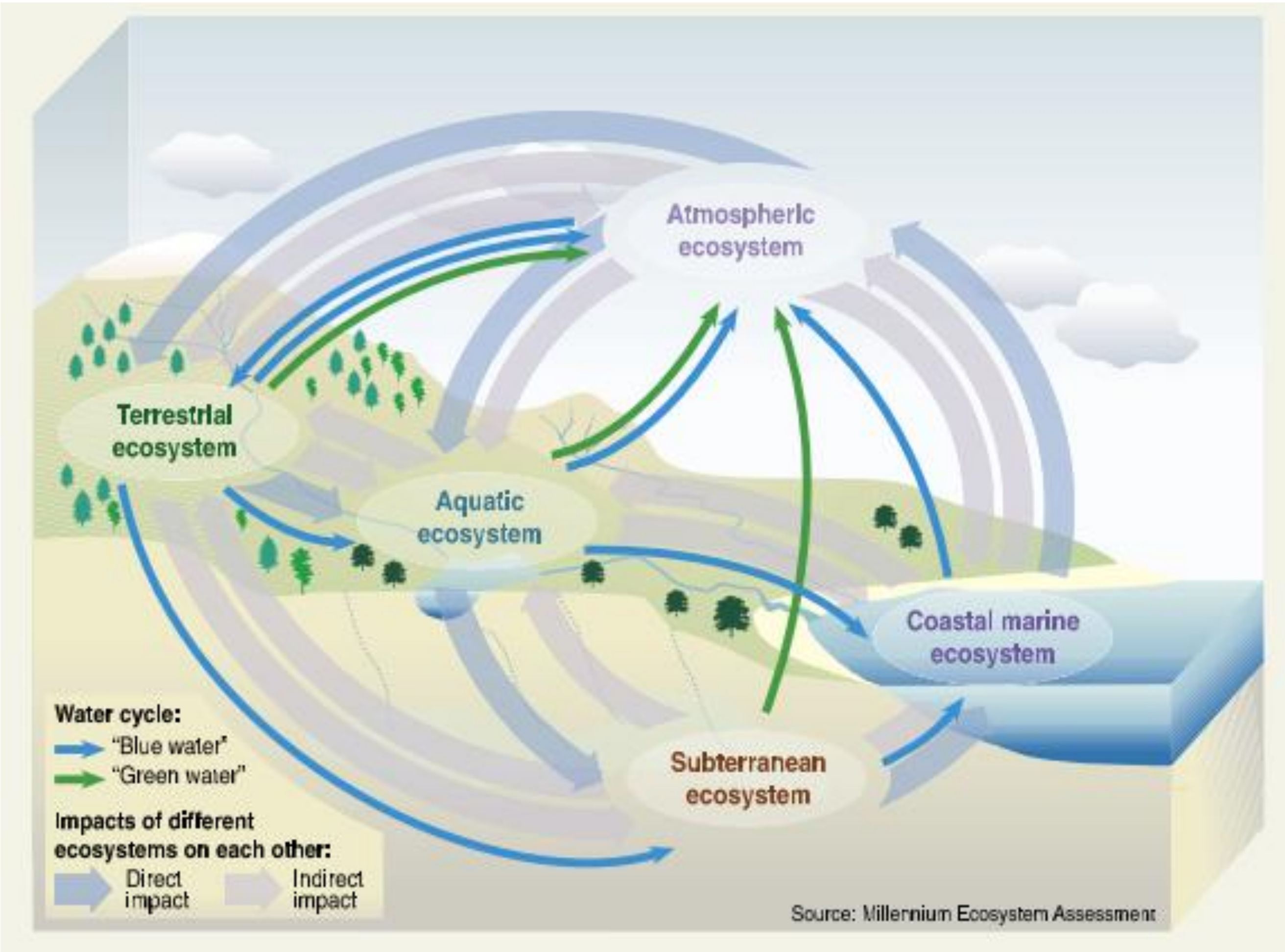

Figure 1: The water cycle on Earth.

11. Water availability for human use, and the quality of it, is a service provided by ecosystems and hence biodiversity. Ecosystems and hence biodiversity also depend upon it. Inland water ecosystems obviously play a key role in the water cycle and are impacted by changes in it. But terrestrial ecosystems are also part of the same cycle; they both influence it and depend upon it. For example, whilst water regulation is a critical service provided by wetlands, an average of 60 per cent of precipitation on land, which eventually recharges wetlands, arises from evapo-transpiration through terrestrial vegetation, particularly forests (Figure 2); and land cover and uses determine how the water reaches inland waters and its condition on arrival.

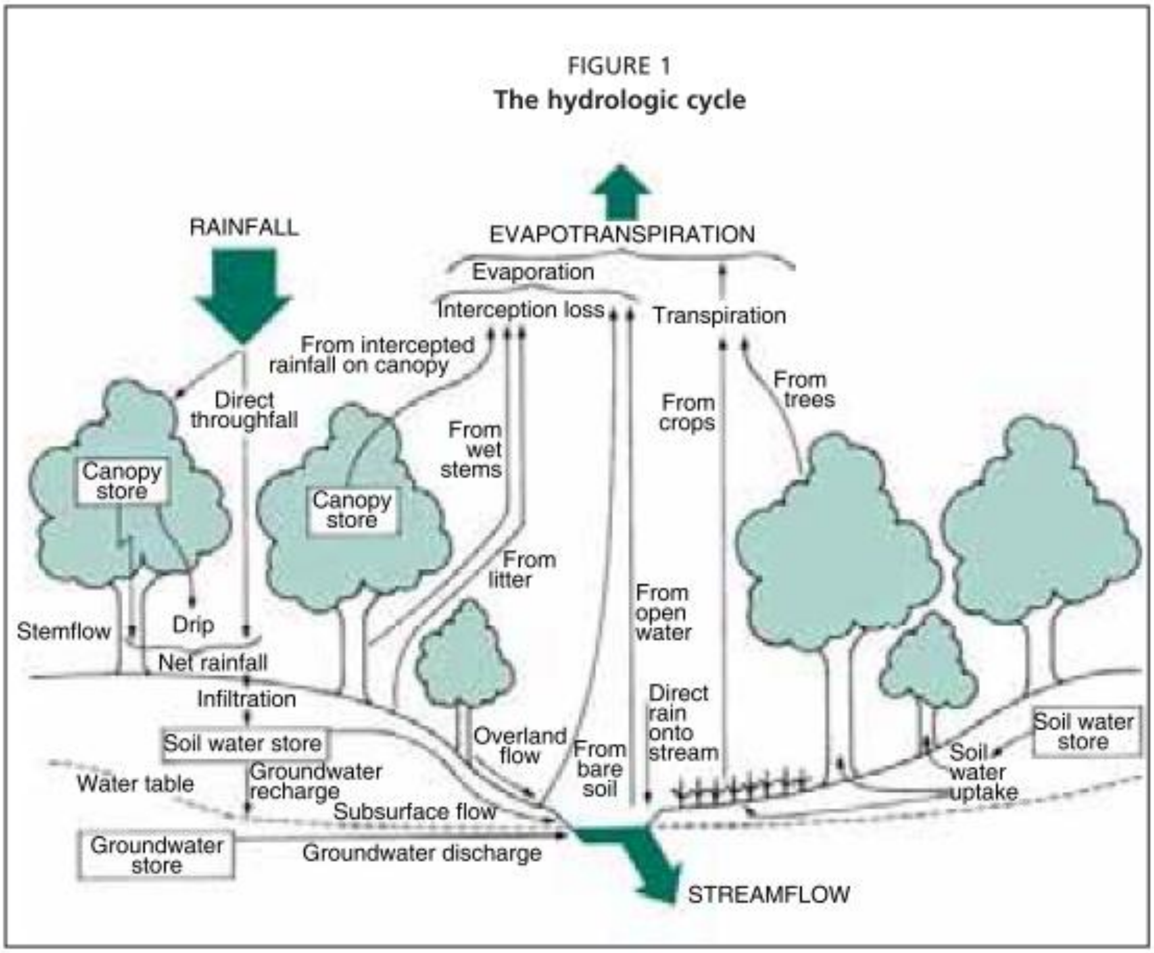

Figure 2: The role of terrestrial vegetation and surface, soil and groundwater in the water cycle (from FAO Forestry Paper 155, Forests and Water).

12. One result of these inter-relationships is that "inland waters biodiversity" cannot be considered independent to that of terrestrial (or coastal) regions; certain fauna or flora might be considered independently, but not the ecosystem upon which they depend.

13. ***Water removes ecological, social and economic boundaries between areas of interest of the Convention on Biological Diversity.*** "Water" represents an important context in which "the biological diversity of inland water ecosystems" should be viewed. It also illustrates the way in which the water cycle creates inter-dependency between all terrestrial and freshwater ecosystems, and many aspects of coastal ecosystems, forging linkages across most, if not all, of the programmes of work under the Convention on Biological Diversity. Humans also depend on this water, directly or indirectly, for almost all aspects of their lives, including for drinking, food production, sanitation, most social and economic activities, energy and cultural well-being. This forges strong links between ecosystems and sustainable development. Because of these dependencies, humans also interfere with the water cycle through a multitude of water and land-use activities, resulting in significant changes to the biodiversity that underpins ecosystem functioning.

14. The water cycle, and hence freshwater resources, is today defined by the interaction of natural and human factors. It is insufficient to view water from purely a biogeophysical perspective, as humans are deeply embedded in 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 fresh water, 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 (WWDR3 2009).

15. ***Water is central to sustainable 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 some are already evident.

16. ***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 agreed by many to be the primary natural resource challenge,*** exceeding the challenge of energy supply, indeed also the challenge of climate change. In addition, ***climate change impacts ecosystems and people primarily by changing the water cycle.***[1] Adapting to climate change is primarily about water security, for both ecosystems and people.

