CONVENTION ON
BIOLOGICAL
DIVERSITY

Ramsar
CONVENTION ON WETLANDS
CONVENTION SUR LES ZONES HUMIDES
CONVENCIÓN SOBRE LOS HUMEDALES
(Ramsar, Iran, 1971)

Ramsar Secretariat and Scientific and Technical Review Panel

and the Secretariat of the CBD

WATER, WETLANDS, BIODIVERSITY AND CLIMATE CHANGE

Provisional outcomes of an Expert Meeting, 23 – 24 March, 2007, Gland, Switzerland

[Advance Unedited Copy][1]

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EXECUTIVE SUMMARY

The objective of the expert meeting was to enhance the availability of scientific and technical information on the linkages between biodiversity, wetlands and climate change **so as to contribute to the international debate** and strengthen in-country adaptation and mitigation planning. Specific activities of the meeting included to: (i) undertake a review of the general state of knowledge on wetlands, biodiversity and climate change linkages based upon published reviews; (ii) identify key areas where wetlands should have a higher profile in the international debate on climate change; and (iii) identify key strategic opportunities to promote the enhanced awareness of the contribution of wetlands to the mitigation of climate change and the need to adequately consider wetlands in climate change adaptation measures.

The meeting based its deliberations on scientifically based evidence and experience but focused its outputs on influencing policies and activities in the non-specialist community.

A summary of key issues, key messages and responses is provided together with an extended set of messages to form the basis of follow-up CEPA work. These are based on reviews of the subject area and are supported by technical and scientific information provided in the report, its annexes and related publications.

There is no time for delay: combating climate change is a vital need. This report addresses this major challenge and provides some solutions regarding wetlands and biodiversity. The opportunities are significant. Wetlands/biodiversity and climate change are interlinked. Climate change threatens these important ecosystems and the services they provide for human welfare. These ecosystems are already declining faster than any other biome and climate change will exacerbate this problem largely because its main impacts will be on water. Climate change affects the hydrological cycle which in turn impacts wetlands. In addition, many response measures to climate change will focus on water (e.g. increased agricultural demand for water).

Wetlands are also critical to mitigating climate change. They have an important and underestimated role in both carbon storage and the regulation of greenhouse gas emissions. Degraded wetlands are already a significant source of atmospheric carbon and the restoration/rehabilitation of wetlands offers a return on investment up to 100 times that of alternative carbon mitigation investments.

The work of the Intergovernmental Panel on Climate Change has also made us all aware that Climate Change is likely to be the main driver of biodiversity loss in the future. Biodiversity has already been affected by recent climate change and projected climate change for the 21st century is expected to affect all aspects of biodiversity. Studies show clearly that changes in distribution and behaviour of a large number of wetland species are the consequence of shifts in local or regional climate, weather patterns and resulting changes of vegetation and habitat quality.

The impacts of climate change and the changes in habitat may be dramatic for certain wetland related species such as birds, fishes, reptiles, amphibians. There is likely to be a general decline in avian species richness, with the mean extent of

species' potential geographical distributions likely to decrease. Species with restricted distributions and specialized species of particular biomes are likely to suffer the greatest impacts. Migrant species are likely to suffer especially large impacts as climatic change alters both their breeding and wintering areas, as well as critical stopover sites, and also potentially increases the distances they must migrate seasonally.

An overview of regional assessments shows mainly that the impacts of global warming has been most pronounced in the Arctic, that small islands are particularly vulnerable to climate change and that Africa is expected to suffer more food and water scarcity (less coastal wetlands and fish). Thus, wetlands can also mitigate another adverse effect of climate change by providing vital biodiversity resources, especially for poor people.

For general CEPA purposes it is clear that there is already enough information to produce a substantial technical document focussing on explanations of key messages identified. The short-term goal, however, might be simpler, shorter materials targeted to specific groups. The International Day for Biological diversity (22 May, 2007) on "biodiversity and climate change", is a good opportunity for providing appropriate materials (for both Ramsar and the CBD).

It is time for the international community to fully recognize that wetlands are more important as carbon stores than other biomes and therefore efforts to protect these vital ecosystems should be expanded. It is already known that peatlands alone store twice the carbon present in forest biomass of the world and that they store this carbon for very long periods of time (thousands of years), contrary to forests. However, precise information concerning the storage-capacity of other types of wetlands is missing. One thing is sure: degradation of wetlands by drainage and fire has severe impacts on carbon emissions to the atmosphere. Therefore, reducing climate change is possible through the conservation, restoration or creation of wetlands but even more difficult if their degradation is not prevented. On this point, it is crucial to note that the Kyoto Protocol excludes the emissions from soil and degraded vegetation, allowing no consideration of peatland degradation which is a huge cause of global warming.

It is urgent that the international community recognizes the crucial importance of wetlands to mitigate climate change (reducing Greenhouse Gases). Equally, adaptation measures for wetlands (which deal with the impacts of climate change) are critically important to human welfare. Wetland services are not only vulnerable to climate change but must be maintained in order to cost-effectively reduce the impacts of climate change on human populations.

The stage is set for action at Convention level. SBSTTA 12 will consider peatlands and advise CBD COP 9. There are indications that improved emphasis on these issues will receive strong support from some Parties – particularly in Europe. CBD COP 10 will consider climate change in detail. An effective partnership between the CBD and Ramsar Secretariats offers the possibility of significant progress in these matters but an effective strategy needs to be designed which includes having a stronger influence on the IPCC and UNFCCC.

Better explanation of wetland-biodiversity-climate change issues can provide significant additional argument for improved management in a rapidly changing world.

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I. INTRODUCTION

1. The expert meeting was held as one activity under the *Project of the Convention on Biological Diversity for Activities on Climate Change and Biodiversity* funded by Canada.

2. The main objective of the overall proposal between the Secretariat of the Convention on Biological Diversity (SCBD) and Canada, of which this expert meeting is a sub-activity, is to provide support to Parties and relevant partners for the enhancement of on-the-ground links between climate change and biodiversity as a follow-up to the awareness raising activities of International Day for Biological Diversity. This overall objective can be accomplished through capacity building and the provision of technical and scientific guidance.

3. The objective of the expert meeting was to enhance the availability of scientific and technical information on the linkages between biodiversity, wetlands and climate change **so as to contribute to the international debate** and strengthen in-country adaptation and mitigation planning. Specific objectives of the meeting included to:

   i. undertake a review of the general state of knowledge on wetlands, biodiversity and climate change linkages based upon published reviews;

   ii. identify key areas where wetlands should have a higher profile in the international debate on climate change; and

   iii. identify key strategic opportunities to promote the enhanced awareness of the contribution of wetlands to the mitigation of climate change and the need to adequately consider wetlands in climate change adaptation measures.

4. The meeting based its deliberations on scientifically based evidence and experience but focused its outputs on influencing policies and activities in the non-specialist community.

5. The outputs of the meeting also contributed to activity 1 of the SCBD-Canada project namely: *Guidance on the integration of biodiversity considerations within adaptation planning.* That activity looked more closely at the UNFCCC five-year work programme on vulnerability and adaptation and explored the technical and operational aspects of adaptation planning including: (i) ensuring that adaptation plans adequately consider the needs of biodiversity, and (ii) enhancing the sustainable use of biodiversity as an adaptation tool.

6. Annex I refers to the meeting agenda, Annex II to the participants list, Annex III to the CEPA issues and Annex IV to the background information. The meeting was opened at 0900 am on Friday 23 March and closed at 1700 pm on 24 March, 2007, by the Deputy Secretary General of the Ramsar Convention. Ms. Rebecca D'Cruz, Vice-Chair of Ramsar STRP, acted as Chair throughout. The meeting decided to set its own arrangements for the organisation of work and to report its findings arranged by subject area.

II RECOMMENDATIONS OF THE MEETING

7. Key messages should be developed and disseminated by appropriate means through Communication, Education and Public Awareness as a follow up to the meeting.

8. Messages contained herein need to be tailored by CEPA specialists according to the target audiences in question. There is an urgent need to do this in view of the current lack of awareness of the critical nature of the issues in question in the international debate on climate change.

RECOMMANDATIONS ON CEPA: *(Recalling the Scientific Expert Group Report on Climate Change and Sustainable Development. Prepared for the 15th session of the Commission on Sustainable Development):*

- Improve communication to accelerate adaptation and mitigation by increasing education efforts and creating forums for dialogue, technology assessment, and planning. The full range of public- and private-sector participants should be engaged to encourage partnerships across industrial and academic experts, the financial community, and public and private organizations.
- National governments and the UN system should take the following steps:
    - Develop an international process to assess technologies and refine sectoral targets for mitigation that brings together experts from industry, nongovernmental organizations, the financial community, and government. The Technology and Economic Assessment Panel of the Montreal Protocol provides an effective model for assessing technological potential and effective, realistic, sectoral mitigation targets.
    - Enhance national programmes for public and corporate education on the needs, paths, opportunities, and benefits of a transition to a low-emission energy future.
    - Enlist the educational and capacity-building capabilities of UN institutions to provide information about climate change and the opportunities for adaptation and mitigation.
    - Under the leadership of the Department of Economic and Social Affairs, the UN should complete an internal study to more effectively engage relevant UN agencies.
- The costs of this are virtually certain to be smaller than the costs of the climate-change damages these measures would avert.

9. The Ramsar CC-GAP should become Multi-convention.

10. An excellent opportunity exists with the Commission on Sustainable Development (CSD) – the focus of the CSD this year being climate change. The Secretariats need to make the necessary efforts to get water-wetlands-

biodiversity-CC issues into the CSD process. These need to focus on the importance of wetlands in adaptation/mitigation measures.

11. Issues and opportunities need to be taken up in the Biodiversity and Joint Liaison Groups.

12. An opportunity exists to further the issues at the Chairs of Subsidiary Bodies meeting *pre* SBSTTA 12 – efforts should be made to get the chair of the UNFCCC SBSTA there. A joint statement from the Subsidiary Bodies would be helpful.

13. A side event at SBSTTA 12, possibly co-chaired by SCBD, Ramsar and the other MEAs should be arranged in the subject CC and wetlands (possibly also including biofuels and incentives?).

14. A follow-up meeting is required in order to co-ordinate CEPA activities and strategies re. the Conventions.

15. There is a need to engage national UNFCCC focal points.

16. In the longer-term the Secretariats need to get more involved in the IPCC process – possibly through working more closely with lead authors. Available information regarding wetlands and CC needs to be published through peer-review in order to increase its credibility with the IPCC.

17. The Ramsar Secretariat should check the response of the IPCC 4th Assessment reports for consistency with the Ramsar COP 8 Ramsar resolution on wetlands and climate change.

18. The meeting suggested that the theme for World Wetlands Day 2009 be "wetlands and climate change".

19. Getting the issues into the Convention processes is a priority CEPA need.

20. Consideration should be given to updating the scientific/technical information available from Ramsar COP-8. A higher priority is however to produce a more general review of the issues focussing on explanations and key messages – as a joint CBD-Ramsar publication. A "coffee table" report can be linked to WWD 2009.

21. The single most urgent and important action that the international community can take regarding wetlands-climate change issues is to halt the degradation of peatlands in South-East Asia and promote sustainable management of these ecosystems including sustainable biofuel production.

III FINDINGS OF THE MEETING

Key messages on water, wetlands, biodiversity and climate change

22. After discussion of the technical background to the subject, the meeting focussed on consensus building for key messages. The full suite of key issues, messages and responses developed by the meeting is included in annex III,

which serves as a resource for future use. The key messages are substantiated by scientific and technical information from peer reviewed documents, details of which are supplied in the following sections including the annexes referred to.

23. The meeting generated a simplified overview of the problem and messages as follows:

- We know what the problem is
- We know what to do
- We know how to do it (technically but not necessarily institutionally)
- Key audiences don't know this and lack of awareness and understanding continues to make things worse
- We need to communicate with these audiences in a fashion which makes wetlands-biodiversity relevant to *them* – to explain how the subject helps them to reach *their* goals

24. The short summarised key messages are provided in Table 1.

25. CEPA should focus in particular on wetland and biodiversity values for people in relation to climate change – backed with hard scientific data to underpin the messages. Highlighting the economic importance for the poor is a key avenue to pursue. Better awareness is required of the linkages between water-wetlands-biodiversity and the achievement of the Millennium Development Goals.

26. We need a breadth of examples looking at different ecosystem services in different areas. Several aid agencies have commenced this process – the topic of this meeting needs to be integrated into these processes better.

27. The ongoing process to operationalise the MA at national level is a key opportunity to elevate the issues in question.

Table 1: Summarised key messages.

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
GENERAL WETLANDS - CC - Wetlands are very vulnerable to CC - CC is an additional pressure for wetlands which accelerates their degradation and loss	- CC will have more adverse impacts than beneficial impacts on wetlands	- Wise use and conservation/restoration/creation of wetlands assist in reducing CC
WETLANDS AND GHG - Wetlands cover	- Release of carbon from	- Generate improved scientific

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
approximately 6% of the Earth's surface and contain about 35% of global terrestrial carbon - Although wetlands are a major source of methane globally, they do not contribute to the enhanced green house effect as they have always been a natural source of methane - Peatlands are the most efficient carbon stores of all terrestrial ecosystem - Peatlands store twice the carbon present in forest biomass of the world and their storage is a very long term, contrary to forests - Peatland emissions in South-east Asia far exceed fossil fuel contributions from major polluting countries - The Kyoto Protocol excludes the CO_2 emissions from peatlands (soil and degraded vegetation)	wetlands degradation will offset the gains made by the world community to reduce GHG emissions - Wetlands are critically important for both mitigation (reducing the rate of CO_2 increases in the atmosphere) - and adaptation (dealing with the severe impacts of climate change) - Peatlands store large amounts of carbon - Peatlands degradation leads to CO_2 emissions which contribute to global warming - Production of Palm oil biofiel from peatlands does not contribute to reduce CC (CO_2 emissions from Palm oil fuel are up to 10 times higher than fossil fuel)	information on GHG fluxes for wetlands other than peatlands. - Develop alternative mechanisms to the CDM to deal with wetlands (peatlands) carbon trading issues. - Invest in carbon emission avoidance through peatland restoration which is 100 times more effective than investments elsewhere. - Establish a global peatland fund to counter the huge CO_2 emissions -Recognize the importance of wetlands (especially peatlands) to mitigate CC in the Kyoto Protocol (as for forests)
WETLANDS BIODIVERSITY AND CC - Wetlands are biodiversity "hotspots" - CC is already having an impact on wetland species - Biodiversity loss is fastest in wetlands than in other biomes	- Significant impacts of CC on wetlands related species include: - Increase of wetlands productivity; - Proliferation of invasive species; - Loss of biodiversity (including many	- Generate improved information of CC impacts on wetlands species other than birds - Develop a long-term monitoring system to predict trends of species-habitats-ecosystems because of the predictable and unpredictable changes in biodiversity of

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
	endangered or endemic species)	wetlands
WETLANDS SERVICES - The services provided by wetlands are: Biodiversity, Freshwater, food, Climate regulation, Pollution control, Hydrological regimes, Nutrient cycling , Soil formation, Cultural, recreation, tourism etc.	- Wetland services are critically important to human welfare - Wetlands services assist in reducing the impact of extreme events due to climate change (eg., floods and coastal erosion)	- Management approaches (ecological and economic) that maintain wetland services
WATER - CC manifests itself through alterations to the hydrological cycle - Water is vital to wetlands - CC will change the distribution of water for wetlands - Wetlands fisheries feed a large part of the world - Wetlands are under important threat from agricultural water resource development (the main user of water especially for irrigation)	- Water is essential for life - Wetlands play an essential role in water cycle and in access to water quantity and quality - Competition for water resources will intensify - Scarcity of water will increase the value of wetlands - As the global population increases, pressures on wetlands will increase	- Restore and preserve wetlands to sustain water resources - Promote effective means of allocating water for the needs of people, resulting in a mutual benefit for all users - Incorporate wetlands into new water management framework. - Engage agricultural and water sectors to maintain or rehabilitate wetlands
WETLANDS AND PEOPLE - Wetlands are important for millions of people, especially the poor, who are directly dependent upon the water, food and the other ecosystem services provided by	- Poor and marginalized groups are particularly vulnerable to CC - Wetlands will become much more vital in the future (providing water and food) - Wetlands loss and	- Pay incremental costs for local communities to undertake biodiversity + carbon storage activities - Pro-poor policies on wetland development, taking into account wetland-dependent people

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
wetlands - Half the world's women still have no adequate drinking water and sanitation at home or nearby (in developing countries, more than 1 out of every 2 families -3 billion people) - Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place - Wetland degradation is a major constraint to achieving the MDGs and climate change exacerbates this problem	degradation accelerated by CC will have a serious negative impact on the world's vulnerable communities - Protecting wetlands in CC adaptation responses will maintain dependent communities - Wetlands are of crucial importance for water security - Sustainable management of wetlands will reduce vulnerability of particularly the poor to CC impacts and is a tool for progress towards achieving the MDGs	- Provide effective mechanisms to involve women in making the choices or responses that will affect their livelihoods (eg., use of wetlands for water, food…) - CEPA has a special responsibility to empower children in the debate as they are the future generation that will be impacted most by wetlands loss and aggravated CC - Restoring and managing wetlands sustainably to reduce the vulnerability of poor people to CC in terms of : water supply, food security , disaster risk reduction (health and infant mortality…)
ECOLOGICAL NETWORKS AND LANDSCAPE APPROACHES - As the climate changes, protected areas, and species living within them, will need to shift location in order to maintain their ecological character - CC has significant impacts on migratory species including wetlands species, eg., waterbirds	- Wetlands are disproportionately important to maintain ecological networks (crucial for CC adaptation) - Including wetlands in landscape level planning for ecosystem services will reduce costs in CC adaptation responses	- Adopt an integrated management approach as the key issue for wetlands wise use - Incorporate wetlands as key elements of protected area network planning -The ability of species to migrate between habitats must be maintained through wetlands protection (corridors and stopover places)
INSTITUTIONAL MECANISMS - There has been little	-Lack of awareness of	- Promote multi-convention

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
attention given so far by policy-makers to the relationship between CC and the conservation and wise use of wetlands - Avoiding the unmanageable and managing the unavoidable will require an immediate and major acceleration of efforts to both mitigate and adapt to CC (including efforts to maintain biodiversity and water resources)	ecological infrastructure and its importance - Lack of coordination between major policy platforms, e.g., the MEAs - Need for greater awareness of the role of wetlands in carbon storage by policy makers within UNFCCC and other international processes and for this awareness to follow through to relevant policy development - Need for more responsive attention from the international community to the issues raised by CC - Need to change the current development policies to reduce wetlands degradation and enhance adaptation/mitigation of CC - Biodiversity is not just the victim of our mismanagement, it is our ally in managing better	cooperation - Adopt pro-poor operational mechanisms - Provide positive incentive mechanisms to local communities for improving wetlands management - Investment in wetlands protection in national economic planning to reduce the costs of climate change adaptation - Planning processes and adaptive management responses that take into account CC scenarios - Feature wetlands substantially in earth observation and other monitoring systems - Financing carbon sequestration and storage that links wetlands, biodiversity and livelihood - Investing in wetland restoration to reduce the costs of insurance premiums - Present wetlands scientific information in an appropriate language to the decision making process - Include CC and importance of wetlands in academic and educational institutions programmes - Join up responses and policies at international scales – this will require greater coherence and policy coordination within government by relevant administrative authorities - Improve communication to accelerate adaptation and

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
		mitigation by increasing education efforts and creating forums for dialogue, technology assessment, and planning - Engage the full range of public- and private-sector participants; partnerships should be encouraged across industrial and academic experts, the financial community, and public and private organizations

Section A - Relevant considerations under the Conventions

28. For more detailed information see Annex IV. An extended version of relevant convention text is also available separately.

29. The stage is well set to get improved attention to wetlands amongst the Conventions. SBSTTA 12 (July 2007) will consider the outcomes of the Global Peatlands Assessment (and recommendations will go forward to CBD COP 9). A section in the pre-session document already includes some reference to peatlands drafted from text supplied by the Global Environment Centre (GEC). Regional activities, especially recently in Europe, have placed increasing attention on wetlands-climate change issues (see Annex IV section E). Germany at least is believed to be supporting these issues and is the host for CBD COP 9 (2008). Climate change as an extended issue is to be discussed at CBD COP 10 (2010). There needs to be a very clear and high profile resolution from the next Ramsar COP to CBD COP 10 to both alert that meeting of issues and to get it to influence the UNFCCC (although CBD COP 9 is a closer and better opportunity).

30. Good co-ordination between the Ramsar Convention and the CBD is required. The best opportunity to get wetlands a higher profile at the CBD, and thereon into IPCC and UNFCCC, is via CBD COP 9. Mechanisms to get increased attention to issues at SBSTTA 12 need to be developed. In addition, support through Parties to the CBD should be forthcoming for both SBSTTA 12 and CBD COP 9. Ramsar can play a role in this by alerting Ramsar Parties – particularly those that have delegations of similar composition present at SBSTTA 12 and CBD COP 9 (although co-operation/communication between focal points etc. between the two conventions is often weak).

31. Within the context of the IPCC and UNFCC, there is already some recognition of the importance of wetlands and biodiversity in relation to climate change. Similarly, such is recognised also by the CBD. This situation needs to be reconciled with statements, for example in the peatlands assessment (see

Annex IV section G), calling for seriously increased attention to wetlands (peatlands) in relation to climate change and the general perception of inadequate attention to relevant issues. The expert meeting has noted that whilst references to wetlands are made, including use of the term "important", they are rarely quantified. In addition, the role of wetlands in climate change mitigation (reducing GHG emission etc.) is at present seriously under-emphasised. For example, there is evidence of a continuing and over-riding focus on forests in both the CBD and IPCCC/UNFCCC, whereas the peatlands assessment information (Annex IV section G) provides clear statements that peatlands alone are more important. The case can be strengthened further by including other relevant wetland types and there is an urgent need for improved information on this topic.

1. The Convention on Biological Diversity (CBD)

32. SBSTTA 9 recognized the mutually supportive objectives of the CBD and UNFCCC.

33. COP 7 recognized the protection of peatlands as a beneficial mitigation option and noted the need to pay particular attention on the role of inland waters in mitigation and adaptation to climate change (Decision VII/4). It also recommended the ecosystem approach to consider mitigating actions to cope with long-term changes such as climate change (Decision VII/11).

34. Decision VII/15 on Biodiversity and Climate Change called to take measures to manage ecosystems so as to maintain their resilience to extreme climate events and to help mitigate and adapt to climate change.

35. "Address challenges to biodiversity from climate change" and "Maintain and enhance resilience of the components of biodiversity to adapt to climate change" are part of the CBD Strategic Plan (Decision VII/30).

36. SBSTTA 11 recognized that:

- The "Integration of biodiversity considerations into the implementation of adaptation activities to climate change" as a substantive issue according to the report of the meeting of the Ad Hoc Technical Expert Group on Biodiversity and Adaptation to Climate Change.
- Conservation provisions and decisions/resolutions from the governing bodies of the UNFCCC, CBD, the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention), have identified concrete adaptation activities[...]recognizing the role of ecosystems in adaptation, promoting biological diversity in climate change adaptation measures, and minimizing the adverse effects of adaptation actions on the environment.
- Effective collaboration and networking between biodiversity and climate change communities at all levels is essential for the successful implementation of adaptation activities for biodiversity.

- One activity of particular relevance to the Convention on Biological Diversity is to reduce greenhouse gases resulting from land use, land-use change and forestry (LULUCF). [Note the absence of attention to wetlands].

37. The Council of the Global Environment Facility has adopted a new system of allocating resources to countries in the focal areas of biodiversity and climate change, known as the Resource Allocation Framework (Decision VIII/13).

38. According to COP 8 climate change is one of the strategic issues that will be discussed at COP 10. The "Biodiversity Technology Initiative", taking into account the Climate Technology Initiative (CTI), was requested to be developed in Decision VIII/12.

39. A Memorandum of Cooperation was signed between the CBD and the R***amsar*** Secretariats (Decision III/21).

40. Decision VIII/30 on biodiversity and climate change recommended to "take into account the maintenance and restoration of the resilience of ecosystems which are essential for sustaining the delivery of their goods and services".

41. COP 8, information document 15, recognized the linkage between the conservation and sustainable use of the biological diversity of inland water ecosystems and poverty alleviation/sustainable livelihood noting the role of water (but this information has not been incorporated explicitly in decision texts).

2. The Ramsar Convention (Ramsar)

42. Resolution VI.9 noted the importance of wetlands for the conservation of global biodiversity. Recognizing the need to make the best use of scarce resources, a range of actions to promote cooperation with the Convention on Biological Diversity (CBD) was identified.

43. The need to further develop links with the UNFCCC, in view of the potential impacts on wetlands of climate change, is clearly articulated in Action 7.2.7. That need was further reinforced by Resolutions VII.4 and VII.9.

44. Recommendation 7.1 on the preparation of a Global Action Plan for the wise use and management of peatlands notes the need to include all wetland carbon sinks and sequestration initiatives as key issues in the global discussion concerning the Kyoto Protocol under the UNFCCC.

45. Recommendation 7.2 on small islands [...] strongly endorses the development of a Memorandum of Cooperation between the Ramsar Convention and the UNFCCC articulated in Resolution VII.4.

46. Hydrology and impacts of climate change were considered as gaps in knowledge at COP 7.

47. Resolution VIII.3 recognized "the potentially important role of wetlands in adapting to and in mitigating climate change" and called upon "all relevant countries to take action to minimize the degradation, as well as promote

restoration, and improve management practices of those peatlands and other wetland types that are significant carbon stores, or have the ability to sequester carbon and are considered as mitigation factors".

48. The Technical Report on "Climate change and wetlands: impacts, adaptation and mitigation" prepared by the expert Working Group of STRP:

- Identified that a number of types of wetland ecosystem are amongst those recognized as particularly vulnerable to the impacts of climate change;
- Highlighted the fundamental importance of maintaining hydrological regimes as a key adaptation option; and
- Focused on opportunities for managing particular wetland ecosystems, notably forested wetlands, peatlands and coastal wetlands, to mitigate climate change impacts.

49. Parties at COP 8 also emphasised the important role of coastal wetlands in mitigating impacts of climate change and sea-level rise in the context of achieving integrated coastal zone management. Importantly, Ramsar Parties also recognised the "potential for conflicting challenges for governments in meeting their commitments to implementing UNFCCC and, where appropriate, the Kyoto Protocol, through revegetation and forest management, afforestation and reforestation, and their commitments to the conservation and sustainable use of wetlands".

3. The United Nations Framework Convention on Climate Change (UNFCCC)

50. COP 5 recognized the major role of wetlands as terrestrial carbon stores and the need to consider them as an instrument for mitigating climate change.

51. COP 6 stated that the CBD/Ramsar Joint Work Plan for 2000-2001 addressed a range of topics of direct relevance to climate change issues, notably including the biodiversity effects of coral bleaching, forest ecosystems, and wetland restoration and rehabilitation, as well as inventory and assessment techniques.

Section B - Scientific and Technical Findings

In the following section, reference sources are provided in Annex IV or references are as quoted by sources therein.

4. Information on the general importance of wetlands concerning climate change

(See Annex IV, section A).

52. Much information is accessible in existing Ramsar materials and CEPA products.

53. For key documents on conditions and trends, the Ramsar synthesis of the Millennium Ecosystem Assessment and the Global Biodiversity Outlook 2 mention relevant information concerning biodiversity, wetlands and climate change:

- Amongst the major biomes, biodiversity loss (and possibly habitat area) is fastest from wetlands than for any other major biome;
- Amongst wetland types, available information confirms that the rate of loss is fastest for freshwaters (this is an important point regarding climate change since the impacts are largely on changes in rainfall patterns).