17. ***Water presents the Convention with considerable opportunities.*** The documented approaches to major resource issues identified in this review are at the forefront of the Convention's interests. These include, as examples, how the relationship between biodiversity and water:

(a) Illustrates how biodiversity use can save a lot of money (on the scale of billions of dollars, even in small watersheds);

(b) Provides one of the best arguments, and most easily understood if well articulated, to influence economic policy;

(c) Offers potential low-cost solutions to address vulnerability of countries to disaster risk, the continued existence of which sustains a 14 per cent reduction in GDP in the least developed amongst them;

(d) Shows the contribution biodiversity can make to post-conflict social and cultural reconstruction (including in Iraq);

(e) Is a primary motivation for the protection and management of forests, globally;

(f) Is a successful basis for effective institutional reform and cross-sectoral dialogue;

(g) Promotes enhanced international cooperation amongst riparian river States, leading to sustained conflict reduction and increased stability and prosperity;

(h) Generates the clearest links between cities and their dependence upon biodiversity and ecosystem functioning beyond their boundaries;

(i) Is a major driving force behind policy shifts in major countries towards ecosystem rehabilitation and the wiser use of natural infrastructure;

(j) Provides some of the best examples of payments for ecosystem services (PES) schemes, and well advanced incorporation of PES approaches into regional water conventions compared to the progress in the Convention on Biological Diversity;

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

(k) Offers clear opportunities for South-South cooperation;

(l) Is a strikingly obvious link between biodiversity, poverty reduction and sustainable development;

(m) Offers engagement with a much broader constituency on a prominent issue (one survey shows that three times as many Americans worry about water compared to climate change, and it is probably the natural resource issue highest on the world political and business agendas, or soon will be);

(n) Provides the far clearest platform linking the objectives of the Multi-lateral Environment Agreements, in particular the UNCCCD, UNFCCC, CBD and Ramsar Convention; and

(o) consistently generates the highest economic values in comparative assessments of ecosystem services across all biomes.

III. STATUS AND TRENDS IN BIODIVERSITY, ECOSYSTEMS AND DRIVERS OF CHANGE

A. Indirect drivers of change

18. ***The indirect drivers of change must be addressed,*** consistent with the findings of the MA and the Third Global Biodiversity Outlook (GBO3). 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.

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 water quality, 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 fresh water of about 64 billion cubic metres a year. The distribution of age and gender also can have considerable implications for consumption and production patterns.

21. ***Sustainable water supplies for urban populations, and reducing their water footprints, is already a major global challenge.*** 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 per cent of urban humanity. But in spite of the great deal of attention that is given to mega-cities, most of the world's urban populations actually live in cities with fewer than 500,000 inhabitants. The growth of small and mid-size cities will have significant impacts on water resources.

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 a finite resource. The outcome is already evident: escalating overexploitation and pollution of aquatic ecosystems, as each sector or user group tries to satisfy its own water needs at the expense of others.

23. ***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"). 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. Global water saving as a result of international trade of agricultural products has been estimated at 6 per cent of the global volume of water used for agricultural production. An estimated 16 per cent of the existing problems of water depletion and pollution in the world relate to production for export (Hoeskstra and Chapagain 2008). 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 elsewhere in this review, China is already making major positive 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 (Blue Plan 2007).

26. Water footprints are estimated by multiplying the volumes of goods consumed (whether produced or manufactured) by their respective water requirement (Hoekstra and Chapagain 2007). 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 externalized. For example, that of European and North American citizens has been significantly externalized 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 per cent of the virtual water flows (water imports embedded in the crops transported) relate to the trade in agricultural products.

2. Domestic drinking water and sanitation

27. Globally, domestic uses of water, particularly for sanitation or drinking are not 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 at levels beyond the capacity of ecosystems to cope). Both topics are discussed further below in relation to water quality.

28. Rapid progress has recently been made in drinking water supply. All regions, except for sub-Saharan Africa and Oceania are on track to meet the MDG drinking water target. But progress towards access to sanitation is seriously lagging. If current trends continue, 2.4 billion people will still be without access to basic sanitation by 2015; more than 5 billion people, 67 per cent of the world population, may

still be without improved access to sanitation in 2030 (WHO/UNICEF 2008). This means that inland water ecosystems will continue to be expected to deal with this waste or transfer it into coastal ecosystems.

3. Agriculture and food consumption patterns[2]

29. ***Water is essential for the production of food and agriculture, by far the greatest global consumer of water, estimated at about 70 per cent 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 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 per cent. 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 water availability 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 to 90 per cent by 2050, an unsustainable situation (Comprehensive Assessment 2007).

31. In the Near-East, irrigation water requirements are expected to grow from 64 per cent to 83 per cent of renewable water resources – 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 per cent, with total water withdrawals representing the equivalent of 92 per cent 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 per cent of all the water withdrawn for agriculture is consumed by crops through transpiration, a substantial share of the unused water returns to 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 (Comprehensive Assessment 2007). 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 2,000-16,000 litres, a kilo of cotton 2,000-8,700 litres, and one cup of coffee 140 litres. According to the Comprehensive Assessment (2007), 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

[2] A major reference source for this section is the Comprehensive Assessment of Water Management in Agriculture 2007.

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 (Comprehensive Assessment 2007).

35. To meet the future food needs and 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; Saudi Arabia is one (El Hadji 2008).

38. Today's food production and environmental trends, if continued, will lead to increasing 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 per cent of total water demands globally. 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. ***Energy and water are inextricably linked.*** The power-water nexus is complex. 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 annual volume of water used in Argentina, of which nearly half evaporates in Egypt (WWDR3 2009). 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 uses, with a final consumption (evaporation) estimated at around 5 per cent. The cooling of nuclear plants, in particular, 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 per cent of water management costs and 14 per cent 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. There are a number of complex, and partly competing, challenges associated with energy production, environmental issues and water resources management. In its 2007 World Energy Outlook, the International Energy Agency (IEA) 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. Electricity generation from hydroelectric and other renewable energy resources is projected to increase at an average annual rate of 1.7 per cent from 2004 to 2030, representing an overall increase of 60 per cent through 2030. This increase is highly significant with respect to its potential impact on water resources.

44. Around 10 per cent of the total energy supply comes from biomass, out of which some 80 per cent 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 per cent 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 per cent, is actually used to produce liquid biofuel for transport and currently accounts for less than 2 per cent of the total needs of transport energy worldwide.

45. 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 voiced as an explanation of the current hostility of some of the most arid countries to the global trends towards increased reliance on bio-energy (WWDR3).

46. Like food security, energy security represents a necessary pathway towards GDP growth. The world will need almost 60 per cent more energy in 2030 than in 2002 (IEA 2007).

47. 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 per cent 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 (Wolff *et al.* 2006). But industrial uses put significant additional pressure on water resources through the impacts of the wastewater discharged and their pollution potential.

B. Direct drivers and ecosystem changes

48. ***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 per cent of suitable inland water systems had been drained for intensive agriculture in Europe and North America, 27 per cent in Asia, and 6 per cent in South America. In New Zealand recent estimates are that 90 per cent of wetland area has been lost since historical times (Ausseil *et al.* 2008). Canada's fourth national report to the CBD provides some estimates of wetland loss. For example, for six out of nine categories and regions assessed, historical loss (up to the middle of the 20th century or thereabouts) exceeds 60 per cent, and 80 per cent for three regions, and 96 per cent of wetlands near major prairie urban centres. Since the 1970s wetlands loss has continued in five selected areas, and one lost a further 20 per cent in ten years (1989-1999).

49. Another example of the impacts of development on wetlands is provided by China where one report is that over 30 per cent of natural wetland area was lost in only 10 years from 1990 to 2000 (Cyranoski 2009). 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 reportedly 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. A recent review suggests that in the five years post 2000, the inland-water area has stabilized, possibly even increasing slightly (Xu *et al.* 2009).

50. 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. Changes in "inland water" area are also difficult to interpret based on published statistics unless they specify habitat types as there are often transformations from natural to artificial areas.

51. 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. For example, the surface area of Lake Chad shrank from 23 000 km^2 in 1963 to less than 2 000 km^2 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 3 m between 1929 and 1977, rose again by 3 m by 1995. Changes in total lake area over the last three 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.

52. The European Commission has published figures for the conservation status of habitats which show that around 70 per cent 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).

53. ***The construction of dams and other structures along rivers has resulted in fragmentation and flow regulation of the majority of the large river systems in the world***. The river fragmentation index is an indicator of the importance of the anthropogenic modifications of river regimes. Nilsson *et al.* (2005) studied 292 large river systems (representing 60 per cent of the world’s river runoff) and recorded that over 50 per cent 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 per cent by area being unaffected. 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.

54. ***Wetland protected areas are degrading and under increasing threats.*** 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. 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. The MedWet (Mediterranean Wetland) Initiative reports that for wetlands in general, not just Ramsar Sites, the most frequent negative drivers are urban development/infrastructure (featuring in 57 per cent of responses), urban/industrial pollution (50 per cent), tourism (45 per cent), water abstraction (43 per cent), agricultural intensification (43 per cent), agricultural run-off (40 per cent) and hunting (42 per cent). 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 per cent were recorded as subject to “high” threat levels, 18 per cent to “very high” levels, and just 6 per cent to “low” levels.

55. 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: 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 biodiversity target.

56. Information at national levels supports the observation on trends and drivers. For example, managers of 15 (54 per cent) 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 (source – Ramsar National Reports).

57. 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 infrastructure/agriculture/water-related threats is common to both the Ramsar National Reports and the Important Bird Area IBA assessments. ***No regions, and probably few if any individual countries, appear to be exempt.***

58. 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 per cent of about 20 x 109 t y^{-1} of global suspended sediment discharge is thought to be trapped by reservoirs (Vörösmarty *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.

The change in reservoir storage has probably 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 this period (although not in proportion to the total water available).

59. ***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.***

1. Water quality

60. ***In spite of improvements in some regions, water pollution in general is on the rise globally*** (WWDR3). 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 as a result of both changes in flow and inputs of chemical and biological waste from human 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.

61. Poor water quality is both a major direct threat to the sustainability of inland waters and an effect of unsustainable activities 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.

62. 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 with 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.

63. 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.

64. 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. 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.

65. 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 and pesticides, mainly from non-point sources in more affluent counties (particularly from agriculture) but point source contamination continues to be a major problem elsewhere. 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 per cent 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 per cent in at least eight of the regions (UNEP-GPA, 2006).

66. Water quality is not mainly an issue for developing countries. A recent study on drinking water in a country in Western Europe considered that more than 3 million people (5.8 per cent of the national population) were exposed to drinking-water quality that does not conform to WHO standards (for nitrates, above 50 ml/g were found for 97 per cent in groundwater samples[4].

67. 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 (Blue Plan 2006).

68. 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 (and this is confirmed through CBD third and fourth national reports).

69. 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.

70. 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 per cent to 90 per cent (WWDR3 2009).

71. Non-point source 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.

72. 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 and 1990 (FAOSTAT). Other countries still exhibit escalating fertilizer use; use could be increased by 50 to 70 per cent by 2025 (Blue Plan 2007). Information on pesticide consumption is less available, although pesticide consumption has stabilized in France (the world's second-biggest user).