54. An area where further clarity is required is quantitative information on wetland and biodiversity values – especially economic valuations which are likely to have a larger influence on many policies particularly regarding climate change.

55. It is important to note that some target groups still ignore the importance of wetlands services for their livelihood.

56. Wetlands are critically important ecosystems, providing significant social, economic and ecological benefits such as: regulation of water quantity and quality; habitat for waterfowl, fish, and amphibians; resources to meet human needs; recreation and tourism. Climate change will degrade these benefits.

5. Impacts of climate change on wetland species

(See Annex IV, section B)

> *"It is not the strongest of the species that survive, nor the most intelligent, but the most responsive to change" Charles Darwin (1835)*

57. Wetlands are biodiversity 'hotspots'.

58. There are many cases studies showing that climate change is already having an impact on wetland species. There is a clear bias towards birds – and in particular birds in Artic region. It is important to note that this information bias is due largely to information availability – birds in particular being a well studied group where good data are available. They are not necessarily more vulnerable to climate change and trends in bird populations are likely a warning sign for many other species groups.

59. 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[2]. However, more information is required concerning impacts of climate change on wetland species and areas.

60. The results available are ambiguous. Some species will clearly be adversely affected whilst others may benefit. Much emphasis is placed on climate change

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[2] *El Cambio Climático y los Humedales en Centroamérica: Implicaciones de la variación climática para los ecosistemas acuáticos y su manejo en la región*, Junio 2003, Área Temática de Humedales, Agua y Zonas Costeras. Oficina Regional para Mesoamérica (ORMA), Unión Mundial para la Naturaleza (UICN), p.19.

disruptions of migrations. Therefore, the most important response regarding climate change will be to focus on wetland services - and not only on species.

61. Climate change scenarios indicate the potential for widespread changes in populations of Arctic breeding water birds. The level of the impact varies from species to species, and will be affected by both the direct effects of changes in the climate and indirect effects of changes in habitat.

62. The Arctic is of major importance for many water birds. More than two thirds of all geese and almost 95% of all Calidrid sandpipers breed in the Arctic[3].

63. Changes to waterbird populations should also be expected in less severely affected areas. Increased temperatures will advance breeding seasons and possibly reduce winter mortality. The vegetation structure of wetlands can be expected to change, altering the physical aspects of habitats and plant productivity. There will almost certainly be great regional variation, with some areas experiencing increases in waterbird populations and others, decrease[4].

64. We may not be able to predict for which particular species these changes will prove to be important, but their inherent physical diversity increases the probability that they will be of importance for at least some rare or threatened species. Of course, we also must ensure that less common physical habitat types, especially wetlands, continue to be protected, and should aim to increase the number of such sites within the protected area network.

65. Many species also depend upon coastal wetland sites, either as areas of non-breeding or as critical stopover sites; these wetlands are likely to be at risk from projected sea-level rise, as well as from projected climatic change, adding further to the future threats to birds species.

66. Wetlands and non indigenous species (NIS):

    a. Of the various types of aquatic ecosystems, wetlands are particularly susceptible to invasions by non indigenous species due to their location at the land-water interface.

    b. Although < 6% of the earth land mass is wetland, 24% of the world most invasive species are wetland species. The fact that wetlands can contain purely aquatic habitats and terrestrial habitats as well as a range of intermediate habitats alone increases the potential for invasions by non indigenous species which can invade through the terrestrial or aquatic component of the wetland.

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[3] WCMC Biodiversity Series No. 11 Water Birds on the Edge. First circumpolar assessment of climate change impact on Arctic breeding water birds World Conservation Monitoring Centre prepared by Christoph Zöckler and Igor Lysenko

[4] *Waterbirds around the world. A global overview of the conservation, management and research of the world's waterbird flyways.* Climate variability and change and other pressures on wetlands and waterbirds: impacts and adaptation, C. Max Finlayson , Habiba Gitay , Maria Bellio , Rick van Dam & Iain Taylor Edinburgh, U.K. The Stationery Office.

6. Impacts of climate change on wetland ecosystems

(See Annex IV, section C)

67. Degradation of coastal ecosystems, especially wetlands and coral reefs, has serious implications for the well-being of societies dependent on the coastal ecosystems for goods and services and therefore, effective adaptation is urgently required.

68. Sea-level rise is virtually certain to cause greater coastal inundation, erosion, loss of wetlands, and salt-water intrusion into freshwater sources.

69. The common hypothesis is that elevated temperature will increase productivity of wetlands and intensify peat decomposition. That will accelerate carbon and nitrogen emissions to the atmosphere.

70. Seasonal shifts in flow, ice cover, precipitation/evapotranspiration and inputs of sediment and nutrients into wetlands have all been identified as climate-related factors controlling their biodiversity, storage regime, and carbon-methane source-sink status.

71. The impacts of Climate Change cause additional pressures on ecosystems that are already stressed by overuse degradation, fragmentation and loss of total area. These factors reduce not only ecosystem resilience, but also human options for coping with a changing environment.

72. Specific impacts on wetlands are projected to include:

- Initially increased productivity in some mid-latitude regions and a reduction in the tropics and sub-tropics, even with warming of a few degrees.
- Adverse affects on coastal wetlands and coastal fisheries, e.g. coral bleaching events are expected to increase and mangroves are expected to decline in many coastal zones.
- Decreased water availability in many arid- and semi-arid regions.
- 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).
- Overall, it is projected that there will be more adverse than beneficial impacts on wetlands.
- The MA demonstrated that freshwater ecosystem services are in trouble particularly.
- The geographical distribution of wetlands is likely to shift with changes in temperature and precipitation, with uncertain implications for net greenhouse gas emissions from non-tidal wetlands.
- 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.

- Inland and coastal systems are likely to experience large and early impacts. These include:
    - o Increased levels of inundation, storm flooding, accelerated coastal erosion, seawater intrusion into fresh groundwater, encroachment of tidal waters into estuaries and rivers;
    - o Elevated sea surface temperatures and ground temperatures; and
    - o Adverse impacts on marine mammal and bird species, especially migratory and nomadic bird populations that depend on coastal habitats.

73. Increased sea levels will likely force wetland systems to migrate inland. However, this migration path could be obstructed by inland land uses or by the ability of these systems and their components to migrate in time sufficient to survive. For example, many coastal and estuarine wetlands will be unable to migrate inland due to the presence of dikes, levees or specific human land uses close to the coastal area.

74. Restoration and creation can compensate to some extent for the loss natural wetland functions, such as flood storage and water quality buffering and provide opportunities to store carbon.

75. Some good data are emerging on the impacts of climate change on cloud forest ecosystems (pers. comm.. David Stroud).

76. There is evidence that wetlands are more vulnerable to Invasive Alien Species and this threat to wetland species is likely to increase with climate change (pers. comm.. Pascal Badiou).

77. The wetlands community needs to talk to the remote sensing community re. wetlands, remote sensing and climate change.

7. Water

(See Annex IV section D)

"We used to think that energy and water would be the critical issues for [this] century. Now we think water will be the critical issue" (Talba, UNEP)

78. Placing water as the central issue is likely the most important and effective strategy for many key CEPA requirements. ***Audiences must understand better how water-wetlands-biodiversity-climate change are interlinked:***

- The greatest impacts of climate change will be on water cycles.
- Climate change will exacerbate water problems.
- Water is crucial to climate stability.
- The water cycle is critical to the provision of wetland ecosystem services and those services in turn help regulate the water cycle.
- Frequent and more extreme weather events – such as storms, floods and droughts are anticipated. These circumstances put great stress on

the institutional, governance and market-related processes for fresh water and watershed management and use.

- Impacts on water resources will significantly affect on key economic activities.
- Many promising solutions to the problems exist - key fields in which good work lies include poverty-oriented surface and groundwater management and provision, integrated water resource management and payments and negotiation for watershed services. Governance is the key to making most promising solutions work.
- We have choices. Historically, water management practice has regarded nature as the adversary and engineered itself against it—often with catastrophic results. We must begin to plan with nature on our side. Biodiversity is not just the victim of our mismanagement—it is our ally in managing better.

79. Ecosystem changes resulting in changes to the sustained delivery of freshwater supply etc. are extremely important for CEPA because of the links between poverty and human development targets.

80. Ecosystem degradation hits the poor hardest and can be the principal factor causing poverty.

81. Water insecurity linked to climate change threatens to increase malnutrition by 75-125 million people by 2080.

82. The Kyoto Protocol has extremely significant implications for the health of ecosystems including the world's wetlands. More attention is paid by the Protocol on increased outbreaks of water-borne diseases decreased availability of drinking water.

83. There is only one explicit water-related MDG. However, the full range of freshwater ecosystem services will come into play, directly or indirectly, in most actions aimed at achieving the many other ambitious MDG targets on poverty reduction, human nutrition, education, health and environment. Governance frameworks need to recognise this.

84. Half the world’s women still have no adequate drinking water and sanitation at home or nearby (in developing countries, more than 1 out of every 2 families - 3 billion people).

8. Government and regional responses

(See Annex IV section E)

85. Government and regional responses were not reviewed comprehensively and the information provided is much on a “case study” basis (largely recently in Europe).

86. The workshop objective “strengthen in-country adaptation and mitigation planning” requires a better understanding of government responses, and the

political drivers of these, in order to develop effective CEPA related interventions.

87. There is clear evidence that governments are responding to relevant issues, particularly regarding water and climate change. Attention paid to biodiversity is evident in many considerations but largely as an ancillary issue whereas wetlands related biodiversity should be central.

88. A major recent event was the European symposium: "Time to adapt: Climate change and European water dimension (vulnerability-impacts-adaptation-Berlin, 12-14 February 2007, Berlin". Notably, the outcomes of this meeting are likely to influence E.U. policies at CBD COP9 (hosted by Germany):

- We have to prepare for potential changes
- EU Emissions Trading Schemes are important
- When we are making Water and CC legislation we need to recognise the possible conflict between ever higher environmental standards and the impact on the CC of using more energy to meet these standards
- Regulation and policy must reflect the broad social implications of CC
- Good communication on all aspects of the climate will be essential
- If we don't get water right, we will not be able to get right any other sector
- Impacts on water resources will significantly affect on key economic activities
- In some countries, already more than 100% of the yearly water supply is consumed (= unsustainable use!)

9. Regional assessments

See Annex IV section F.

89. Recalling the Scientific Expert Group Report on Climate Change and Sustainable Development[5] specific impacts on wetlands include:

- In Europe: more intense winter precipitation.
- In the Arctic: significant retreat of ice; disrupted habitats of polar flooding, and other hazards; increased summer heat mega fauna; accelerated loss of ice from Greenland Ice Sheet. Warming has been most pronounced in the Arctic region. Globally, all general circulation models (GCM) predict a sharp increase in temperature ranging from 1.3 ^{o}C to 2.4 ^{o}C over the next 50 to 80 years with a doubling of carbon dioxide in the atmosphere. The Arctic region will experience the

[5] The Scientific Expert Group Report prepared for the 15th Session of the Commission on Sustainable Development. Scientific Expert Group on Climate Change (SEG), 2007 "Confronting climate change: avoiding the unmanageable and managing the unavoidable".

strongest warming - up to 5 °C, depending on the model - with the most notable warming in winter and spring.

- In North America: reduced springtime snowpack; waves and melting of mountain glaciers; greater water mountain glaciers; shifting of fisheries; replacement of most tundra changing river lows; shifting ecosystems, with stress in southern regions; intensifying regional climatic by boreal forest; greater exposure to UV-radiation loss of niche environments; rising sea level differences; greater biotic stress, causing shifts in flora; and increased intensity and energy of Atlantic tourism shift from Mediterranean region hurricanes increase coastal flooding and storm damage; more frequent and intense heat waves.
- In Central and Northern Asia: widespread melting of and wildfires; improved agriculture and forest permafrost, disrupting transportation and buildings; productivity for a few decades greater swampiness and ecosystem stress from warming; increased release of methane; coastal erosion due to sea ice retreat.
- In Central America and West Indies: greater likelihood of intense rainfall.
- In Southern Asia: sea level rise and more intense cyclones and more powerful hurricanes; increase flooding of deltas and coastal plains; major increased coral bleaching; some loss of mangroves and coral reefs; melting of mountain inundation from sea level rise; glaciers reduces vital river lows; increased pressure, biodiversity loss, water resources with rising population and need for irrigation; possible monsoon perturbation.
- In the Pacific and Small Islands: inundation of low-lying coral islands as sea level rises; salinization. In Africa: Declining agricultural yields and diminished food aquifers; widespread coral bleaching.
- In global oceans: made more acidic by increasing CO2 security; increased occurrence of drought and stresses powerful typhoons and possible intensification of concentration, deep overturning circulation possibly on water supplies; disruption of ecosystems and loss of ENSC extremes reduced by warming and freshening in North Atlantic biodiversity, including some major species; some coastal inundation.
- In South America: disruption of tropical forests and significant loss of biodiversity; melting glaciers Australia and New Zealand: Substantial loss of coral reduce water supplies; increased moisture stress.
- In Antarctica and the Southern Ocean: increasing risk of significant ice loss along Great Barrier Reef; significant diminishment of water in agricultural regions; more frequent occurrence of from West Antarctic Ice Sheet, risking much higher sea level in centuries resources; coastal inundation of some settled areas; intense periods of rain, leading to

more lash floods ahead; accelerating loss of sea ice, disrupting marine life and penguins increased ire risk; some early benefits to agriculture.