73. 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 United Nations Economic Commission for Europe (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 top

[4] Ministere de la santé et des solidarités, République Française, l'eau potable en France, 2002-2004, eau et santé, guide technique H2O).

tropic-level fish. 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", 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 (Bagchi 2007).

74. 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., residues of birth-control pills, 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.

75. 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 biological oxygen demand (BOD), making assessments of progress since 2000 more difficult.

76. 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 per cent of sewage in developing countries is discharged untreated, thereby polluting rivers, lakes and coastal areas. Almost 80 per cent of diseases in developing countries are associated with water, causing about 1.7 million deaths every year (WHO and UNICEF 2008).

77. 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 per cent) 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 (Green *et al.* 2004). 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 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.

78. The Biodiversity Indicators Partnership has developed the “Water Quality Index for Biodiversity” (WQIB), which incorporates additional parameters relevant to 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.

79. Average nitrate concentration in European rivers has decreased by approximately 10 per cent since 1998 (European Environment Agency, www.eea.europa.eu). 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 per cent reduction in the average concentration, and a statistically significant decrease at 38 per cent of lake monitoring stations (4 per cent showed an increase). The overall trend is thought to be partly due to lower nitrogen oxide 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 per cent, 8 per cent and 6 per cent in the western, northern and eastern countries, respectively.

80. 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 per cent 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 per cent 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 (European Environment Agency, www.eea.europa.eu).

81. 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.

82. Industrial wastewater, expressed in terms of the volume of 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 localized 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 to 20 per cent, continuing a trend observed between 1970 and 1995 (MA 2005).

83. 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 per cent 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 (Vörösmarty *et al.* 2003).

2. Trends in water use

84. ***The ecological limits of water available for abstraction have probably already been reached.*** 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 agriculture-based economies. 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” (Comprehensive Assessment 2007). There are sound reasons to conclude this is already at the limits of ecological sustainability (Molden 2009). However, it is important to reflect that "nature" is still the most important user of water and evapo-transpirates an estimated 70,000 km^3/year from forests, natural vegetation and wetlands. It is inevitable that as water for humans becomes scarcer, human demands 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 becoming increasingly critical that policies and management are better informed about how the hydrological cycle functions and the role of ecosystems and biodiversity in sustaining it.***

85. 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 (WWDR3).

86. ***In 2030, 47 per cent of the world population will be living in areas of high water stress*** (OECD 2008). This statistic is alarming enough, but the environment (and biodiversity) experiences water stress long before people do.

87. 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 per cent of the available resources. But a very different reality exists inside the country’s boundaries and indicates that water stress and shortages exist on large regional scales.

88. 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.

89. 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), 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.

90. ***The groundwater component of the water cycle has already been subject to massive change and is subject to over-exploitation at regional/continental scales.*** 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 level of biodiversity and migratory birds. Excess use of groundwater in many large coastal cities (e.g., Lima, Jakarta, Chennai, Tel Aviv) has depleted local aquifers, allowing seawater to intrude and salinize them.

91. Groundwater already represents 20 per cent of total water use in agriculture and is increasing fast, particularly in dry areas (Comprehensive Assessment 2007). The development of the energized 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 and Po). 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. Subsidized rural electrification in South Asia has been a key driver of groundwater use within existing irrigation demands, especially in “dryland areas” with no surface water services, in addition to bankrupting government energy suppliers (Shah *et al.* 2006).

92. 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 recognized interrelation between groundwater and urbanization 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).

93. Groundwater flow processes are usually much slower than atmospheric or surface water processes, often by two or three 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 50 years, it has become very popular to pump groundwater for irrigated agricultural production. Some 70 per cent of the global groundwater abstraction is thought to be used for irrigation, where enormous amounts of water are used 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 salinization.

94. Sharp points of competition over groundwater resources between urban and rural users are also now becoming more apparent. Expanding municipalities and light industries 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.

95. ***The changes occurring threaten biodiversity at all levels and across most ecosystems and biomes.*** For example, groundwater depletion and contamination (through direct use, without considering additional climate change impacts) threatens terrestrial vegetation (forest included), and the terrestrial fauna which depends upon it, sometimes at continental scales. The implications of these considerations extend to the undermining of sustainable development. They also question the sustainability of climate change mitigation efforts through REDD.

96. Competition for water exists at all levels and is forecast to increase with demand in almost all countries. Water management around the world presents major shortcomings in terms of performance, efficiency and equity (WWDR3 2009). Water-use efficiency, pollution mitigation and implementation of environmental measures are low in most sectors. The conflict between agriculture and cities (urban and domestic sectors) is paramount. This reflects the fact that half the world already lives in cities, and over 80 per cent will do so by 2030, yet agriculture is generally the largest user of water.

C. Status and trends of inland waters species[5]

97. Available data show that the 2010 biodiversity target, and most sub-targets, for inland waters have not been met; the most robust data indicate an acceleration away from the 2010 target.

98. 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 per cent of all vertebrate species diversity is concentrated close to or in inland waters. Some 40 per cent 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.

99. ***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 faster than those dependent on other ecosystems.

100. ***Inland water species have an overall worse status than the terrestrial and marine species studied.*** The results in the 2008 Living Planet Index show an average decrease of 35 per cent in the populations of the inland waters/freshwater species studied over the years 1970-2003 (with 95 per cent confidence limits ranging from 10 per cent to 52 per cent); the index figures show average declines of 28 per cent and 14 per cent for terrestrial and marine biomes 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.

---

5 Information in this section is largely from an assessment undertaken for the in-depth review by the Secretariat and Scientific and Technical Review Panel of the Ramsar Convention, contained in section II of the background document available at: http://www.cbd.int/waters/doc/sbstta-14/background-document

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

102. 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 per cent) of the world’s waterbird populations for which reliable trend data are available, overall 40 per cent of these are in decline, 17 per cent increasing and 43 per cent stable (the picture varies regionally and is worst in Asia, where the proportion of all waterbird populations in decline is 59 per cent). Some long-term country-level studies paint an even more dramatic picture. For example, a recent review of long-term trends in shorebird populations in eastern Australia reports that migratory populations have dropped by 79 per cent over a 24-year period, although this decline is attributed to disturbances beyond Australia in the Asian fly-ways, and the habitats in question are coastal and may or may not be classified also as "inland", depending on definitions and the influences in play. The true global situation may be still worse than that portrayed.

103. The 2010 biodiversity target refers to a change in the rate of biodiversity loss. 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 to 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.

D. Climate change[6]

104. Climate change is an additional driver of change and, by and large, amplifies the same direct and indirect drivers, as outlined above; this includes the socio-economic and political drivers in play. Most sections of the background document address climate change; section VI is devoted specifically to it. For current purposes some clear headline messages are derived:

a) The impacts of climate change occur mainly through changes in the water cycle, and this is the key consideration for biodiversity, ecosystems and societies[7]; this ***includes most changes observed or predicted for terrestrial ecosystems, and many in coastal areas;***

b) The impacts of climate change on humans are due to ecosystem changes – these are largely driven by water-related changes;

c) Adaptation to climate change, therefore, requires mainly water-related responses;

d) Unsustainable water use and degradation 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

e) Responses to climate change begin by better recognizing these realities.

105. The findings of the IPCC confirm that the changing water cycle is central to most of the climate change-related shifts in ecosystems and human well-being. The IPCC Fourth Assessment Report lists 32

6 The information in this section, unless otherwise stated, is derived mainly from the IPCC Fourth Assessment Report and its Technical Report *Climate Change and Water*, and additional inputs from Ramsar STRP and WWDR3 (see the background document section VI).

7 Acidification, caused by carbon dioxide directly, is an exception.

examples of major projected impacts of climate change amongst eight 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 IPCC technical report on climate change and water (2008) is more specific, concluding unambiguously, *inter alia*, that: ***"the relationship between climate change and freshwater resources is of primary concern and interest"***; so far, ***"water resource issues have not been adequately addressed in climate change analyses and climate policy formulations"***; and, according to many experts, ***"water and its availability and quality will be the main pressures, and issues, on societies and the environment under climate change".*** [8] An expert study for the 15th Session of the Commission on Sustainable Development came to similar conclusions [9].

106. Advocacy on climate change has brought to the fore a dire projection of a worsening water situation – an additional driver, 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 (WWDR3 2009).

107. The fundamentals about water and climate change are such that they have promoted consensus in UN-Water, representing all 26 United Nations members and 17 partners dealing with water, to present a message to the 15th Conference of the Parties to the UNFCCC 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”.

108. 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 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. Climate change requires a holistic ecosystem approach, and the role of water is paramount in identifying inter-linkages. Commentators have remarked that ***"climate change mitigation is about carbon – adaptation is about water"***; although noted below that there are important inter-relationships between carbon and water.

109. ***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.

110. 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 is 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

---

8 Intergovernmental Panel on Climate Change. 2008.Climate Change and Water. Technical Paper of the IPCC. Document IPCC-XXVIII/Doc.13 (8.IV.2008); pp. 7 – 8.

9 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.

salinity, and 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.

1. Changes to ecosystems and species

111. Inland water ecosystems provide a disproportionate amount 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.

112. Observed and potential impacts on inland water (and coastal) ecosystems are obviously substantial and well documented; these are listed in the background document, and some are also listed in the in-depth review of the programme of work on biodiversity and climate change (document UNEP/CBD/SBSTTA/14/6, and its supporting information documents).

113. 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.

114. 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 who are dependent on seasonal glacial meltwater for sustainable water supplies. Over one sixth of the world's population lives in areas where surface water is predominantly 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.

115. 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 ranges up to 35 460 km^3 or an equivalent of 8.8 m sea-level rise (Zhang *et al.* 1999). 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.

116. Most climate change impacts on land, because they are both mediated through and have feedback mechanisms to the water cycle, have implications for inland water ecosystems. Desertification, for example, is a process driven by the loss of water from land which contributes to reduced cycling of water through inland water ecosystems. Land changes are therefore relevant to inland waters.

117. 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 a 2-degree warming, 60-80 per cent of species may be lost in the Southern Mediterranean, while the Cape Fynbos in South Africa may lose 65 per cent 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 experiencing more rapid 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[10].

118. Specific impacts on wetlands are projected to include:

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

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

(c) Decreased water availability in many arid- and semi-arid regions; and

(d) 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 evapotranspiration and groundwater levels are uncertain.

119. Overall, it is projected that the impacts on wetlands will be more adverse than beneficial (Finlayson *et al.* 2006). Inland and coastal systems are likely to experience major and early impacts. These include identifiable changes in coastal wetlands:

(a) Increased levels of inundation, storm flooding, accelerated coastal erosion, seawater intrusion into fresh groundwater;

(b) Encroachment of tidal waters into estuaries and river systems, and elevated sea surface temperatures and ground temperatures; and

(c) 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.

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

121. Increased water demand for consumption and irrigation as a result of climate change will place increased pressure on inland water systems. 54 per cent of accessible runoff is already appropriated for

[10] The rigidity of the IPCC's analysis of glacier retreat for the Himalaya region has recently been questioned, although not its analysis of glacial retreat globally (*The Economist*, print edition 21 January 2010).

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 is estimated to range from 1 to 3 per cent by the 2020s and 2 to 7 per cent by the 2070s.

122. 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.

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

124. 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 per cent at high latitudes, and decreased by 10-30 per cent 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.

125. 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 (i.e., drinking water, aquaculture, recreation) and ecosystem functioning/biodiversity.

126. 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.

127. 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 to 19 per cent by 2050 in the upper Murray-Darling Basin in Australia, for example. Salinization of water resources is also predicted to be a major hazard for island nations, where coastal seawater intrusion is expected with rising sea levels.

128. 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.

129. 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 Arctic 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.

130. 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.

131. 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.

132. For inland waters, water temperature change, globally, is a secondary concern to water cycle changes (but not necessarily locally). Water temperature increases 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 (this is also reported by a number of Parties in their 3rd and 4th National Reports). Increased water temperatures are also affecting the growth rates and reproduction of organisms and species.

133. 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 per cent of the Earth land mass is wetland, 24 per cent 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.

2. Shifts in ecosystem services

134. The impacts of climate change on inland waters will have varied effects on ecosystem services and human well-being but the trend will be predominately negative overall. Wetter conditions in parts of southern South America have 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.

135. 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 considerations relating to the direct use of biodiversity in terms of global repercussions (Foote and Krogman 2006).

136. 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 to cease to perform these functions, at least seasonally. This is especially of concern for seasonal flows in savannah regions in sub-Saharan Africa.

137. 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.

138. 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 (WWDR3 2009).

139. 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.

140. Among the recent extreme high-impact water-related events are: floods in Europe in 1997 and 2002, and floods in China in 1996 (US$ 26 billion in material damage) and 1998 (US$ 30 billion in material damage). Destructive floods observed in the last decade all over the world have led to record-high levels of 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 (WWDR3 2009). 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 of this in-depth review is that almost always, 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.

141. 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 mitigation 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.

142. Adaptation to climate change adds a critical challenge for all countries, particularly for cities in coastal zones, 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.

143. 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 experience would be the most exposed.

3. Climate change mitigation and influences on carbon fluxes

144. ***Mitigation efforts must pay more attention to inland water ecosystems—and their role in both the water and carbon cycles—in order to sustain their mitigation benefits and those provided by terrestrial carbon stores (including forests).***

145. The Economics of Ecosystems and Biodiversity (TEEB) notes that "The carbon cycle and the water cycle are perhaps the two most important large-scale bio-geological processes for life on Earth" (TEEB 2009).

146. 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 per cent increase in area between 1974 and 2000) may have resulted in a 58 per cent increase in lake CH_4 emissions (Walter *et al.* 2006).

147. Several studies have observed marked increases in the annual fluxes of dissolved organic carbon (DOC) in many temperate and boreal streams around the world (e.g., Worrall and Burt 2007). 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 (Smith *et al.* 2007). 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.

148. 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. The actions listed in the global Assessment on Peatlands, Biodiversity and Climate Change for the conservation and sustainable use of peatlands have already been noted by the Convention on Biological Diversity in decision IX/16, section D.

149. A significant danger lies in the lack of attention to the mitigation options for wetlands and the relative benefits of doing so. Where benefits are actually lower 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).

150. 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 which on biodiversity are already widely known; a significant amount of water is also 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.

151. 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, localized, even regional, deforestation, coupled with the overuse of water, is 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 (Lenton *et al.* 2008).

152. 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.

4. Adaptation

153. ***The primary adaptation response will be to increase water storage – essentially to prepare for the increased frequency and severity of both droughts and floods*** (WWDR3 2009)**.** 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. 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 (i.e., dam and levee construction) 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.

154. ***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.

155. ***It is absolutely critical that climate change adaptation strategies fully recognize the central role of water, are aware of the 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.

156. ***"Natural infrastructure" solutions to the problems faced in developing countries may be particularly promising – if for no other reason than the fact that financial resources are unavailable for capital-intensive fixes.*** Funding mechanisms for developing countries to cope with climate change, where the needs are broadly about development, are woefully lacking (WWRD3 2009). 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.

157. ***The picture emerges, in many places, of coastal wetlands being "sandwiched" in an unsustainable location.*** 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 per cent of coastal wetlands (National Academy of Sciences, http://www.koshlandscience.org/exhibitgcc/index.jsp); most projections for sea-level rise already exceed this. Clearly, responses to sea-level rise (and increasing severity of coastal storms) more than ever require a more holistic ecosystem-based approach. Where feasible, the flood and storm adaptation services provided by coastal wetlands need to be rehabilitated.

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

5. Economics and financing

159. ***The Stern Review (The Economics of Climate Change) recognized that climate change presents very serious global economic risks - often mediated through water.*** 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.

160. 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 up to US$ 22 trillion by 2030. Current GEF funds are several orders of magnitude too low to meet the projected environment-related needs.

161. 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.

162. 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 per cent reduction in GDP of low-income countries (Delli and Wolfe 2009). Such disasters are already occurring, and 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.

163. 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.

6. Challenges and contexts

164. 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.

165. One challenge to addressing climate change impacts for inland waters is that there is evidence that change has occurred already. In most cases, the change is 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 usually 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, though not all, these impacts are likely to be secondary to impacts already arising and projected through increasing demand on, and the over- and misuse 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.

166. Adapting to climate change is mainly about adapting water management. 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 recognize it as "important" – it is central. This must be explicitly stated and recognized. All 26 United Nations agencies and programmes dealing with water agree on this point and stated this explicitly in a one page message delivered to UNFCCC COP-15 stating, *inter alia,* that:

(a) Climate change adaptation is mainly about water;

(b) Water is the primary medium through which climate change influences the Earth's ecosystems and therefore people's livelihoods and well-being;

(c) Water resources and how they are managed impact almost all aspects of society and the economy;

(d) Adaptation to climate change is mainly about better water management;

(e) Adapting to increasing climate variability and change through better water management requires significant investments and policy shifts;

(f) 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; and

(g) 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.

167. The role of inland water ecosystems (wetlands) in this context is paramount. They provide services of enormous value that are 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.

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

169. In most regions, including the developed world, the most promising strategy is to enhance the adaptive potential of inland waters ecosystems 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.

170. 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.

7. Progress in related matters under the Ramsar Convention

171. The most detailed information on the carbon mitigation aspects of wetlands remains in relation to peatlands, as noted in paragraph 148. The ninth meeting of the Conference of the Parties to the Convention on Biological Diversity already considered the global Assessment on 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. 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 programme areas under the Convention on Biological Diversity). Some points made include, *inter alia*:

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

- 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 their climate change responses (such as revegetation, forest management, afforestation and reforestation) do not lead to serious damage to the ecological character of wetlands (para. 4); and

- 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).

172. 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: 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 requested it "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

173. 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:

(a) Existing risks and vulnerability for biodiversity, ecosystem services and the humans that depend on these; and

(b) The urgency of taking action in an already critical area.

174. Some further comments on the relevance of the scope of the programme of work are provided below and in the annex.

175. 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.

IV. IMPLEMENTATION AND RESPONSES

A. Progress towards Integrated Water Resources Management (IWRM)

176. ***Implementation of IWRM has had a slow start but substantial progress is now being made.*** IWRM is a cornerstone of the programme of work on inland waters under the Convention on Biological Diversity; and many of the ongoing and future needs relate to improved and more systematic implementation of IWRM. Examples of the impacts of the lack of effective IWRM continue to abound.

177. 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." 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 (UN-Water 2008).

178. A report by the United Nations University (UNU) 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" (UNU 2007). Based on a survey in 2007/08, the UN-Water report (2008) concluded that only 6 out of 27 respondents (22 per cent) from developed countries had fully implemented national IWRM plans. A further 10 countries had 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 lagged behind Asia and the Americas on most issues, although it was more advanced in stakeholder participation, subsidies and micro-credit programmes. Asia appeared to be leading in institutional reform. An additional survey finding was that indicators and monitoring could provide countries with a better assessment of their needs to advance IWRM implementation.

179. In the third national reports to the Convention on Biological Diversity, nearly 80 per cent 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 to explain 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.

180. 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. But it is emerging that progress in more holistic IWRM is now accelerating. 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 which also noted that its review on progress in the water and sanitation sector should go beyond mere stocktaking of IWRM efforts.

181. Reforms in water resource planning, policy and institutions are ongoing in developed and developing countries. Water reforms are also ongoing in many middle-income and least-developed countries in Africa, Asia and Latin America, many focusing on the principles of IWRM. An important rationale behind river basin management units is to improve coordination in water decision-making. The European Union Water Framework Directive is a stringent programme 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 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. Experience shows 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.

182. The Government of Quebec, Canada has deposited a draft water law that identifies river basins as the fundamental water management unit. Utilization of organizations and catchment bodies smaller than the river basin scale may be ineffective. Evidence from countries such as South Africa suggests that some may simply be too complex to implement, with it being difficult to clearly determine what benefits may be obtained. Several river basin organizations have concluded that implementation of river basin organizations is challenging, with considerable 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.

183. Activities in the São Francisco Basin in Brazil developed a watershed management programme for the Rio São Francisco Basin. The basin traverses five states in northeastern Brazil before discharging into the Atlantic Ocean. A subsequent comprehensive Diagnostic Analysis and Strategic Action Programme for the Integrated Management of the San Francisco Basin was completed in 2003, and is currently ongoing (see a case study on this in the background document section V).

184. 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 involvement and a focus on sustainability and climate proofing related to anticipated future developments. This example demonstrates 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.

185. 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.

186. 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 (Gyawali *et al.* 2006). 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.

187. Tunisia developed a national water-savings strategy for both urban and agricultural needs at an early stage of water planning. A rare commodity, water is traditionally used frugally and treated as a heritage resource, making Tunisia's approach a virtual "oasis" of sound water management (Treyer 2004). Because of this tradition, irrigation water demands have been stable for the past six 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. Wastewater 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 is also 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, an impetus for considering scenarios to address fundamental future water allocation choices.

188. 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. The sector is, however, beginning to recognize that \ the decisions by others outside the water sector determine how water will be used (WWDR3 2009).