10. Carbon Storage and Greenhouse Gas Emissions

(a) Non-peat wetlands

90. There is some understanding of the role of non-peatland wetlands but it is limited in comparison to peatlands. There is a low understanding of fluxes (the way in which GHG are absorbed and released by wetlands). Basic estimates of gases/vapours stored/emitted from ecosystems are required. Current activities in estimating fluxes are based largely on terrestrial systems. Specific information is available for some wetlands. This needs to be reviewed in more detail. Where data are available they confirm positive carbon sequestration attributes of wetlands (Pascal Badiou and Robert McInnes pers. comm.).

91. Natural emissions from wetlands are not the issue. The issue is how human induced impacts on wetlands are a catalyst for GHG emissions and carbon storage. A considerable amount of carbon is stored in wetlands – the response re. CC is to leave it where it is through the wise use of wetlands.

92. Attention also needs to be given to forested wetlands. A considerable amount of the "forest" biome is wetland dependent (e.g., the Amazon). These systems have very high biodiversity and are very productive (e.g., for fisheries, Coates pers. Comm.). There is a need to engage forest management and policy processes (e.g. UNFF) in this subject.

93. Non-peat wetlands may well sequester carbon more effectively than peatlands.

94. The meeting again stressed that the real issue with wetlands is not sequestration – but in the avoidance of increased emissions through wetlands degradation. The issue is to look at net emissions generated through degradation, or what can be avoided through rehabilitation.

95. Wetland restoration has potential to offset 2.4% of the annual fossil CO2 emission reported for North America in 1990[6]

(b) Peatlands

(See Annex IV section G)

96. Peatland information is the strongest available for wetland-climate change issues (particulary re. GHG emissions relevant to the IPCC).

97. There is already evidence that recent peat data has influenced government policies and investment.

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[6] North American prairie wetlands are important nonforested land-based carbon storage sites. Science of The Total Environment, Volume 361, Issues 1-3, 15 May 2006, Pages 179-188. Ned H. Euliss, Jr., R.A. Gleason, A. Olness, R.L. McDougal, H.R. Murkin, R.D. Robarts, R.A. Bourbonniere and B.G. Warner

98. Peatlands storage:

- Peatlands are the most efficient carbon stores of all terrestrial ecosystems.
- Peatlands cover 3% (some 4 million Km2) of the Earth's land area and store a large fraction of the Worlds terrestrial carbon resources: up to 528, 000 Megatonnes, equivalent to one third of global soil carbon and to 70 times the current annual global emissions from fossil fuel burning (approximately 7, 000 Mt/y in 2006 in carbon equivalent or 26, 000 Mt/y in CO_2 equivalents).

99. Peatlands emissions

- The current peatland CO_2 emission for degraded SE Asian Peatlands is estimated at a minimum of 2000 Mt/y equals. This is almost 8% of global emission from fossil fuel burning. It also arises from only 12 million ha - covering less than 0.2% of the global land surface. This accounts for about 67% of total global emissions from peat. We are thus dealing with a very large but concentrated problem. This distinguishes the peat CO_2 issue significantly from the avoided deforestation issue.
- Deforested and drained peatlands in SE Asia are a globally significant source of CO_2 emissions and a major obstacle to meeting the aim of stabilizing the greenhouse gas emissions, as expressed by the international community.
- Peatland emissions in South-east Asia far exceed fossil fuel contributions from major polluting countries and overshadow the reductions being sought under the Kyoto Protocol. Almost nothing is being done to address this problem even though there are cost-effective solutions and opportunities to do so.
- Siberian peat lands may be a bigger player in climate change than we knew before. If degraded they would release a lot of the carbon they have taken up for centuries.

100. Peatlands biodiversity:

- Peatlands, biodiversity and climate change have very strong mutual feedback relations.
- Peatlands are often the last remaining natural areas in degraded landscapes.
- Peatlands also support adaptation by providing habitats for endangered species and those displaced by climate changes.
- Peatlands demand special approach to biodiversity role and losses evaluation, although they are not recognised as specific objects in conservation strategies and land use plans.

101. Actions needed:

  - o Individual countries, regional authorities (like the EU) and international conventions should establish legislation and practice to curtail the problems of imports of products from vulnerable peatland areas, e.g.: - timber from illegal logging, - biofuel from oil palm plantations on peatlands, - pulp wood and related products from pulp plantations on peatlands.

- Contracting Parties to the UNFCCC should ensure that the CO2 emissions from peatland degradation are taken into account in climate change mitigation strategies.
- An alternative finance mechanism should be developed to trigger and support peatland protection and restoration as an urgent action by nations within their suite of climate change strategies.
- Linked to this, a Global Peatlands Fund should be established to restore peatlands world wide, but with a priority on South-east Asia. Development here should have a pro-poor approach and be based on principles of sustainable use of these vulnerable areas. Local people should be paid for restoring and conserving these globally important areas.
- Methods and support mechanisms for improved water management in agricultural and conservation peatland areas is needed.

102. Many other areas in the world are facing similar problems.

103. The Kyoto Protocol excludes the emissions from soil and (degraded) vegetation and limits itself to reducing emissions from industry, housing, traffic and agriculture. As a result there is little or no attention for peatland degradation, a huge cause of global warming.

11. Biodiversity, wetlands and climate change strategies

(See Annex IV section H)

104. A common strategy to deal with wetland management, aquatic biodiversity conservation and climate change measures, depends on a critical degree of coherence between sectors that are responsible for water resource protection and management, biodiversity conservation, land use management (including agricultural resources), and integrated development planning.

105. An overall recommendation is, as a matter of urgency, to develop a clear understanding of cooperation as a strategy.

106. The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to reduce greenhouse gas emissions in a manner that will allow ecosystems to adapt naturally to climate change (Article 2).

107. Wetlands, in particular peatlands, are significant carbon stores, and so the role of their conservation also needs to be considered in the development of climate change mitigation strategies.

108. There has been little attention given so far by policy-makers to the relationship between climate change and the conservation and wise use of wetlands.

109. Clear responses to mitigation are required. The Stern review (see annex IV section F) has drawn wide attention to the economic importance of mitigation measures.

110. There is considerable confusion of the use of the terms "mitigation" and "adaptation". Although clearly defined by the IPCC – confusion remains, even amongst the scientific community. Caution needs to be taken when using these terms. In particular, CEPA efforts, unless directed at specific groups where terminology is understood, should avoid using the terms altogether and instead use more understandable terms and concepts.

111. A clear mitigation strategy is to avoid deforestation on wetlands.

12. Vulnerability of wetlands to climate change

112. "Vulnerability" is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, the sensitivity and adaptive capacity of that system.

113. Wetland ecosystems are very vulnerable to the impacts of climate change. The conservation and sustainable management of wetlands faces significant challenges in this regard – in particular from inappropriate responses to climate change.

114. Wetland plants are particularly vulnerable to climate change because of the delicate balance between the rainfall, temperature and evapotranspiration that governs their physiology.

115. Some wetlands are more vulnerable to the impacts of climate change. In its Third Assessment Report (TAR), the Intergovernmental Panel on Climate Change (IPCC) concluded that some wetlands, including reefs, atolls, mangroves, and those in prairies, tropical and boreal forests, and arctic (including permafrost) and alpine ecosystems, are considered to be amongst those natural systems especially vulnerable to climate change because of their limited adaptive capacity, and may undergo significant and irreversible damage.

116. Some inland aquatic ecosystems (arctic, sub-arctic ombrotrophic bog communities on permafrost, depressional wetlands with small catchments, drained or otherwise converted peatlands) are most vulnerable to climate change .

117. Coastal zones particularly low lying areas are particularly vulnerable to climate change.

118. The vulnerability of peatlands increases with the exports of their products - e.g.: timber from illegal logging, biofuel from oil palm plantations on peatlands, pulp wood and related products from pulp plantations on peatlands.

119. Islands wetlands, whether located in the tropics or higher latitudes have characteristics which make them especially vulnerable to the effects of climate change, sea level rise and extreme events.

120. Arid and semi-arid areas are especially vulnerable to changes in precipitation as a decline in precipitation can dramatically affect wetland areas.

121. Wetlands in high altitude systems (e.g. Latin America, Africa) are particularly vulnerable. National reports to the UNFCCC contain information on this.

122. Small Island States are particularly vulnerable to wetlands-climate change interactions – particularly along their coastline.

123. The vulnerability of wetlands is partly due to their ecological nature but largely because CC impacts occur mainly on water.

124. There is a need to link vulnerability of wetlands and socio-economic impacts and the case for doing so, and information available, strong. Vulnerability of humans "sells" better than vulnerability of wetlands.

125. The term "disaster" needs to be embedded better in statements. IWMI is doing work currently on the severity of changes in hydrological cycles but this is not currently linking considerations fully to wetlands and ecosystems. .

126. Experience with CC in terms of water availability for wetlands in the United Kingdom shows a need to break down CC impacts into components.

127. Wetlands are already under the most severe threat and CC is an added and significant driver of further change.

128. Wetlands will be much more vital in the future. As water becomes more scarce – the value of wetlands services increases. The MA is a good source of information on this subject.

129. The "rich" are also vulnerable (e.g., the New Orleans flood).

130. A useful indicator of vulnerability is insurance premiums for water related risk. Although many poor groups do not have access to insurance – in many cases it is governments who effectively underwrite potential losses.

131. Vulnerability can also be expressed in terms of "environmental refugees" – a good CEPA term.

132. Vulnerability in developing countries leads to reduced economic growth, and in some cases negative growth. This in turn will have an impact upon OECD countries. This provides improved incentives for appropriately target aid measures.

133. Where extreme events occur (e.g., flooding in New Orleans – China) there needs to be greater awareness that such impacts essentially occur because of inappropriate wetland management.

134. Vulnerability is also linked to the issue of wetlands a human health (e.g., water-born vectors of disease).

135. Protected areas are also vulnerable. As the climate changes, ecological conditions will shift. This may be particularly significant for wetlands. Protected area planners need an increase awareness of this issue. In addition, water (and hence wetlands) forms a significant component of terrestrial

protected areas. Stresses on water availability and wetland functions within these protected areas will likely be a major threat.

136. One of the issues is really to focus on the responses regarding water management and how they impact wetlands. Responses to climate change by the water sector, particularly in water scarce areas, are relatively easy to predict. In many cases direct human needs for sanitation or agriculture (etc.) will certainly override priorities for environmental uses. Massive long-term investments are being planned by many countries (e.g., Australia 20 bn $ to water sector) and this is mirrored by investment banks and donors. These investments are not designed directly to deal with adaptation to climate change but are to deal with its consequences (e.g., water scarcity). There needs to be a clear understand amongst these powerful interests of the role that wetlands can play in helping them achieve more sustainable water supplies and in particular reducing their investment costs. We also need improved understanding of how wetlands are being affected by this process.

137. Large scale water infrastructure responses to climate change are also not necessarily pro-poor. Much information is available on this general subject. CC will exacerbate these problems if the vulnerability of wetlands, and hence of the poor, is not taken into account in policies.

138. The example of Biofuels (palm oil) in Indonesia (see annex IV section G) is an excellent example of how perverse incentives coupled with inadequate knowledge and understanding can lead to inappropriate mitigation responses. In this example, not only is biofuel production leading to net negative carbon storage/ losses but also biodiversity loss and increased poverty. Investments in biofuels clearly need to be aimed at sustainability of production and be pro-poor.

139. The “vulnerability” of wetlands needs to be safeguarded by looking more at what wetlands can do to help achieve human development in relation to water. Appropriate responses are to use the “ecological infrastructure” of wetlands as part of response options. Engineer with nature not against it.

140. Arguments must be developed that will influence policies at “treasury” level.

13. General adaptation measures for wetlands regarding climate change

141. Conservation provisions and decisions/resolutions from the governing bodies of the UNFCCC, CBD and the RAMSAR Convention have already identified concrete adaptation activities.

Examples of complementarity in adaptation options/activities/objectives between selected multilateral environmental agreements (MEAs) [7]/:

Activities	*Source*

[7] This is a sample of the activities listed under the adaptation section of the biodiversity and climate change module of UNEP’s Issue-Based Modules for Coherent Implementation of Biodiversity Conventions (http://svs-unepibmdb.net/)

Activities	*Source*
Element 1. Develop adaptation options	
Ramsar Convention	
Encourage the development of appropriate methods of integration of flood and natural hazard management and water quality control through maintaining natural coastal wetland processes in all phases of integrated costal zone management (ICZM)	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management , Annex (Principles and guidelines for incorporating wetland issues into ICZM)): Action 5.5, Guideline No. 5 –Ensuring the recognition by Contracting Parties of the role of coastal wetlands in regulating water flows and water quality
CBD	
Develop methods for adapting marine and coastal protected areas management in response to possible changing species and habitat distribution patterns, which may result from climate change	**CBD Decision VII/5**, Marine and coastal biological diversity, Annex I (Elaborated programme of work on marine and costal biological diversity): paragraph (c), priority 2.3: Identifying the best indicators for assessing management effectiveness at various scales within an overall system, Appendix 4, research priorities, including research and monitoring projects associated with programme element 3: marine and coastal protected areas
Element 2: Assess adaptation options	
Component 1: protected areas	
UNFCCC	
Provide opportunity for research, including for adaptive measures for protected areas to cope with climate change:	**UNFCCC Article 4.1(e)**, **KP Article 11.2**
Component 2: coastal wetlands	
Ramsar Convention	
Assess the feasibility of adaptation options for coastal wetlands in relation to climate change and sea-level rise scenarios	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management, Annex (Principles and guidelines for incorporating wetland issues into ICZM): Action 6.3, Guideline No. 6 – Ensuring recognition by Contracting Parties of the role of coastal wetlands in mitigating impacts of climate change and sea level rise
Review opportunities for the rehabilitation or restoration of degraded coastal wetlands:	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management, Annex (Principles and guidelines for incorporating wetland issues into ICZM): Action 5.2,