189. Coordination with related sectors (i.e., land, agriculture, energy) 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. 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 operationalize water law on environmental protection (WWDR3 2009).

190. 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 (Velasco 2003). This new regulatory structure began in 1993 under a programme of survey and registration of ongoing abstractions and disposals, and required ten years, and a series of intermediate regulatory adjustments and massive information campaigns, to complete the process.

191. 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. Science is 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.

192. The Integrated Flood Management (IFM) approach considers the positive as well as the negative aspects of flood waters and considers flood plains a valuable resource. 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.

193. Hence, 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. These two needs are related in that the changing environment 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 socio-economic outcomes, the framework for being environmental change and its impact on the delivery of ecosystem 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. For this to happen, it must be recognized 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 that are the real key to outcomes for water and the biodiversity associated with it.

B. Economics and financing

194. ***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. WWDR3 (2009)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. ***The services provided by inland water ecosystems are central to the achievement of sustained economic well-being and therefore offer strong arguments for expanded attention to the programme of work***.

195. Awareness of the evidence of macro-economic returns of investments in water is growing, and likewise the impacts of not investing (Delli *et al.* 2009). Projections of average annual GDP growth rates across Africa drop by as much as 38 per cent 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 per cent. During the decade from 1992-2001, floods comprised 43 per cent 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 almost 14 per cent 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 per cent 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 disaster risk-reduction by rehabilitating natural infrastructure.

196. Further examples of the national economic costs 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 per cent reduction in GDP. The Mozambique floods of 2000 caused a 23 per cent reduction in GDP and a 44 per cent rise in inflation (Gichere *et al.* 2006). Inability to tackle hydrological variability in Ethiopia has been estimated to cause a 38 per cent decline in GDP and a projected 25 per cent increase in poverty for the period 2003–2015 (Biemans *et al.* 2006). 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 (United Nations 2008).

197. The cost of a series of major typhoons and resulting flood damage in post-war Japan has been estimated at between 5 per cent and 10 per cent of GDP (Japan Water Forum and World Bank 2005). 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 per cent. Much, but not all, of the response was through investment in physical infrastructure (i.e., dams, river embankments) 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 has also been a shift in the recent decade towards addressing the advantages of managing natural infrastructure more explicitly.

198. 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 United Nations 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 (UN-Water 2007). In accumulation, these crises risk threatening the lives and livelihoods of billions of people and irrevocably change ecosystems. Localized fatalities due to violent conflicts over water issues are already evidenced, and without improved approaches these tensions can conceivably lead to armed conflict (Human Development Report 2006).

199. Similarly, excessive environmental degradation caused by water pollution and withdrawals is also 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 on the order of US$ 9 billion per year, or 2.1 to 7.4 per cent of GDP, with a mean estimate of 5.7 per cent (Hussein 2008).. 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 US$ 60 billion and will continue to rise as more is known (WWDR3 2009).

200. Expert opinion indicates that poor water, sanitation and hygiene, and inadequate water resources management contributed to 50 per cent of the consequences of childhood and maternal underweight (World Bank 2008). 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[11]. Climate change is likely to result in an overall increase in the displacement of people.

201. 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 per cent, Yemen 1.5 per cent, Egypt 1.3 per cent and Tunisia 1.2 per cent (World Bank 2007).

202. 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 (e.g., aquifer depletion, contamination) 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.

---

11 UNEP former Executive Director,, Klaus Töpfer, talks of 22-24 million environmental migrants (Biermann 2001), whereas Myers (2005) reports “at least” 25 million in 1995 (latest date for a comprehensive assessment), especially in the African Southern Sahara, China, Central America and South Asia, and expects the number to reach around 50 million by the year 2010. The Office of the United Nations High Commissioner for Refugees (Castles 2002) 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 (WWDR3 2009).

203. It is not the case that restoring ecosystem functions (i.e., 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 the case studies presented in the background document 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.

204. ***One of the major constraints to re-focussing investments on natural infrastructure is the limited opportunities for corruption in doing so.*** Not always should it be assumed that investment approaches to infrastructure are driven by impartial economic reasoning. For example, a global report on corruption (Transparency International 2008) states that corruption in the water sector can raise the investment costs of achieving the MDGs on water and sanitation by 25-30 per cent, equivalent to almost US$ 50 billion or over US$ 5 billion a year to 2015 (more than five times the current GEF allocations for biodiversity).

205. Large financial investments are required and already being made in water infrastructure. For example, in the United States one estimate is that bringing water supply and sewerage infrastructure up to current standards will cost more than US$ 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 aging water supply and sanitation infrastructure in industrial countries alone may be as high as US$ 200 billion a year (WBCSD 2005). Even if 1 per cent of these sums are spent restoring inland water ecosystem functions, this represents US$ 2 billion per year (in industrial countries alone). Meanwhile, estimates of global investment requirements in water by 2030 reach US$ 22 trillion, about the same as that required for energy[12]. This represents a trillion dollars a year. Only 1 per cent of this sum spent on better ecosystem management is $10 billion per annum.

206. ***The primary need related to investment in "inland waters biodiversity" is to make ongoing, planned and future water-related investments more intelligent.*** The aforementioned investment figures vary widely and can be controversial as to precision, but not scale. Achieving even an incremental shift in these investments towards enhancing the services provided by inland water ecosystems dwarfs traditional investments made directly in "biodiversity".

207. ***Inland water ecosystems generate the highest ecosystem values.*** 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) evaluate wetland services as accounting for 45 per cent of the total global value of all ecosystem services of US$ 33 trillion annually. These are gross comparisons and do not take into account the fact that inland wetlands comprise less than 6 per cent of the earth's terrestrial area (about 2 per cent of the marine area); on a per unit area basis this makes them approaching an order of magnitude more valuable than terrestrial or marine systems. The importance of paying attention to valuations was, for example, highlighted in Canada’s third national report to the Convention on Biological Diversity, where valuations, although problematic, were a key to galvanising increased attention to investment in their management.

---

12 Presentation by the FAO at the 5th World Water Forum, although such projections involve a high degree of uncertainty.

208. Even for many terrestrial ecosystems (such as forests) values related to water services outstrip more conspicuous benefits (such as timber products and carbon storage). For example, The Economics of Ecosystems and Biodiversity (TEEB) has published an note for UNFCCC COP-15 with 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 per cent of the total value of forests, and exceeding the combined value of climate regulation, food, raw materials, and recreation and tourism.

209. 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).

210. ***It is critical to reflect the full suite of ecosystem services provided by inland water ecosystems in more effective financing frameworks.*** Virtually all water-related activities or projects, whether structural or non-structural (e.g., planning, data collection, regulation, public education) 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. 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 that are sensitive to ecosystem considerations. Whilst this need is evident for perhaps most biodiversity considerations, it is particularly pertinent for inland waters because of the high values of the services on offer. One increasingly promising approach to influence financing policies is to demonstrate how considering natural ecosystem infrastructure can actually lead to financial savings. There is a growing body of evidence based on case-studiesthat this often can be the case (the background document contains several convincing and well documented examples).

211. There is a pressing need to better align "biodiversity" and "development". If this is not done, not only will opportunities for improved socio-economic sustainability through efficient use of ecosystems be missed, but inland waters biodiversity in particular will not be sustained in the face of overwhelming competition for water.

C. Awareness of the issues

212. The magnitude and importance of the issues and needs in relation to the programme of work on inland waters, more so regarding water, prompts the question as to the extent to which they are recognized in relevant agendas at the global, regional and national levels. A brief, and by no means comprehensive, assessment of this subject in the background document reveals that in many circles the required awareness is there but in too many others attention is seriously lacking. The following provides only a snapshot of examples.

213. One leading businessman recently referred to water as "...the oil of the 21st century"[13], echoing similar remarks of a former UN Secretary-General that "Water will be more important than oil this century"[14]. The heads of African States recently recognized that water is and must remain a key to sustainable development in Africa and that states must put in place adaptation measures to improve the

13 Reported by Gideon Rachman, *Financial Times*, Jan 2008.

14 "Water will be more important than oil this century" (Boutros-Boutros Ghali).

resilience of countries to the increasing threat of climate change and variability of water resources[15]. The Asian Water Development Outlook (2007) emphasizes a “multidisciplinary 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 is home to 500 million people without access to safe drinking water and 1.8 billion without access to basic sanitation, as well as 90 per cent of people affected by water-related disasters and two-thirds of the world’s hungry; meanwhile, the region’s 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”.

214. Water has been prominent in the discussions of the Commission for Sustainable Development since its early deliberations and is now largely considered 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.

215. 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.

216. 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" .

217. A recent Gallup survey revealed that pollution of drinking water is Americans’ number-one environmental concern, with 59 per cent saying they worry “a great deal” about the issue, *versus* just 34 per cent worried about “global warming”. In a survey of Fortune 1000 companies, 40 per cent said the

---

15 11th Ordinary Session of the Heads of State and Government of the African Union, Sharm El-Sheikh, Arab Republic of Egypt, June to 1 July 2008

impact of a water shortage on their business would be "severe" or "catastrophic," although only 17 per cent said they have prepared for such a crisis (Kershner and Geraghty 2009).

218. The fifth World Water Forum (Istanbul, 16-22 March 2009) was, according to its website, attended by 33,058 participants from 192 countries, including nine Heads of State, 85 Ministers and 14 high level representatives of international organizations (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 recognizes 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 generalized 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."

219. The level of real recognition and awareness of the role of ecosystems (and hence biodiversity) in water-related considerations is another matter. Where they are weak, the Convention on Biological Diversity needs to reinforce them; where they are strong they are significant opportunities for mainstreaming.

220. That there is still much awareness-raising to do is illustrated by several relevant arenas appearing to miss important 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. Water remains absent as an explicit agenda item in many major summits, even though it has strong links with all human development and many more related issues. For example, at a United Nations Summit from June 3 to 5, 2008 in Rome, 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, that water was not an explicit agenda item in this meeting 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.

221. According to the Third World Water Development Report (WWDR3 2009), few current Poverty Reduction Strategies (PRSs) 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 are better understood, the required development-oriented finances are unlikely to follow. Economic growth has yet to receive much prominence in PRSs 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 PRSs and National Development Strategies (NDSs), that are more sustainable and growth-orientated will help make essential connections.

D. Scenarios, challenges and approaches

222. ***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 already needed. To make matters worse, the review also concludes that, based on current trends, protected area approaches are unlikely to have a sustainable contribution to biodiversity conservation in many, if not most, areas. 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 the availability of water and its quality and their implications for inland water, coastal and terrestrial biodiversity and human development, to put it mildly, present considerable challenges – arguably the main challenge to a sustainable planet.