Activities	*Source*
	Guideline No. 5 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in regulating water flows and water quality
Consider the creation of additional constructed wetlands within coastal areas	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management, Annex (Principles and guidelines for incorporating wetland issues into ICZM): Action 5.2, Guideline No. 5 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in regulating water flows and water quality
Assess options for maximizing benefits of coastal wetlands in mitigating climate change and sea-level rise impacts:	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management , Annex (Principles and guidelines for incorporating wetland issues into ICZM): Action 6.2, Guideline No. 6 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in mitigating impacts of climate change and sea-level rise
Component 3: coral reefs	
CBD	
Support further target research programme that investigate management options to building resilience to mass coral bleaching on both short- and long-time frames	**CBD Decision VII/5**, Marine and coastal biological diversity, Annex I (Elaborated programme of work on marine and costal biological diversity): Subparagraph 2(a)(v)(c) of Appendix 1, specific work plan on coral bleaching
Estimate the cost to implement the necessary activities to meet the targets of the programme of work on protected areas	**CBD Decision VII/28**; Protected areas (Articles 8 (a) to (e)), paragraph 10
Element 3: Effectively manage natural systems	
Component 1: general	
CBD	
Take measures to manage ecosystems so as to maintain their resilience to extreme climatic events and to help mitigate and adapt to climate change	**CBD Decision VII/15**, Biodiversity and Climate Change, paragraph 12
Component 2. marine and coastal zones	
UNFCCC	
Develop and elaborate appropriate and integrated plans for coastal	**UNFCCC Article 4.1(e)** and **KP Article 11.2**

Activities	*Source*
zone management	
CBD	
Take measures to manage coastal and marine ecosystems, including mangroves, seagrass beds and coral reefs	**CBD Decision VII/5**, Marine and coastal biological diversity, paragraph 8. The objective is to maintain their resilience to extreme climatic events.
Maximize the effectiveness of marine and coastal protected areas and networks	**CBD Decision VII/5**, Marine and coastal biological diversity, paragraph 8. The objective is to enhance biodiversity by addressing threats.
Identify, test and refine management regimes	**CBD Decision VII/5**, Marine and coastal biological diversity, Annex I (Elaborated programme of work on marine and costal biological diversity): Subparagraph 1(a)(ii), Management actions and strategies to support reef resilience, rehabilitation and recovery, an action identified as being of highest priority for implementation. Specific examples given of means to implement these actions are the application of appropriate protective status, reduction of reef stressors, and management of reef communities. The objective is to enhance reef resilience to and recover from higher sea temperatures and/or coral bleaching.
Component 3: water resources and agriculture	
UNFCCC	
Develop and elaborate appropriate and integrated plans for water resources and agriculture	**UNFCCC Article 4.1(e)** and **Kyoto Protocol Article 11.2**
CBD	
Carry out a series of case studies to identify key goods and services provided by agricultural biodiversity	**CBD Decision V/5**, Agricultural biodiversity: review of phase I of the programme of work and adoption of a multi-year work programme, Annex 5 (Programme of work on agricultural biodiversity): Activity no. 2.1, Programme element 2. Adaptive management. One of the specific issues that the case studies are required to deal with is the role of genetic diversity in providing resilience, reducing vulnerability, and enhancing adaptability of production systems to changing environments and needs. According to the Appendix to CBD Decision V/5 agricultural biodiversity provides the

Activities	*Source*
	following climate-related ecological services: erosion control and climate regulations and sequestration.
Component 4: drought, desertification and floods	
UNFCCC	
Develop and elaborate appropriate and integrated plans for protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods	**UNFCCC Article 4.1(e)** and **Kyoto Protocol Article 11.2**
Component 5: wetlands	
Ramsar Convention	
Plan the management of mangrove ecosystems, including required adaptation measures	**Ramsar Resolution VIII.32**, Conservation, integrated management, and sustainable use of mangrove ecosystems and their resources, paragraph 20. The objective is to ensure that they may respond to impacts caused by climate change and sea-level rise.
Manage wetlands through effective strategies, among others, through promoting wetland and watershed protection and restoration.	**Ramsar Resolution VIII.3**, Climate change and wetlands: impacts, adaptation and mitigation, paragraph 14. The objective is to increase wetland resilience to climate change and extreme climatic events and to reduce the risk of flooding and drought in vulnerable countries.
Integrate fully the "Principles and guidelines for wetland restoration" into National Wetland Policies and Plans.	**Ramsar Resolution VIII.16**, Principles and guidelines for wetland restoration, paragraphs 11 and 12
Put priority on wetlands which are of special significance for coastal protection	**Ramsar Resolution VIII.25**, The Ramsar Strategic Plan 2003-2008, Annex (The Ramsar Strategic Plan 2003-2008): Action 3.3.1, Operational Objective 3.3: Increase recognition of significance of wetlands for reasons of water supply, coastal protection, flood defence, food security, poverty alleviation, cultural heritage, and scientific research, Operational Objective 3. Integration of wetland wise use into sustainable development.
Component 6: migratory species	
CMS	

Activities	*Source*
Maintain a network of suitable habitats in relation to the migration routes of migratory species in CMS agreements	**CMS Article 5(f)**
Component 7: Effectively manage forest ecosystems	
CBD	
Promote the maintenance and restoration of forest biodiversity in forests	**CBD Decision VI/22**, Forest biological diversity, paragraph 10 and CBD Decision VI/22, Annex (Expanded programme of work on forest biological diversity): Programme element 1: conservation, sustainable use and benefit-sharing, goal 1: to apply the ecosystem approach to the management of all types of forests, objective 3: mitigate the negative impacts of climate change on forest biodiversity, activity (c). The objective is to enhance the capacity of forests to adapt to climate change.
Develop coordinated response strategies and action plans on forest biological diversity at global, regional and national levels	**CBD Decision VI/22**, Forest biological diversity, paragraph 10 and CBD Decision VI/22, Annex (Expanded programme of work on forest biological diversity): 10: Programme element 1: conservation, sustainable use and benefit-sharing, goal 1: to apply the ecosystem approach to the management of all types of forests, Objective 3: mitigate the negative impacts of climate change on forest biodiversity, Activity (b)
Element 4: Promote societal actions	
Activities	Source
Ramsar Convention	
Increase the adaptive capacity of society to respond to the changes in wetland ecosystems due to climate change	**Ramsar Resolution VIII.3**, Climate change and wetlands: impacts, adaptation and mitigation, paragraph 15
CBD	
Consider and promote the mainstreaming of agricultural biodiversity into national plans, programmes and strategies	**CBD Decision VII/3**, Agricultural biological diversity, paragraph 10
Element 5: Restore degraded ecosystems	
CBD	

Activities	*Source*
Develop and implement programmes to restore degraded mountain ecosystems.	**CBD Decision VII/27**, Mountain biological diversity, Annex (Programme of work on mountain biological diversity). The objective is to enhance the capacity of mountain ecosystems to restore and adapt to climate change.
Ramsar Convention	
Review opportunities for the rehabilitation and restoration of degraded coastal wetlands	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management , Annex (Principles and guidelines for incorporating wetland issues into ICZM): Action 1.2.1 of Goal 1.2: To protect, recover and restore mountain biological diversity, Programme element 1: direct actions for conservation, sustainable use and benefit-sharing
Element 6. Integrate adaptation measures into other policies and strategies	
CBD	
Integrate climate change adaptation measures in protected area planning, management, and design	**CBD Decision VII/28**, Protected areas (Articles 8 (a) to (e)), Annex (Programme of work on protected areas): Suggested activity no. 1.4.5, Goal 1.4 – To substantially improve site-based protected area planning and management, Programme of Work on Protected Areas
Ramsar Convention	
Apply the *Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM)*	**Ramsar Resolution VIII.4**, Wetland issues in Integrated Coastal Zone Management, Annex (Principles and guidelines for incorporating wetland issues into ICZM): Action 6.2, Guideline No. 6 – Ensuring the recognition by Contracting Parties of the role of coastal wetlands in mitigating impacts of climate change and sea-level rise of Principle 3. Coastal wetlands have important values and functions and provide multiple goods and services of high economic value: Ensure that information on the implications and vulnerability of coastal wetlands in relation to climate change and sea-level rise, and the options for maximizing their benefits in mitigating climate change and sea-level rise impacts are made available to the integrated coastal zone management (ICZM) processes

142. Adaptation procedures and risk management practices for the water sector are being developed in some countries and regions (e.g. Caribbean, Canada,

Australia, Netherlands, UK, USA, Germany) that recognize the uncertainty of projected hydrological changes.

143. Opportunities for adaptation measures need to be sought where possible. Many options are not necessarily understood at the planning level. Awareness needs to be raised of adaptation measures available.

144. The meeting felt that there were no real gaps in adaptation measures – although the economic costs and benefits of such measures need to be explored and elaborated more clearly in many instances. Adaptation measures are available – but are site specific.

145. In coastal areas a key measure is to keep options open for mangroves to retreat in response to sea-level rise.

146. Regarding adaptation measures for wetlands within ecological networks – there is a proportionately higher role of wetlands. Wetlands are one of the last remaining links between ecosystems. Adaptation measures should focus on wetlands. These include wetlands as "corridors" (e.g. rivers), including their riparian terrestrial zones, and as "stepping stones". Wetlands are also critical for drinking water etc. for migratory species or species that shift their distributions in response to CC.

147. Restoration of wetlands is a key requirement under general adaptation measures for wetlands.

14. Gaps in information

148. Hydrology and impacts of climate change were considered as gaps in knowledge at RAMSAR COP 7.

149. The following five gaps have already been identified[8]:

   i) Obtaining knowledge of the extent of many wetland types, their condition and their hydrology ;

   ii) Improved understanding of the response of wetlands and wetland species to changes in climatic factors and other pressures;

   iii) Development of data and models for the geographical distribution of species and their response to climate change at regional level;

   iv) Development of models that include patterns of human land use and water use to provide a realistic projection of the future state of wetlands; and

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[8] *Waterbirds around the word: A global overview of the conservation, management and research of the world's waterbird flyways, Climate variability and change and other pressures on wetlands and waterbirds: impacts and adaptation,* C. Max Finlayson , Habiba Gitay , Maria Bellio , Rick van Dam & Iain Taylor, Edinburgh, U.K. The Stationery Office.

v) Indicators to measure the effect of adaptation and mitigation options for climate change.

150. The meeting identified the following additional gaps, some of which overlap:

i) The key gap is valuation of wetland services regarding interactions with climate change;

- values of wetlands for CC mitigation
- values of wetlands for adaptation (or costs of inappropriate or no adaptation)
- Without improved information on this subject it will continue to be difficult to further engage with the CC community.

ii) Flux measurements for non peat wetlands;

- Currently flux measurements are based largely on terrestrial systems

iii) Disaggregate forested wetlands from forest data in order to engage the forestry community better;

iv) Map current wetlands extent v. agricultural expansion in relation to water to refine scenarios for water use, demand and potential impacts on wetlands Undertake an analysis of how sectors will respond to climate change and the implications of these responses for wetlands; and

v) Investigate the role of incentives (positive and negative) on wetlands in relation to climate change.

Annex I

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Annex II

Agenda of the meeting

Friday 9.00 am – 1.00 pm

ITEM 1. OPENING OF THE MEETING

The meeting will be opened by Nick Davidson (Deputy Secretary General, Ramsar Convention) 0900 h on Friday, 23 March, 2007.

ITEM 2. OBJECTIVES AND OUTPUTS OF THE MEETING

David Coates (SCBD) will explain the background, objectives and anticipated outputs of the meeting, which will include:

i. The key messages and technical information concerning the subject in question;

ii. recommended strategies re. Communication, Education & Public Awareness (CEPA) etc. and synergies between conventions, and

iii. Priority CEPA materials required.

The actual CEPA materials themselves will be produced post workshop – subject to available resources.

A background document will be provided to all participants which will include a summary of much, but not all, relevant background information. This document has no official status and is a resource to help the meeting process.

ITEM3. ORGANIZATIONAL MATTERS

The meeting organisers will present the proposed organisation of the meeting

ITEM 4. KEY MESSAGES, AND INFORMATION AVAILABLE TO SUPPORT THEM

The following topics will guide the meeting in terms of identifying and assessing current information available and priority information needed in order to raise the awareness of wetland-biodiversity considerations in the international debate on climate change. The deliberations of the meeting will be used (following the meeting) to draft CEPA materials to achieve this purpose. The meeting will focus on key points to be made in short, concise, and easily understood CEPA materials.

CONDITIONS AND TRENDS

4.1 Information on the general importance of wetlands and the biodiversity it supports *(See Background report p.24)*

4.2 Trends in wetlands and wetland biodiversity in general

(See Background report p.7-8)

4.3 Vulnerability of wetlands to climate change

(See Background report p.19-23)

4.4 Evidence of impacts of climate change on wetlands

- Examples of impacts on wetland species *(See Background report p.26-28)*

- Examples of impacts on wetland services *(See Background report p.28-30)*

- Key impacts of climate change on wetlands *(See Background report p.5-6)*

RESPONSES, ADAPTATION AND MITIGATION

4.5 General adaptation measures for wetlands regarding climate change

(See Background report p.5, 6, 10-12, 17-19)

4.6 The role of wetlands in greenhouse gas emissions/carbon storage

(See Background report p.11-14)

- Emissions from degraded wetlands

- Potential of wetlands for carbon sequestration

4.7 Mitigating the impacts of climate change

(See Background report Annex II)

- Maintaining restoring wetland functions as a response to mitigate CC

- Key responses to reduce GHGs

4.8 Vulnerability of wetlands to inappropriate adaptation measures

(See Background report Annex II)

- Impacts of land adaptation

- Impacts water use adaptation (e.g., responses by agriculture re. water use)

- The impacts of "business as usual" wetland response measures to climate change (pouring more concrete)

Friday 2.00 – 6.00 pm

ITEM 5. PRIORITY CEPA-RELATED NEEDS

The meeting will identify priority CEPA related needs in relation to immediate outcomes of the meeting, including identifying some key target groups or processes where CEPA is required, some key messages to those groups, and the basic format and style of such messages.