223. One perverse reason for hope that things will improve is that 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 improvements in its management tend to arise from crisis. The best hope, therefore, lies in the fact that rapidly escalating crises will force more intelligent approaches.

224. 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 has devoted much space to looking beyond "what lives in fresh water and what directly affects it". Sustaining inland waters "biodiversity" requires an approach in which ecosystem services are central and which captures the importance of drivers of change in those services.

225. Many solutions to the problems exist. The need is to harness these more systematically. Regarding water, 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, IWRM 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.

226. 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, recognize how important it is to get things right with inland waters. Water is often a very local issue. National policies need to describe broad principles and objectives and empower, or legislate for, local implementation according to local circumstances and needs.

227. Recommendations from other forums that target various sectors, including governmental organizations, NGOs and industry, 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; 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;

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

c) 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 under threat due to water scarcity and chemical contamination;

d) Stopping and certainly reversing degradation of important ecosystem services demands major policy changes; and

e) 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 these related goals.

228. The recent economic crisis also brings heightened attention to opportunities for stimulating economies, where the concept of “payments for ecosystem services” (PES, see below) may be introduced as an option to finance adaptation/mitigation measures, while simultaneously stimulating economic activity. The current focus on a "green economy" offers significant opportunities in these regards in relation to inland waters. 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.

229. 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.

The effectiveness of good wetland policies

230. 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.

Payments for environmental services

231. 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 Convention on Biological Diversity [16].

Water quality – mitigating pollution

232. 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 economic costs of inaction are high. The OECD (2008) reports evidence of increasing investments in "Change in Production

---

16 For example, the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Watercourses Convention, 1992) in 2006 adopted guidelines on payments for ecosystem services (PES) in IWRM

Process" technologies (CPP). There is a steady growth of companies seeking certification through ISO. The globalization of the economy can contribute to cleaner production even with the delocalization 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 globalization 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.

Progress in addressing water resources sustainability

233. The so-called "green revolution", which enabled massive increases in food production during the 1960s and 70s, 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). Water, not just land, is now a major constraint to increasing agricultural production. Most commentators agree that there will be no second "green revolution" to save the day. From now on, it is tough going. However, 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.

234. 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 and recognising the need to make more efficient use of scarce water resources*** (Saudi Arabia is one example)[17].

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

236. 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 significant 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

[17] Saudi Arabia’s Agricultural Project: From Dust to Dust, by Eli El Hadj, in the Middle East Review of International Affairs, June 2008

countries have the financial resources for wholesale remediation of aquifers. Groundwater reservoirs add persistence 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 base-flow and wetlands *(and vice versa)*, groundwater is frequently ignored in water balance calculations. For longer-term evaluations, such as those 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.

Work of selected non-governmental organizations

237. A snapshot 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) has contributed to the in-depth review (further details are provided in section v of the background document).

238. Because of their experience in practical implementation, the perspectives of these NGOs on constraints, priorities and successes and failures are extremely valuable for the purposes of the in-depth review of the programme of work on inland waters under the Convention on Biological Diversity. Examples of approaches are successfully demonstrated through 50 NGO case studies included in the review.

239. 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.

240. 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 Convention on Biological Diversity 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.

241. 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 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.

242. 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.

243. 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 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.

244. 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.

Private sector responses

245. ***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[18]. Examples of successes in creating social marketing campaigns around water issues can be found in almost all countries.

246. Tourism is a growing sector of the global 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.

Climate Change - hazards versus opportunities

247. 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. Above all, there is a significant opportunity to use the current attention to climate change to leverage improved attention to the role of ecosystems and ecosystem rehabilitation in addressing climate change responses and especially regarding water resources.

18 www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=MTUxNQ&doOpen=1&ClickMenu=LeftMenu.

Biotechnology

248. 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.

Reaching the Millennium Development Goals

249. One critical need is to recognize that ***water is the key mechanism linking the various MDGs*** (Figure 3).

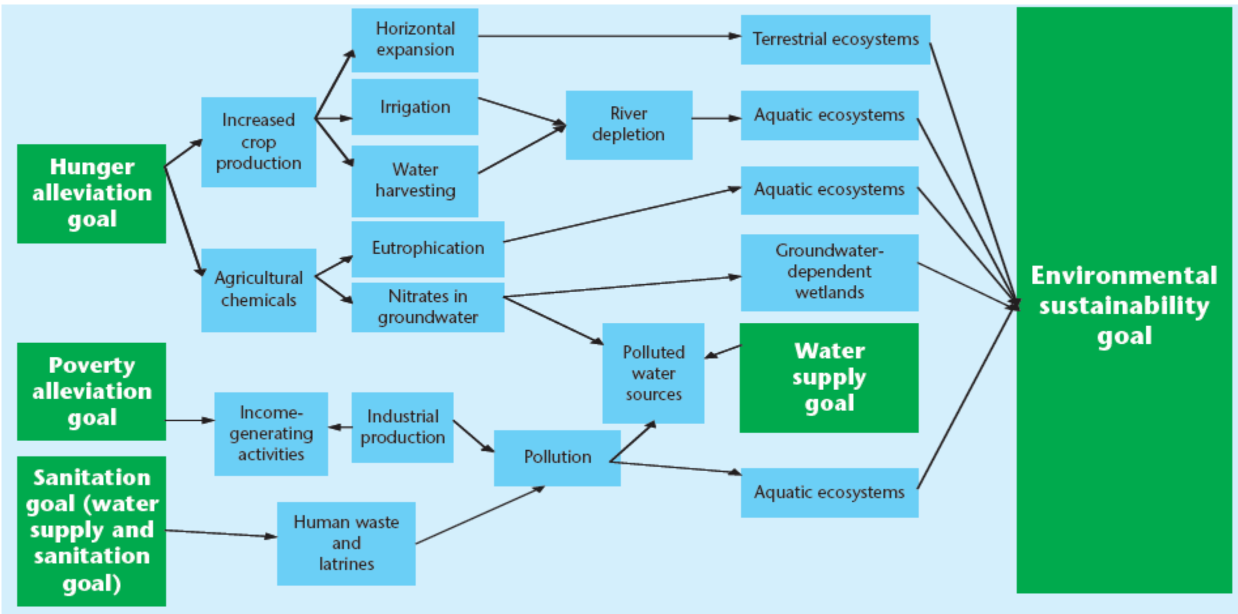

Figure 3: Some ways in which the sustainability of water availability forges linkages between the MDGs (based on Cosgrove 2006).

250. ***Water is the key entry point for biodiversity interests in the broader development dialogue.***

251. Commentators have observed that ***water is a primary reason why "environmental sustainability" targets were incorporated into the MDGs*** originally. Attention to drinking water and sanitation (now target #3 of MDG7) was largely responsible for sparking the debate about environmental sustainability (now target #1 of MDG7); explaining why the drinking water and sanitation target is rather oddly clustered amongst the others under MDG 7. This opened the door for the later incorporation of the 2010 biodiversity target itself under the same MDG7 (as target # 2)[19]. The importance of water is arguably why the 2010 biodiversity target was eventually recognized as also relevant. But ***the current lack of inclusion of water security issues in the Convention on Biological Diversity suggests that the lessons of history have been forgotten***.

252. 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 recognize the biodiversity link. ***The availability of water is an ecosystem service, and biodiversity underpins this. Achieving the MDGs sustainably and collectively is***

19 The numbering of the targets has been revised more than once and does not represent the historical sequence of their adoption.

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.

The way forward on water resources management

253. Tested approaches available to water managers, as identified in the WWDR3 (2009), that show promise lies within the fields of:

i. 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;

ii. 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 corporatization 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;

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

iv. 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;

v. Developing appropriate solutions through innovation and research; and

vi. Institutional and human capacity development.

254. 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.

255. 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.

256. Regarding information availability, according to WWDR3, 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.

257. Reliable and accurate water resources information and data provide 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 on

understanding and managing the water cycle (essentially – hydrological data). But this must be accompanied by better information on the role of ecosystems (including but not limited to 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 recognize that investment in environment-related information is investment in more sustainable development.

258. 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.

259. 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.

V. INFORMATION CONTAINED IN NATIONAL REPORTS UNDER THE CONVENTION ON BIOLOGICAL DIVERSITY REGARDING IMPLEMENTATION OF THE PROGRAMME OF WORK

260. National reports under the Convention on Biological Diversity continue to provide more 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 a national level. Regarding MEA national reports, and as recognized in decision VII/4, para. 2 of the Convention on Biological Diversity, 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 national reports under the Convention on Biological Diversity 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 organized reporting on water use and influences on the hydrological cycle (as relating to biodiversity considerations) through other programmes of work.

A. Third national reports under the Convention on Biological Diversity

261. Some indications from third national reports were:

i. the level of priority accorded to the programme of work on inland waters varied significantly between Parties, but overall it was ranked as medium priority; among the thematic programmes of work, forest biodiversity was ranked as a high priority by 70 per cent of reporting countries, the programmes of work on agricultural biodiversity and marine and coastal biodiversity were in second and third place, respectively;

ii. there was an under-emphasis on inland water protected area sites;

iii. implementation of the programme of work into NBSAPs was incomplete – but more significantly, very few Parties had integrated the programme of work into policies, strategies, and plans related to development; it is unlikely that the majority of Parties did not recognize 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;

iv. 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;

v. 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;

vi. 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;

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

viii. only nine Parties had taken comprehensive measures for joint implementation between the Ramsar Convention and the Convention on Biological Diversity; and

ix. data generation for inland waters continued to be dominated by technical and biological interests whereas socioeconomic data were clearly still weak – about 50 per cent of Parties had taken steps to improve national data on goods and services provided by inland water ecosystems, 60 to 65 per cent had taken steps to improve hydrological data but only 38 per cent 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 was also a weak area.

262. The responses to target-related questions were conflicting. According to the responses on the section on the 2010 target, overall more than 60 per cent of Parties reported that they had 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 per cent of Parties had established outcome-oriented targets for this programme of work. Less than 20 per cent of reporting Parties had established relevant targets and identified priority actions to achieve them.

263. 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 showed a generally high level of engagement in the programme of work, but not always. Developing countries often "outperform" them and the total scores were only marginally different between these two groupings. Countries with economies in transition were ranked third overall (and their total score was 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 was 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. Nor could any case be made that freshwater needs are lower in countries with economies in transition.

264. There were also interesting differences with regards to target setting. Least developed countries ranked highest in the ideal scenario of having targets and identified activities to achieve them. They were

approaching three times better on this point than developed countries. Even developing countries "out performed" developed countries in this area. Developed countries ranked highest only where priorities had been identified but no targets established. LDCs were second highest (after developed) in integrating the programme of work into NBSAPs. Better progress was 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 ranked 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).

265. Developing countries were 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, flood-mitigation) – although the goods and services provided by inland waters (collectively) are in reality probably of equal importance amongst country groupings.

266. The main challenges identified by many countries in their third national reports for implementing this work programme were unchanged from previous or other related assessments and included:

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

ii. Limited capacities for inland waters ecosystem management;

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

iv. Lack of financial, human and technical resources;

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

vi. Lack of inter-sectoral coordination or synergies.

267. There were 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.

268. 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 were 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.

269. 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; furthermore, the response rate for the second national report was relatively low. Following trends through to the fourth national report is even more difficult due to its quite different format.

B. Fourth national reports under the Convention on Biological Diversity

270. 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 in document UNEP/CBD/SBSTTA/14/3.

271. 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- and 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). 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

272. 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 organizations 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.

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

273. 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 Convention on Biological Diversity and second, third and fourth national communications to the UNFCCC.

274. Examples of activities reported by Parties include:

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

ii. Programmes for the restoration of degraded wetlands;

iii. Halting development in flood plains;

iv. Improved fisheries management;

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

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

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

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

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

275. The vast majority of Parties reported on adaptation activities and vulnerability and impact assessments, with only four 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.

276. 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.

277. 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:

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

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

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

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

278. A number of Parties have already integrated the conservation and sustainable use of inland waters as a part of national adaptation programmes. While some 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.

VI. ASSESSMENT OF THE RELEVANCE OF THE PROGRAMME OF WORK AND ITS IMPACT

279. There are few clear examples (based on national reports) of Parties that use the programme of work to guide policies and management. Notification 2008-18 (voluntary reports) specifically invited Parties to comment, *inter alia*, on the impact of the programme of work on national policies and activities other than those dealing with biodiversity conservation directly as well as on water-related policies. All four Parties that addressed this question (Canada, Islamic Republic of Iran, Spain, Unions des Comores) stated unambiguously that the programme of work was generally not influential in the broader policy

framework nor, importantly, on water resource policy[20]. Although this is a small sample, it supports the view that a major problem is that the programme of work does not adequately address a major driver of biodiversity loss – water resources use.

A. Assessing the contribution of the programme of work towards the achievement of the 2010 biodiversity target

280. Superficially, the fact that the biodiversity of inland waters represents the fastest acceleration away from the 2010 target suggests that the programme of work is the least effective. But implementation must be viewed in the context of the drivers of change, which are considerable, complex, rapidly escalating and probably more severe than for any other programme area. This is due to the combined impacts of land-based activities and water use, and demands upon these; see document UNEP/CBD/SBSTTA/14/3 for more information.

B. Findings regarding implementation of the elements, goals and activities of the programme of work

281. Some key findings of the review in relation to the elements, goals and activities of the programme of work are summarized in the annex below.

282. ***The review finds that the elements, goals and activities in the programme of work remain a generally well thought out and reasonably comprehensive foundation for action.*** The larger needs relate to priority-setting, awareness-raising, capacity-development and the context in which the programme of work is viewed and/or implemented. In particular, despite its title, the programme of work does not adequately emphasize "water" in the broader ecosystem context, its relationships with sustainable development and its prominence in climate change adaptation. Document UNEP/CBD/SBSTTA/14/3 discusses this subject further.

283. In its voluntary report, Canada notes that: (i) the programme of work, while containing several references to ecosystem services provided by wetlands, makes no connection between ecosystem services and climate change apart from a reference to carbon sequestration and peatlands in activity 1.1.10(c); and (ii) there is only one minor reference to hydrologic services in the programme of work (in activity 2.2.2) – an observation which echoes needs identified elsewhere (UNEP/CBD/SBSTTA/14/3).

VII. REFERENCES

ASCE (American Society of Civil Engineers). 2008. 2005 Report Card on America's Infrastructure. 2008 Update. American Society of Civil Engineers.www.asce.org/reportcard/2005/index.cfm.

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.

Bagchi, S. 2007. Arsenic Threat Reaching Global Dimensions. *Canadian Medical Association Journal* 177 (11): 1344-45.

Biemans, H., T. Bresser, H. van Schaik and P. Kabat. 2006. *Water and Climate Risks: A Plea for Climate Proofing of Water Development Strategies and Measures*. 4th World Water Forum, Cooperative Program on Water and Climate, Wageningen, The Netherlands.

Biermann, F. 2001. Umweltflüchtlinge, Ursachen und Lösungsansätze. In*: Aus Politik und Zeitgeschichte,* B 12/2001.

---

[20] This does not necessarily mean that these Parties do not have good policies, including for water, and most refer to other mechanisms and frameworks addressing the needs which are independent of the programme of work.

Blue Plan. 2007. *Water Demand Management, Progress and Policies: Proceedings of the 3rd Regional Workshop on Water and Sustainable Development in the Mediterranean*. Zaragoza, Spain, 19-21 March. Mediterranean Action Plan Technical Reports Series 168. Athens: United Nations Environment Programme.

Castles, S. 2002. Environmental change and forced migration: making sense of the debate. In: *New Issues in Refugee Research*. Working Paper No.70. United Nations High Commissioner for Refugees, Geneva.

Comprehensive Assessment of Water Management in Agriculture. 2007. *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*. London: Earthscan, and Colombo: International Water Management Institute.

Cosgrove, W. J. 2006. Water for growth and security. In *Water Crisis: Myth or Reality*. Fundacion Marcelino Botin. Taylor and Francis London 2006.

Cyranoski, D. 2009. Putting China's wetlands on the map. *Nature*: 458, pg. 134 (12 March 2009).

Delli P. J., and A. T. Wolf. 2009. *Managing and Transforming Water Conflicts.* International Hydrology Series. Cambridge, UK: Cambridge University Press.

El Hadj, E. (2008). Saudi Arabia's Agricultural Project: From Dust to Dust. Middle East Review of International Affairs; June 2008.

Finlayson M., H. Gitay , M. Bellio , R. van Dam and I. Taylor. 2006. 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. Edinburgh, U.K. The Stationery Office.

Foote L. and N. Krogman. 2006. Wetlands in Canada's western boreal forest: Agents of Change by, November/December 2006, VOL. 82, No. 6 — The Forestry Chronicle.

Gichere, S., R. Davis, and R. Hirji. 2006. Climate Variability and Water Resources Dgradation in Kenya: Improving Water Resources Development and Management. World Bank Working Paper Series 69, World Bank, Washington, DC.

Green, P. A., C. J. Vörösmarty, M. Meybeck, J. N. Galloway, B. J. Peterson, and E. W. Boyer. 2004. Pre-Industrial and Contemporary Fluxes of Nitrogen through Rivers: A Global Assessment Based on Typology. *Biogeochemistry* 68 (1): 71-105.

Gyawali, D., J. A. Allan, P. Antunes, A. Dudeen, P. Laureano, C. L. Fernández, P. Monteiro, H. Nguyen, P. Novácek, and C. Pahl-Wostl. 2006. *EU-INCO Water Research from FP4 to FP6 (1994-2006)– A Critical Review.* Luxembourg: Office for Official Publications of the European Communities.

Hoekstra, A. Y. and A. K. Chapagain. 2007. Water Footprints of Nations: Water Use by People as a function of their consumption pattern. *Water Resources Management* 21 (1): 35-48.

Hoekstra, A. Y. and A. L. Chapagain. 2008. *Globalization of Water: Sharing the Planet's Freshwater Resources.* Oxford: Blackwell Publishing.

Human Development Report. 2006. *Beyond Scarcity: Power, Poverty and the Global Water Crisis.* New York: Palgrave Macmillan.

Hussein, M. A. 2008. Costs of Environmental Degradation: An Analysis in the Middle East and North Africa Region. *Management of Environmental Quality* 19 (3): 305-17.

IEA (International Energy Agency). 2007. *World Energy Outlook 2007.* Paris: Organisation for Economic Co-operation and Development and International Energy Agency.

Japan Water Forum and World Bank. 2005. A Study on Water Infrastructure Investment and Its Contribution toSocioeconomic Development in Modern Japan. World Bank, Washington, DC.

Kershner, E.M. and M. Geraghty. 2009. *Water Worries: Update #2*. Citigroup Global Markets, 20 May

2009.

Lenton, T. *et al*. 2008. Tipping elements in the Earth's climate system. *Proceedings of the National Academic of Sciences (PNAS)*, Vol. 105(6), pp. 1786 – 1793.

MA. 2005. Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

Molden, D. 2009. A global limit on water consumption is necessary, but the suggested planetary boundary of 4,000 cubic kilometres per year is too generous. www.nature.com/reports/climatechange. Published online: 23 September 2009.

Myers, N. 2005. *Environmental Refugees: An Emergent Security Issue*. 13th Economic Forum, Prague, 23-27 May 2005.

Nilsson C., C. A. Reidy, M. Dynesius and C. Revenga. 2005. Fragmentation and Flow Regulation of the World's Large River Systems. *Science* 308: 405-408.

OECD (Organisation for Economic Cooperation and Development). 2008. *OECD Environmental Outlook to 2030.* Paris: Organisation for Economic Cooperation and Development.

TEEB. 2009. TEEB Climate Change Issues Update. eptember 2009.

Shah, T., O. P. Singh, and A. Mukherji. 2006. Some Aspects of South Asia's Groundwater Irrigation Economy: Analyses from a Survey in India, Pakistan, Nepal and Bangladesh. *Hydrogeology Journal* 14 (3): 286-309.

Smith, L. C., T. M. Pavelsky, G. M. Mac-Donald, A. I. Shiklomanov, and R. B. Lammers. 2007. Rising Minimum Flows in Northern Eurasian Rivers: A Growing Influence of Groundwater in the High-Latitude Hydrologic Cycle. *Journal of Geophysical Research* 112: G04S47.doi:10.1029/2006JG000327.

Transparency International, 2008. *Global Corruption Report 2008.* TI Berlin.

Treyer, Sébastien. 2004. Introducing Political Issues in the Debate on Water Resources Planning in Tunisia: A Necessity for the Implementation of Water Demand Management Policies. In:*Proceedings of the Workshop on Water and Politics: Understanding the Role ofPolitics in Water Management, Marseille, France, 26-27 February 2004.* Marseille, France: World Water Council. www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/Proceedings_Water_Politics/proceedings_waterpol_full_document.pdf

UNEP (United Nations Environment Programme)/GPA (Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities). 2006. *The State of the Marine Environment: Trends and Processes*. The Hague: United Nations Environment Programme/Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities.