The meeting will revisit this item after discussing key messages (below). But before discussing messages (and technical justification for them) – it is considered important to have an initial overview of the CEPA issues and needs.

Under this item the meeting will also discuss responses by the Conventions:

(See Background report, Annex I)

i. current activities under relevant conventions;

ii. linkages between conventions; and

iii. priority strategies to raise the profile of wetlands & climate change in conventions.

Saturday 9.00 am – 6 pm

ITEM 5. PRIORITY CEPA-RELATED NEEDS CONTINUED

ITEM 6. GAPS IN INFORMATION

The meeting will discuss gaps in the available information in relation to achieving desired CEPA outcomes.

The meeting may also, subject to time availability, consider how priority gaps may be addressed.

ITEM 7. CLOSURE OF THE MEETING

The meeting will close at 1800 h on Saturday 24 March 2007.

Annex III

Key messages

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
GENERAL WETLANDS - CC Amongst the major biomes, biodiversity loss (and possibly habitat area) is fastest from wetlands than for any other major biome; Amongst wetland types, the rate of loss is fastest for freshwaters (this is an important point regarding climate change since the impacts are largely on changes in rainfall patterns). Climate change is already having an impact on wetland species. Some species will clearly be adversely affected whilst others may benefit. Initially increased productivity in some mid-latitude regions and a reduction in the tropics and sub-tropics, even with warming of a few	- Wetlands are severely affected by CC. - Wetlands loss and degradation accelerate CC. - Coastal and inland wetlands can mitigate social and economic costs of extreme weather events - Climate Change is likely to be the main driver of biodiversity loss in the future. Biodiversity has already been affected by recent climate change and projected climate change for the 21st century is expected to affect all aspects of biodiversity (IPCC 2002).	- Maintaining healthy wetlands is an insurance against CC impacts. We must use them wisely - Good wetlands management and protection assists in reducing CC.

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
degrees Increased forest productivity, including that of forested wetlands Overall, it is projected that there will be more adverse than beneficial impacts on wetlands. Wetland ecosystems are very vulnerable to the impacts of climate change.	- Wetlands are very vulnerable to inappropriate adaptation measures to climate chance.	
WETLANDS AND GREENHOUSE GAS EMMISSIONS - Wetlands cover approximately 6% of the Earth's surface and contain about 35% of global terrestrial carbon - Although wetlands are a major source of methane globally, they do not contribute to the enhanced green house effect as they have always been a natural source of methane - 1/3 of land use release CO2 emissions coming from peatland degradation - Palm oil as a biofuel is a major driver of peatlands degradation which cover in SE Asia 0.2% of the earth's land surface, but emit an equivalent of 8% of global fossil fuel emission	- Wetlands can be both a source or sink for GHG depending upon management policies - Wetlands regulate local climates - Release of carbon from wetlands degradation will offset the gains made by the world community to reduce GHG emissions. - Wetlands are critically important for both mitigation (reducing the rate of GHG increases in the atmosphere) - and adaptation (dealing with the severe impacts of	- Pay local communities for biodiversity + carbon store activities - Restoring and preserving wetlands will protect and enhance carbon stores globally - Regulate and act in the long term bearing in mind CC scenarios - Plan to use wetlands in mitigating CC. - Generate improved scientific information on GHG fluxes for wetlands other than peatlands - The restoration of flood plain wetlands

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
- Investments in carbon emission avoidance through peatland restoration are 100 times more effective as investments elsewhere. Peatlands alone store twice the carbon present in forest biomass of the world and that their storage is a very long term, contrary to forests. Precise information concerning the storage-capacity of other types of wetlands is missing Kyoto Protocol excludes the emissions from soil and degraded vegetation, allowing no consideration of peatland degradation which is a huge cause of global warming Peatlands are the most efficient carbon stores of all terrestrial ecosystems Peatlands cover 3% (some 4 million Km^2) of the Earth's land area and store a large fraction of the Worlds terrestrial carbon resources: up to 528, 000 Megatonnes, equivalent to one third of global soil carbon and to 70 times the current annual global emissions from fossil fuel burning (approximately 7, 000 Mt/y in 2006 in carbon equivalent or 26, 000 Mt/y in CO2 equivalents)	climate change) - Biofuel production does not necessarily reduce GHG emissions – it can increase them in addition to having negative net outcomes for biodiversity and poverty - Urgent need to reduce / eliminate avoidable carbon emissions from wetland loss and degradation- especially from peatlands - the crucial role of some wetlands (e.g. peatlands as carbon stores) is not currently recognised by some key institutions and mechanisms	will result in the accumulation of carbon and assist in moderating climate change - Establish immediately a global peatland fund to counter the huge CO2 emissions and address poverty, biodiversity and water & land degradation issues. - UNFCCC, UNCCD, CBD, Ramsar, World Water Forum & CSD should form one global committee on peatlands to establish the policy mandate for action and investment. - Promote sustainable palm oil production - Develop alternative mechanisms to the CDM to deal with wetlands (peatlands) carbon trading issues. - Promote multi-convention cooperation - Promote free trade in avoided Carbon emissions - Adopt pro-poor operational mechanisms

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
The current total peatland CO2 emission of 2000 Mt/y (S.E. Asia) equals almost 8% of global emission from fossil fuel burning. Peatland emissions in South-east Asia far exceed fossil fuel contributions from major polluting countries and overshadow the reductions being sought under the Kyoto Protocol. Peatlands, biodiversity and climate change have very strong mutual feedback relations		
WETLAND SPECIES AND CC Wetlands harbor an enormous level of biodiversity , the impacts of climate change on wetlands is likely to have significant effects on their biodiversity. Significant impacts of CC on wetlands related species include: decrease of wetlands productivity; proliferation of invasive species; loss of biodiversity (including a lot of endangered or endemic species)	- Monitoring of some species can provide cost effective indicators of changing wetland conditions	- Generate improved information of CC impacts on wetlands species other than birds - Strengthen monitoring of wetlands and its biota so as to guide adaptive management. - Develop a long-term monitoring system to predict trends of species-habitats-ecosystems because of the predictable and unpredictable changes in biodiversity of wetlands

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
WETLANDS SERVICES - Wetlands provide many ecosystem services important for security and especially for marginalized and poor sectors. These services are dependent on maintenance of the biodiversity in wetlands. - The services provided by wetlands are: **Freshwater :** Trapping of water within a catchment – wetlands protect water quality and quantity **Climate regulation:** **Pollution control:** Sanitation, waste management (human +agriculture), replacement cost and health implications **Hydrological regimes:** Groundwater recharge (linked to freshwater) + Regulation/moderation of extreme events (linked to natural hazards-floods and storage) **Erosion :** Link to extreme events –trapping sediments **+** Regulation of erosion supports – sustainable agriculture **Natural hazards :** Loss will exacerbate impacts	**-** Wetland services are critically important to human welfare - Wetlands services are impacted directly and indirectly by climate change - Wetlands mitigate against the impact of extreme events due to climate change **(**natural hazards-floods and storage) - Freshwater ecosystem services are in trouble particularly	- Management approaches that maintain wetland services (ecological and economic) - Maintain, restore or create wetlands - Strategic planning for wetlands (as a response option especially to floods)

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
to most vulnerable people + infrastructure (wetland dependent communities)**+** Wetlands will buffer effects of extreme events (rising sea level) **Food :** Food security -eg. fisheries + rice padi for wetlands dependent communities +Use of wetlands for aquaculture and agriculture – increased of water from wetlands for irrigation **Nutrient cycling :** Removal functions **+** Impact on food chain**.** Wetlands are locally and globally important for cycling nutrients (links to sanitation – water purification and detoxification) **Soil formation :** Accumulation at organics – sequesters carbon **Biodiversity (links to food etc.):** Rates of migration of the ecosystem will not keep up with CC		
WATER The main impact of CC is on water	- CC will manifest itself through alterations to the hydrological cycle	- Restore and preserve wetlands to sustain water resources in the face of

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
	- Water is vital to wetlands, changing climates will change the distribution of water and wetlands - Water is essential for life. Wetlands play an essential role in water cycle- access to water quantity and quality - Competition for water resources will intensify. -The direct needs of potable water supply will conflict with needs for maintained wetlands ecosystems, most likely to detriment of wetlands biodiversity - Scarcity of water will increase the value of wetlands - Food production is affected by CC - Fisheries feed a large part of the world - fish need wetlands and rivers - Wetlands are under threat already from agricultural water resource development (the main user of water) – as the global population	climate change. - Maintain wetlands intact and open as an engineering response – working with wetlands - Maintain wetland functions that support environmental security (e.g. buffer floods, erosion, disease control) - Promote effective means of allocating water for the needs of people, resulting in a mutual benefit for all users – including local communities - Incorporate wetlands into new water management framework. - Water management planning to integrate technological & infrastructure solutions with the environmental services provided by wetlands -Urgently integrate coastal zone management including managed retreat of inter-tidal habitats as a response to rising seas levels - Include wetland option in economic cost

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
	increases those pressures will increase. - Wetlands can reduce the costs of new water infrastructure needed to cope with the impacts of CC. - Impacts on water resources will significantly affect on key economic activities	analysis for response options - Engage agricultural and water sectors to maintain or rehabilitate wetlands
WETLANDS AND PEOPLE Wetlands provide sustainable livelihoods for billions people, many of which are vulnerable and impoverished. Millions of people are directly dependent upon the water, food and the other ecosystem services provided by wetlands. Women undertake 80 % of agriculture in the developing world and/or support many households or family structure. Agriculture depends on water. Half the world's women still have no adequate drinking water and sanitation at	- Wetlands loss and degradation accelerated by CC will have a misappropriate impact on the world's vulnerable communities - Securing wetlands in CC adaptation responses will maintain viable communities - Wetlands must be protected to maintain dependent communities - Wetlands are of crucial importance for water security especially for the poor.	- Promote wetlands preservation/ restoration as a means to respond to climate change impacts on livelihoods of people depending on wetlands resources/services - Pro-poor policies on wetland development, taking into account wetland-dependent people. - Provide effective mechanisms to involve women in making the choices or responses that will affect their livelihoods (e.g., use of wetlands for water, food…)

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
home or nearby (in developing countries, more than 1 out of every 2 family -3 billion people) Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place. Avoiding the unmanageable and managing the unavoidable will require an immediate and major acceleration of efforts to both mitigate and adapt to climate change (including efforts to maintain biodiversity and water resources).	- Women in developing countries are particularly vulnerable to changes in services provided by wetlands. - Poor and marginalized groups are particularly vulnerable to CC - Children are the future generation that will be impacted most by wetlands loss and aggravated CC Restoring and managing wetlands sustainably will reduce the vulnerability of poor people to CC in terms of : water supply, food security , disaster risk reduction (health and infant mortality…) There are significant negative health impacts of CC on wetlands (e.g. distribution and spread of waterborne disease, sanitation) - Wetland degradation is a major constraint to achieving the MDGs, climate change exacerbates this problem - Sustainable management of	- Wetlands-climate CEPA with a special responsibility to empower children in the debate as they are the future generation that will be impacted most by wetlands loss and aggravated CC

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
	wetlands will reduce vulnerability of particularly the poor to climate change impacts and is a tool for progress towards achieving the MDGs	
ECOLOGICAL NETWORKS AND LANDSCAPE APPROACHES As climate changes – protected areas, and species living within them, will need to shift location (e.g., by altitude and latitude) in order to maintain their ecological character Climate change has significant impacts on migratory species. The ability of species to migrate between habitats must be maintained.	- Wetlands are disproportionately important to maintain ecological networks (crucial for climate change adaptation) - Adequate national (and thus international) networks of protected areas will be essential to provide core habitats for establishment of biota whose distributions are changing. Such networks should include linkages provided by ecological corridors - Including wetlands in landscape level planning for ecosystem services will reduce costs in climate change adaptation responses	- Adopt an integrated management approach as the key issue for wetlands wise use - Incorporate wetlands (and especially corridors along rivers) as key elements of protected area network planning. - Use wetlands to maintain corridors between terrestrial protected areas.

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
	- Many current conservation measures could become redundant under CC scenarios as wetlands change (migrate, desiccate, and flood)	
<u>INSTITUTIONAL MECANISMS</u> Climate change, and appropriate responses for wetlands, require appropriate institutional mechanisms to deal with the challenges and maximise the contribution of wetlansds to human welfare in a changing world. There has been little attention given so far by policy-makers to the relationship between climate change and the conservation and wise use of wetlands.	- Impacts of climate change on a local level will resonate at a global level via ripples and ultimately waves, across the global macro-economic pond. - Lack of awareness of ecological infrastructure and its importance - Lack of coordination between major policy platforms, e.g., the MEAs - Need for greater awareness of role of wetlands in carbon storage by policy makers within UNFCCC and other international processes and for this awareness to follow through to relevant policy development - The objectives of RAMSAR, CBD	- Mainstream wetlands into sectoral planning, including economics, health, tourism etc. - Embed simple and robust monitoring systems into planning - Business deals between the global community and local communities that combine poverty reduction with environment protection and biodiversity conservation -National economic planning include investment in wetlands protection –to reduce the costs of climate change adaptation - Planning processes and adaptive management responses that take into

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
	and UNFCCC are interlinked – especially in relation to wetlands, biodiversity and climate change - The UNFCCC, CBD and the RAMSAR Convention have already identified concrete adaptation activities, implementation is required - Governance is the key to making most promising solutions work. - Biodiversity is not just the victim of our mismanagement—it is our ally in managing better	account CC scenarios. - Feature wetlands substantially in earth observation and other monitoring systems - Planning cycles that embed long-term climate change scenario's, taking account of e.g. flooding and drought risks and the potential of wetlands for mitigating such risks. - Improved coordination between MEAs duplication of work avoided - Treasury guidelines on rates of recovery / financial models that consider climate change impacts. - Establish trading mechanisms as an incentive for preservation of existing carbon stores within well managed wetlands at the local level - Financing carbon sequestration and storage that links environment, biodiversity and livelihood - Investing in wetland restoration to

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
		reduce the costs of insurance premiums - Establish finance mechanisms that directly empower local communities and indigenous people (under effective governance and with high transparency in policy and decision making) - Micro-financing systems linking conservation objectives with livelihood improvement. - Provide positive incentive mechanisms to local communities for improving wetland management (enhancing climate adaptation capacity) - The use of technical and scientific information is the key issue for an integrated management approach - Wetlands scientific information must be presented in language appropriate to the decision making process - Academic and educational institutions include climate change and importance of wetlands in their curriculum (according to the level of grades)

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
		- Institutions that are more inclusive and equitable, empowering marginalized groups - Change the current development policies to reduce wetlands degradation and enhance adaptation/mitigation of climate change - Wetlands included in national adaptation plans - Insert wetlands into water & climate change fora/dialogues, & water, sanitation and poverty reduction fora - More responsive attention from the international community to the issues raised by CC - Join up responses and policies at international scales – this will require greater coherence and policy coordination within government by relevant administrative authorities - The Kyoto protocol has to include wetlands as carbon sinks (as for forests) and allow credits for avoiding

KEY ISSUES	KEY MESSAGES	KEY RESPONSES
		deforestation including peatlands in developing countries - Improve communication to accelerate adaptation and mitigation by increasing education efforts and creating forums for dialogue, technology assessment, and planning. - Engage the full range of public- and private-sector participants should be engaged to encourage partnerships across industrial and academic experts, the financial community, and public and private organizations

Annex IV

Some information relevant to CEPA

1. In the following sections sources of information are noted as appropriate. Specific references are as quoted in the main reference.