United Nations. 2008. *World Economic and Social Survey 2008: Overcoming Economic Insecurity*. New York: Department of Economic and Social Affairs, United Nations. www.un.org/esa/policy/wess/wess2008files/wess08/overview_en.pdf

UNU. 2007. 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.

UN-Water. 2007. Outcome of the Seminar on Coping with Water Security, 23 August, Stockholm. www.unwater.org/www-seminar2.html.

UN-Water. 2008. Status Report on IWRM and Water Efficiency Plans for CSD 16. Paper prepared for 16th session of the Commission on Sustainable Development in May 2008, UN-Water.

Velasco, H. G. 2003. *Water Rights Administration – Experiences, Issues and Guidelines.* Rome: Food and Agriculture Organization of the United Nations.

Vörösmarty, C. J., M. Meybeck, B. Fekete, and K. Sharma. 1997. The Potential Impact of Neo-Cartorization on Sediment Transport by the Global Network of Rivers. In *Proceedings of the Fifth IAHS Scientific Assembly at Rabat, Morocco, April-May 1997,* eds. D. E. Walling and J.-L. Probst. Wallingford, UK: International Association of Hydrological Sciences.

Vörösmarty, C. J., M. Meybeck, B. Fekete, K. Sharma, P. Green, and J. P. M. Syvitski. 2003. Anthropogenic Sediment Retention: Major Global Impact from Registered River Impoundments. *Global and Planetary Change* 39 (1-2): 169-90.

Walter, K. M., S. A. Zimov, J. P. Chanton, D. Verbyla, and F. S. Chapin. 2006. Methane Bubbling from Siberian Thaw Lakes as a Positive Feedback to Climate Warming. *Nature* 443, 71-75. doi:10.1038/nature05040.

WBCSD (World Business Council for Sustainable Development). 2005. Water Facts and Trends. World Business Council for Sustainable Development, Washington, DC.

WHO (World Health Organization) and UNICEF (United Nations Children's Fund). 2008. Joint Monitoring Programme. *Progress on Drinking Water and Sanitation: Special Focus on Sanitation*. New York and Geneva: World Health Organization.

Wolff G., H. Cooley, M. Palaniappan, A. Samulon, E. Lee, J. Morrison, D. Katz and P. Gleick. 2006. The World's Water 2006-2007: The Biennial Report on Freshwater Resources. Island Press.

World Bank. 2007. Making the Most of Scarcity: Accountability for Better Water Management Results in the Middle East and North Africa. MENA Development Report. Washington, DC: World Bank.

World Bank. 2008. *Environmental Health and Child Survival: Epidemiology, Economics Experiences.* Washington, DC: World Bank.

Worrall, F., and T. P. Burt. 2007. Trends in DOC Concentration in Great Britain. *Journal of Hydrology* 346: 81-92.

WWDR3. 2009. *The United Nations World Water Development Report 3: Water in a Changing World.* World Water Assessment Programme. Paris: UNESCO, and London: Earthscan.

Xu, H., X. Tang, J. Liu, H. Ding, J. Wu, M. Zhang, Q. Yang, L. Cai, H. Zhao and Y. Liu. 2009. China's Progress toward the Significant Reduction of the Rate of Biodiversity Loss. *BioScience* Vol. 59 No. 10 (November 2009): 843-852.

Zhang T., Roger G. Barry, K. Knowles, J., A. Heginbottom, and J. Brown. 1999. Statistics and Characteristics of Permafrost and Ground Ice Distribution in the Northern Hemisphere. *Polar Geography* 23 (2): 147-69.

Annex

Summary of some findings of the review regarding the various elements and goals of the programme of work on the biological diversity of inland water ecosystems. Enhanced implementation across all areas of the programme of work is required, and the summary below outlines some areas where particular difficulties or opportunities lie. These are generalizations; there are significant differences in needs and opportunities between countries.

Programme elements/goals	Findings of the review
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 (EA).	Remains the primary requirement for overall implementation. Its successful achievement is central to the achievement of most other goals. Remains the most consistently reported major constraint. But very difficult to achieve due to multiple demands on land and water. Significant institutional constraints identified as continuing by most Parties, assessments and organizations. Some good progress reported through various approaches – particularly IWRM (see text for further details). IWRM recognized as sometimes being one of the best examples of the ecosystem approach. Key needs are: to orient the main sector interests around a common objective of sustaining the delivery of relevant and desired ecosystem services; and to make sustained economic benefits a key area of focus. More attention is required throughout on the indirect drivers of change and their impacts on direct drivers of biodiversity loss through land and water use activities (see UNEP/CBD/SBSTTA/14/3).
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.	Good progress made in increase in designation of protected areas (PA) (quantification presented only for Ramsar site area). Progress also reported in some areas on improved transboundary cooperation. Needs remain regarding representivity across various wetland types (Ramsar STRP is doing further work to quantify). But because integrated catchment/watershed/basin management remains weak, many protected areas continue to degrade. Water-related services widely identified as a major economic benefit provided by both wetland and terrestrial protected areas (particularly forests). PA approaches need to be more holistic – and with better incorporation of aquatic ecosystem protection with terrestrial protected areas. The Convention on Biological Diversity attention to protected areas networks needs to better recognize the existence of, and experience from, the Ramsar network of protected areas established since 1971.
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.	Inland water ecosystem restoration is progressing substantially, including in developed countries (considerably more is required). Importantly, the main motivations are usually for economic reasons (restoring desired ecosystem services, cost-effectively). Water-related economic considerations are driving shifts in government policy towards more sustainable ecosystems. There is good evidence of recovery of some of the most critically endangered species (but not all) – where effective conservation measures are implemented. But usually as a last resort (crisis recovery) and often only for charismatic species.
Goal 1.4: To prevent the introduction of invasive alien species (IAS), including exotic stocks that potentially threaten the biological diversity of	Difficult to quantify progress. There is evidence that IAS impacts on inland water systems are increasing. These systems are more vulnerable to invasion, partly because they are degrading but also due to the land/water interface. IAS are often directly implicated in species extinctions; but, in general, biodiversity loss is caused by

Programme elements/goals	Findings of the review
inland water ecosystems, and to control and, where possible, eradicate established invasive species in these ecosystems.	multiple drivers. Climate change will increase invasions.
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.	See goal 1.1. Ways and means to make the programme of work more relevant to the sectors is to focus on the ecosystem services that those sectors rely on. Major constraints are terminology and awareness. Many sector interests do not include or understand "biodiversity". Terminology must shift towards concepts relevant to sector interests. Ramsar reports indicate a positive link between the existence of appropriate policies and outcomes for wetlands.
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.	Considerable development and application of low-cost technology has been identified – particularly relating to using natural infrastructure to address water resources management needs (especially for drinking water quality, flood management and sustainable water supplies). There are considerable opportunities for further transfer – and in particular South-South cooperation and in relation to cities. Movement toward ISO certification as an innovative approach to water resource management.
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)	Good progress in valuation approaches, with demonstrated benefit, but much opportunity for expanded use. A major perverse incentive is lack of incorporation of inland water ecosystem services values in economic planning. Perverse incentives in water use remain a significant constraint. The indirect effects of trade are identified as a key consideration, and often an opportunity, in particular in relation to trade in virtual water (see UNEP/CBD/SBSTTA/14/3). Payments for ecosystem services (PES) approaches are becoming increasingly prominent. Inland waters demonstrate some of the best developed, implemented and successful approaches to PES incentive schemes. A major opportunity is to integrate the programme of work better into finance/economic considerations (e.g., Ministries of Finance, and amongst donors) by demonstrating cost-effective solutions to water and land problems – and thereby to mobilize considerable non-traditional sources of funding (especially through ongoing and planned investments in water security) (see UNEP/CBD/SBSTTA/14/3 for more information).
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 particular attention to matters relating to the conservation and sustainable use of the biological diversity of inland water ecosystems.	Progress difficult to assess. Awareness is rapidly increasing in some circles but in general remains inadequate. Lack of awareness is identified as a major constraint. Activities to support this goal need to be considerably strengthened. A key need is to improve understanding of biodiversity and ecosystem functions and benefits. Climate change represents an enhanced opportunity for increased engagement in CEPA – yet to be fully taken up. A major need is to increase awareness in institutional circles, including nationally and internationally.

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.	Progress difficult to quantify – but this is widely identified as being a key ingredient to the successful implementation of cross-sectoral measures (e.g. IWRM). Many examples of ways and means to successfully achieve this are now available. Erosion of traditional knowledge is identified as a constraint to implementation (including in developed countries).
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.	Good progress observed (see also goal 2.3). Rapidly increasing evidence base and tools regarding inland water ecosystem values, also increased scientific understanding and assessment of system functions, including relationships with terrestrial ecosystems and the water cycle (see UNEP/CBD/SBSTTA/14/3). The major constrain remains to mainstream such information into improved cross-sectoral and cross-biome approaches.
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.	Some uptake of the rapid assessment guidelines for inland waters biodiversity is reported (although many Parties observe they have more comprehensive tools nationally). Assessments of threats in terms of water and land use and pollution are relatively well developed regionally and globally and reported through other processes (e.g., World Water Development Report 3), but not necessarily nationally. Increasing use of remote sensing is noted; this is an increasingly effective tool. Responses to threats by different types of ecosystem are not well assessed or studied – but broadly, all ecosystem types probably respond in a similar fashion to the same common key threats. Threats themselves are largely unchanged in terms of nature and origins, but all are escalating. There is a critical need to pay more attention to groundwater (depletion and pollution) and its relationships with surface waters, wetlands and terrestrial systems (see UNEP/CBD/SBSTTA/14/3).
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 (IA), including consideration of their potential impact on sacred sites and on lands and waters traditionally occupied or used by indigenous and local communities.	Extent of application of IA is difficult to quantify. Status and trends results suggest either limited application or limited impact of rigorous IA. IA needs to be incorporated better as a tool to assist achieving goals 1.1 and 2.1. Where IA is applied independently of broader land and water use considerations the effectiveness of the tool will be limited. IA needs to be part of IWRM.
Goal 3.4. To introduce and maintain appropriate monitoring arrangements to detect changes in the status and trends of inland water biodiversity.	Significant gaps in monitoring remain, in particular for trends in relevant ecosystem services. Some good progress in monitoring of ecosystem ecological condition is reported and in particular good progress is made at the species level, and major assessments of this are ongoing. Monitoring wetland extent remains a serious gap. Data sets for populations of extensively monitored inland water species (in particular waterbirds) remains one of the most robust and useful sources of information on trends – approaches need to be strengthened and expanded to other groups.