Section A - Information on wetlands values and functions

2. *General information from RAMSAR*[9]

Wetland ecosystems are part of our natural wealth. A recent assessment of the dollar value of our natural ecosystems estimated them at US$ 33 trillion*. The study estimated the global value of wetland ecosystems at an amazing US$ 14.9 trillion, 45% of the total. This reflects the many functions of wetlands.

Reservoirs of biodiversity

Freshwater wetlands hold more than 40% of the world's species and 12% of all animal species. Some wetlands contain significant numbers of endemic species - such as Lake Tanganyika with 632 endemic animal species and the Amazon river with an estimated 1,800 endemic species of fish.

Wetland biodiversity is a significant reservoir of genes that has considerable economic potential in the pharmaceutical industry and in commercial crop plants such as rice.

Coral reefs rival tropical rainforests in terms of biological diversity; they may contain 25% of all marine species. Reefs hold an estimated 4,000 species of fish and 800 species of reef-building corals; total number of species associated with reefs may be over one million.

Commercially bred crops, such as rice, have a "lifespan" of 10-15 years before new genetic material is required to combat pest and disease problems. Wetland animal and plant species play a role in the pharmaceutical industry – 80% of the world's population depends on traditional medicine for primary health care.

Climate change mitigation

Wetlands have been identified as significant storehouses (sinks) of carbon.

Using Ramsar's broad definition of wetlands this may amount to as much as 40% of global terrestrial carbon. Peatlands and forested wetlands are particularly important as carbon sinks. Although covering only 3% of the world's land area, peatlands are estimated to store over 25% of the soil carbon pool.

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[9] http://www.ramsar.org/info/values_intro_e.htm

Although wetlands are known to play an important role in the global carbon cycle their full role is not yet completely understood. What is clear is that drainage, conversion to agricultural use and degradation of wetlands will release large quantities of carbon dioxide (which accounts for at least 60% of the warming effect) as well as other greenhouse gases contributing to global warming.

Wetlands and climate change

The interactions of physical, biological and chemical components of a wetland, such as soils, water, plants and animals, enable the wetland to perform many vital functions, for example: water storage; storm protection and flood mitigation; shoreline stabilization and erosion control; groundwater recharge (the movement of water from the wetland down into the underground aquifer); groundwater discharge (the movement of water upward to become surface water in a wetland); water purification through retention of nutrients, sediments, and pollutants; and stabilization of local climate conditions, particularly rainfall and temperature.

Wetland ecosystems are very vulnerable to the impacts of climate change. The conservation and sustainable management of wetlands faces significant challenges in this regard – in particular from inappropriate responses to climate change.

Wetlands also offer opportunities for significant mitigation of the impacts of climate change ranging from the improved management of green house gas emissions, and absorption, by wetlands (in particular peatlands) to the role of healthy wetlands in mitigating the impacts of extreme climatic events (for example, mitigating extreme floods or droughts and protection of coastal areas from storms).

Water purification

Plants and soils in wetlands play a significant role in purifying water, removing high levels of nitrogen and phosphorous and, in some cases, removing toxic chemicals.(Florida cypress swamps removed 98% of all nitrogen and 97% of all phosphorous entering the wetlands from waste water before this water entered the ground water).

Sediment and nutrient retention and export

Wetlands slow the passage of water and encourage the deposition of nutrients and sediments carried in water. Nutrient retention in wetlands makes them among the most productive recorded, rivalling even intensive agricultural systems (interest for biodiversity).

Flood control

Wetlands often play a crucial role in flood control. Loss of floodplains to agriculture and human habitation has reduced this capacity.

Constructions of levees and dams on rivers to improve flood control have often the reverse effect.

Groundwater replenishment

Many wetlands help recharge underground aquifers that store 97% of the world unfrozen freshwater. Groundwater is of critical importance to billions of people as their only source of drinking water. Groundwater is the only source of water for many irrigation programmes -17% of the world's cropland is irrigated.

Shoreline stabilisation and storm protection

Coastal wetlands play a critical role in many parts of the world in protecting the land from storm surges and other weather events (mitigation of CC consequences); they reduce wind, wave and current action, and coastal vegetation helps to hold sediment in place.

Wetland products

The list of products from wetlands exploited by humans is immense. One billion of people eat fish as their primary source of protein. The majority are marine fish, two third of which rely on coastal wetlands at some stage in their life cycle. Well managed, coral reefs can produce 15 tonnes of fish and other seafood per km^2 per year.

Cultural value

Although largely an unexplored, poorly documented subject, wetlands are frquently of religious, historical, archeological and other cultural significance at the local or national level (eg: in a preliminary survey of Ramsar sites, over 30% of 603 Ramsar sites recorded)

Recreation and tourism

Many wetlands are prime locations for tourism. Wetlands offer activities such as fishing, hunting and boating etc. They are ideal environment for involving the public and school children in a recreational atmosphere to raise awareness of environmental issues.

Section B - Information on the impacts of climate change on wetlands species

3. *Migratory Species and Climate Change: Impacts of a Changing Environment on Wild Animals, UNEP / CMS Secretariat, Bonn, Germany. Produced by UNEP / CMS Convention on Migratory Species and DEFRA, Coordinator Heidrun Frisch, CMS Secretariat*

The impacts of climate change on biodiversity are already visible. Studies show clearly that changes in distribution and Behaviour of a large number of species are the consequence of shifts in local or regional climate, weather patterns and resulting changes of vegetation and habitat quality. The work of the Intergovernmental Panel on Climate Change has also made us all aware that Climate Change is likely to be the main driver of biodiversity loss in future.

The impacts of Climate Change cause additional pressures on ecosystems that are already stressed by overuse degradation, fragmentation and loss of total area. These factors reduce not only ecosystem resilience, but also human options for coping with a changing environment.

4. *Global Climate Change and Wildlife in North America, The Wildlife Society, Technical Review 04-2, 2004*

Biodiversity has already been affected by recent climate change and projected climate change for the 21st century is expected to affect all aspects of biodiversity (IPCC 2002).

Enhancing or replacing other services, such as contributions to nutrient cycling, ecosystem stability, and ecosystem biodiversity are much harder to imagine. The loss or reduced capacity of ecosystem services may be one of the major sources of surprise from climate change and variability.

5. *WCMC Biodiversity Series No. 11 Water Birds on the Edge. First circumpolar assessment of climate change impact on Arctic breeding water birds World Conservation Monitoring Centre prepared by Christoph Zöckler and Igor Lysen*ko

During the course of the past century global temperature increased by 0.5 C. This is strongly correlated with carbon dioxide levels, which have steadily increased from 280 ppmv before industrialisation to 355 ppmv at present. Warming has been most pronounced in the Arctic region. Recently, Oechel et al. (1993) observed a rise in summer temperature over the last 25 years in North Alaska. Globally, all general circulation models (GCM) predict a sharp increase in temperature ranging from 1.3 C to 2.4 C over the next 50 to 80 years with a doubling of carbon dioxide in the atmosphere. The Arctic region will experience the strongest warming - up to 5 C, depending on the model (Neilson & Drapek 1998) - with the most notable warming in winter and spring.

The Arctic is of major importance for many water birds. More than two thirds of all geese and almost 95% of all Calidrid sandpipers breed in the Arctic (Zöckler 1998).

The well-being of Arctic birds depends on many different factors, some operating wholly outside of the Arctic. Although the birds spend most of their annual life cycle outside the Arctic region, the three to four months that they spend in the Arctic each year are critically important. Here they breed and rear their young.

This first analysis focuses on the loss of tundra. Other, more southerly distributed biomes will also be affected by a changing climate.

Species will not react statically to climate change, and will certainly respond to changing habitats. Many species will be able to extent their range along with the northward shifting distribution of their favourite habitat. But naturally there are limits and in particularly those species breeding on the edge in high Arctic habitats will find less and less suitable conditions as the climate warms up.

The impacts of climate change and the changes in habitat may be dramatic for certain species, yet a more holistic understanding is required before any mitigation actions can be recommended.

Climate change scenarios indicate the potential for widespread changes in populations of Arctic breeding water birds. The level of the impact varies from species to species, and will be affected by both the direct effects of changes in the climate and indirect effects of changes in habitat. In summary, the gentle warming with earlier snowmelt and increasing temperatures during the Arctic summer will favour reproductive success for most populations.

Additionally, habitat changes may limit the species' range considerably. They may occur relatively slowly. For most of the considered species there will be enough time for adaptation. However, concern remains for those species which already have restricted ranges or specialised habitat requirements, and especially those species listed as globally threatened.

6. *Waterbirds around the world. A global overview of the conservation, management and research of the world's waterbird flyways. Climate variability and change and other pressures on wetlands and waterbirds: impacts and adaptation, C. Max Finlayson , Habiba Gitay , Maria Bellio , Rick van Dam & Iain Taylor Edinburgh, U.K. The Stationery Office, 2006.*

    Changes to waterbird populations should also be expected in less severely affected areas. Increased temperatures will advance breeding seasons and possibly reduce winter mortality (Crick & Sparks 1999, Winkler et al. 2002). The vegetation structure of wetlands can be expected to change, altering the physical aspects of habitats and plant productivity. There will almost certainly be great regional variation, with some areas experiencing increases in waterbird populations and others, decrease (Smart & Gill 2003).

    Relationships between the geographical distributions of birds and present climate have been modeled for species breeding in both Europe and Africa. The resulting models have very high goodness-of-fit and provide a basis for assessing the potential impacts of anthropogenic climatic changes upon avian species richness in the two continents. Simulations made for a range of general circulation model projections of late 21st century climate lead to the conclusion that the impacts upon birds are likely to be substantial. The boundaries of many species' potential geographical distributions are likely to be shifted ≥ 1000 km. There is likely to be a general decline in avian species richness, with the mean extent of species' potential geographical distributions likely to decrease. Species with restricted distributions and specialized species of particular biomes are likely to suffer the greatest impacts. Migrant species are likely to suffer especially large impacts as climatic change alters both their breeding and wintering areas, as well as critical stopover sites, and also potentially increases the distances they must migrate seasonally. Without implementation of new conservation measures, these impacts will be severe and are likely to be exacerbated by land-use change 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.

We may not be able to predict for which particular species they will prove to be important, but their inherent physical diversity increases the probability that they will be of importance for at least some rare or threatened species.

Of course, we also must ensure that less common physical habitat types, especially wetlands, continue to be protected, and should aim to increase the number of such sites within the protected area network.

Many species also depend upon coastal wetland sites, either as areas of non-breeding or as critical stopover sites; these wetlands are likely to be at risk from projected sea-level rise (IPCC 2001), as well as from projected climatic change, adding further to the future threats to birds species (Rehfisch & Crick 2003).

7. *"Canadian Tundra Turning Green", Edmonton, Canada, March 6, 2007, Environment news service (ENS)*

Coniferous trees are invading the tundra, a consequence of the changing climate. Danby added that the shift will have adverse impacts on tundra species such as caribou and wild sheep, which will also be forced upwards as tundra habitats fragment and disappear.

- Non indigenous species (NIS), an exert from Pascal Badiou thesis, 2005

Of the various types of aquatic ecosystems, wetlands are particularly susceptible to invasions by NIS (non indigenous species) due to their location at the land-water interface. Zedler & Kercher (2004), found that although <6% of the earth land mass is wetland, 24% of the world most invasive species are wetland species. Additionally, Lavoie et al. (2003) found that exotic species comprised 13.7% of the vascular flora of the St. Lawrence River wetlands. The fact that wetlands can contain purely aquatic habitats and terrestrial habitats as well as a range of intermediate habitats alone increases the potential for invasions by non indigenous species who can invade through the terrestrial or aquatic component of the wetland.

Section C - Information on the impacts of climate change on wetland ecosystems

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

The magnitude of the influence of boreal carbon and water supplies may overshadow biodiversity contributions in terms of global repercussions. In very pragmatic and economic terms, functions, values and ecosystem services provided to humans from the vast boreal ecosystem exert a large influence over millions of more southerly humans by altering climatic conditions, affecting atmospheric gas balances, capturing and delivering water for hydro-power, producing habitat for billions of migratory birds, partially regulating precipitation and storm patterns, producing forest products, and maintaining recreational opportunities for people. These goods and services are scale important, in part, because of the multi-million km from which they emerge. Wetlands however, provide a disproportionate amount of production of these ecological goods and services. Because wetlands are dependent on a single major driver, hydrology, they may experience greater rates of change than terrestrial systems under climate change scenarios (Schindler 1998).

9. *Waterbirds around the world. A global overview of the conservation, management and research of the world's waterbird flyways, Climate variability and change and other pressures on wetlands and waterbirds: impacts and adaptation, C. Max Finlayson , Habiba Gitay , Maria Bellio , Rick van Dam & Iain Taylor, Edinburgh, U.K. The Stationery Office.*

Specific impacts on wetlands are projected to include:

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

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

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

Increased forest productivity, including that of forested wetlands, although forest management will become more difficult because of an increase in disturbances (pest outbreaks and forest fires).

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

1. Increased levels of inundation, storm flooding, accelerated coastal erosion, seawater intrusion into fresh groundwater, encroachment of tidal waters into estuaries and river systems, and elevated sea surface temperatures and ground temperatures; and
2. Adverse impacts on marine mammal and bird species, especially migratory and nomadic bird populations that depend on coastal habitats.

Identified information needs and gaps:

1. Obtaining knowledge of the extent of many wetland types, their condition and their hydrology (Finlayson et al. 1999);
2. Improved understanding of the response of wetlands and wetland species to changes in climatic factors and other pressures (van Dam et al. 2002);
3. Development of data and models for the geographical distribution of species and their response to climate change at regional level (van Dam et al. 2002, IPCC 2002);
4. Development of models that include patterns of human land use and water use to provide a realistic projection of the future state of wetlands; and
5. Indicators to measure the effect of adaptation and mitigation options for climate change.

In addition to the climate regulating services provided by water bodies - sequestering and releasing a major proportion of fixed carbon in the biosphere – some water ecosystem services support mitigation of climate change. Sea level rise and increases in storm surges associated with climate change will result in the erosion of shores and habitat, increased salinity of estuaries and freshwater aquifers, altered tidal ranges in rivers and bays, changes in sediment and nutrient transport, and increased coastal flooding and, in turn could increase the vulnerability of some coastal populations. Wetlands such as mangroves and floodplains, can play a key role in the physical buffering of climate change impacts.

The MA demonstrated that freshwater ecosystem services are particularly in trouble. It found that the degradation of lakes, rivers, marshes and groundwater systems is more rapid than that of other ecosystems. Similarly it found that the status of freshwater species is deteriorating faster than those of other ecosystems. The loss of species and genetic diversity decreases the resilience of ecosystems – their ability to maintain particular ecosystem services as conditions change. Ecosystem degradation hits the poor hardest: Degradation of ecosystem services hits the poor disproportionately. It is also sometimes the principal factor causing poverty. Climate change will exacerbate water problems

10. *Climate change impacts on freshwater wetland Habitat, Terry P. Dawson*, Pam M. Berry & E. Kampa*

Wetland ecosystems depend on water levels and therefore climate change, especially changes in precipitation, is likely to have a significant impact on these habitats and associated species. There has been little attention to date given by conservation bodies to the relationship between climate change and the protection and management of wetland ecosystems. The projected changes in climate are likely to affect wetlands significantly, in their spatial extent, distribution and function (IPCC 1992, 2001).

11. *An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts in Nepal, India and ChinaWWF Nepal Programme, March, 2005 (http://www.panda.org/downloads/climate_change/himalayaglaciersreport2005.pdf)*

More than half of humanity relies on the freshwater that accumulates in mountains (Mountain Agenda 1998). Glaciers 'mother' several rivers and streams with melt runoff. A significant portion of the low flow contribution of Himalayan rivers during the dry season is from snow and glaciers melt in the Himalayan region. The runoff supplies communities with water for drinking, irrigation and industry, and is also vital for maintaining river and riparian habitat. It is posited that the accelerated melting of glaciers will cause an increase in river levels over the next few decades, initially leading to higher incidence of flooding and land-slides (IPCC, 2001a). But, in the longer-term, as the volume of ice available for melting diminishes, a reduction in glacial runoff and river flows can be expected (IPCC 1996b, Wanchang *et al.* 2000). In the Ganga, the loss of glacier meltwater would reduce July-September flows by two thirds, causing water shortages for 500 million people and 37 percent of India's irrigated land (Jain 2001; Singh *et al.* 1994).

Glacial lake outburst floods (GLOFs) are catastrophic discharges of water resulting primarily from melting glaciers. An accelerated retreat of the glaciers in recent times has led to an enlargement of several glacial lakes. As the glaciers retreat they leave a large void behind. The ponds occupy the depression earlier occupied by glacier ice. These dams are structurally weak and unstable and undergo constant changes due to slope failures, slumping, etc. and run the risk of causing GLOFs.

Principally, a moraine dam may break by the action of some external trigger or self-destruction. A huge displacement wave generated by rockslide or a snow/ice avalanche from the glacier terminus into the lake may cause the water to top the moraines and create a large breach that eventually causes dam failure (Ives 1986). Earthquakes may also be one of the factors triggering dam break depending upon magnitude, location and characteristics. Self-destruction is a result of the failure of the dam slope and seepage from the natural drainage network of the dam.

Characterized by sudden releases of huge amounts of lake water, which in turn would rush down along the stream channel downstream in the form of dangerous flood waves, GLOF waves comprise water mixed with morainic materials and cause devastation for downstream riparian communities, hydropower stations and other infrastructure. In South Asia, particularly in the Himalayan region, it has been observed that the frequency of the occurrence of GLOF events has increased in the second half of the 20th century. GLOFs have cost lives, property and infrastructure in India, Nepal and China.

Glacial Lake Out-burst Floods (GLOF) are the main natural hazards in the mountain areas of this region. A 1964 GLOF in China destroyed many kilometers of highway and washed 12 timber trucks 71 km from the scene. An outburst of Zhangzangbo Lake in 1981 killed four people and damaged the China-Nepal Friendship Bridge in the northern border, seven other bridges, a hydropower plant, Arniko highway and 51 houses. The damage was estimated to be USD 3 million. The 1985 GLOF at Dig Tsho was triggered by a large avalanche. A hydroelectricity project, 14 bridges, 30 houses and farmlands worth USD 4 million were destroyed. In 1998, the outburst of Tam Pokhari in Nepal killed two people, destroyed more than six bridges and washed away arable land. Losses worth over 150 million rupees have been estimated. A high water level was observed even after 19 hours in the Koshi barrage near the Indo-Nepal border. The river reverted to its original flow only after three days (Dwivedi 2000).

There are about 159 glacier lakes in Koshi basin (Sharma 1998). Nearly 229 glacier lakes were identified in Tibet's Arun basin, out of which 24 are potentially dangerous (Meon & Schwarz 1993). Since 1935 more than 16 GLOFs have been reported which either occurred or extended into Nepal.

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 not only on crop production but eventually on basic human indices like available food supplies for people and malnutrition.

While the impacts of deglaciation are briefly outlined in the aforementioned categories there are, as mentioned earlier, details specific to each of the countries that will be dealt within the country-specific case study. It would be useful to refer to each country analyses with the thematic support literature covered in the previous sections. The country case-studies are useful in understanding physical and climatological characteristics of the region and serve as useful bases of reference for further research.

12. *The Ramsar Archives, Ramsar and climate change: report from Kyoto Wetlands and Climate Change - a report from Kyoto by Ramsar's Special Consultant, Dr Ken Lum 23 December 1997. Appendix*

The Third Conference of the Parties to the UN Framework Convention on Climate Change held in Kyoto was probably the most significant trade negotiation the world has ever undertaken. Not only that, the Kyoto Protocol also has extremely significant implications for the health of ecosystems including the world's wetlands.

In the case of use of mangrove forests and fuel from wetlands, a shift towards renewable energy sources will clearly reduce the stress on wetlands from this type of activity. At Kyoto, climate change was highlighted as a major stress on ecosystems and water resources adding to those from human alteration and pollution as well as other indirect effects of the utilization of natural resources.

The geographical distribution of wetlands is likely to shift with changes in temperature and precipitation, with uncertain implications for net greenhouse gas emissions from non-tidal wetlands.

Some coastal ecosystems (saltwater marshes, mangrove ecosystems, coastal wetlands, coral reefs, coral atolls and river deltas) are particularly at risk from climate change and other stresses. Changes in these ecosystems would have major negative effects on freshwater supplies, fisheries, biodiversity and tourism. Many of these ecosystems, already under stress from human activities, may be significantly altered or diminished in terms of their extent and productivity as a result of future climate change.

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.

In addition, an observational network for early detection and accurate description of the expected climate changes in the future is essential to provide as solid a foundation as possible for dealing with the climate change issue. The work of Ramsar and the wetlands community on assessment of wetlands and in monitoring change in ecological character would be an important contribution towards this goal.

And given the considerable attention at Kyoto on increased outbreaks of some infectious diseases carried by mosquitoes and other water-borne diseases, and the decreased availability of drinking water related to climate-induced change in hydrological patterns, there is scope as well for a contribution that responds to the resolution on Ramsar and Water.

Table 4 Examples of impacts resulting from projected changes in extreme climate events (modified from IPCC 2001b).

Projected Changes during the 21st Century in Extreme Climate Phenomena	**Examples of Projected Impacts**
Higher maximum temperatures, more hot days and heat waves over nearly all land areas	Increased heat stress in wildlife

Projected Changes during the 21st Century in Extreme Climate Phenomena	Examples of Projected Impacts
Higher minimum temperatures, fewer cold days, frost days and cold waves over nearly all land areas	Extended range and activity of some pest and disease vectors
More intense precipitation events over many areas	Increased flood, landslide, avalanche, and mudslide damage Increased soil erosion Increased flood runoff could increase recharge of some floodplain aquifers
Increased summer drying over most mid-latitude continental interiors and associated risk of drought, Intensified droughts and floods associated with El Niño events in many different regions	Decreased water resource quantity and quality Increased risk of fires
Increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities (over some areas)	Increased coastal erosion and damage to coastal buildings and infrastructure Increased damage to coastal ecosystems such as coral reefs and mangroves

Table 5 Projected impacts in some key water-based systems and water resources under temperature and precipitation changes approximating those of the SRES scenarios (modified from IPCC 2001c)

Indicators	2025	2100
Corals	Increase in frequency of coral bleaching and death of corals	More extensive coral bleaching and death Reduced species biodiversity and fish yields from reefs

Indicators	**2025**	**2100**
Coastal Wetlands and Shorelines	Loss of some coastal wetlands to sea level rise Increased erosion of shorelines	More extensive loss of coastal wetlands Further erosion of shorelines
Ice environments	Retreat of glaciers, decreased sea ice extent, thawing of some permafrost, longer ice free seasons on rivers and lakes	Extensive Arctic sea ice reduction, benefiting shipping but harming wildlife (e.g. seals, polar bears, walrus) Ground subsidence leading to changes in some ecosystems. Substantial loss of ice volume from glaciers, particularly tropical glaciers
Water supply	Peak river flow shifts from spring toward winter in basins where snowfall is an important source of water	Water supply decreased in many water-stressed countries, increased in some other water-stressed countries
Water quality	Water quality degraded by higher temperatures Water quality changes modified by changes in water flow volume Increase in salt-water intrusion into coastal aquifers due to sea level rise.	Water quality effects amplified
Water demand	Water demand for	Water demand

Indicators	2025	2100
	irrigation will respond to changes in climate; higher temperatures will tend to increase demand	effects amplified.
Floods and droughts	Increased flood damage due to more intense precipitation events Increased drought frequency	Flood damage several fold higher than "no climate change scenarios" Further increase in drought events and their impacts

Section D - Information on the impacts of climate change on water

13. *Issues Paper for discussion in developing a DFID research programme on Water ecosystem services and poverty reduction under climate change. Draft: March 2007, Prepared by International Institute for Environment and Development:*

> Freshwater ecosystem services are central to human well-being. Each person needs over 4,000 litres of water each day to produce enough food for a healthy diet. A calorie of food takes a litre of water to produce. A kilo of grain takes 500-4,000 litres, a kilo of industrially produced meat 10,000 litres. People in Cambodia obtain about 60-80% of their total animal protein from the inland fishery in Tonle Sap and associated floodplains. Intact mangroves in Thailand have a total net present economic value (marketed products such as fish and non-marketed services such as protection from storm damage) of at least $1,000 per hectare (and possibly up to $36,000 per hectare) compared with about $200 per hectare when converted to shrimp farms. Over 60% of the world's food is produced from green water (mostly soil moisture from rainwater, rather than irrigation). In sub-Saharan Africa this figure reaches 95%. Fresh water is crucial to climate stability. For example, although covering only an estimated 3-4% of the world's land areas, wet peatlands are estimated to hold 540 gigatons of carbon, representing 25-30% of global carbon contained in terrestrial vegetation and soils. (*Sources: CAA (2006), Falkenmark and Rockstrom (2005), MAW&W (2005), UNDP (2006)*)

> The Intergovernmental Panel on Climate Change predict that the global temperature will rise by up to 6.4 degrees C by the end of this century,

with their “best guess” scenario putting the range at between 1.8 and 4 degrees C. Water insecurity linked to climate change threatens to increase malnutrition by 75–125 million people by 2080, with staple food production in many Sub-Saharan African countries falling by more than 25%. Marked reductions in water availability in East Africa, the Sahel and Southern Africa are predicted as rainfall declines and temperature rises, with large productivity losses in basic food staples. Projections for rainfed areas in East Africa point to potential productivity losses of up to 33% in maize and more than 20% for sorghum and 18% for millet. Disruption of food production systems has been predicted, exposing an additional 75–125 million people to the threat of hunger. Accelerated glacial melt is expected, leading to medium term reductions in water availability across a large group of countries in East Asia, Latin America and South Asia. Models suggest disruptions to monsoon patterns in South Asia, with the potential for more rain but also fewer rainy days and more people affected by drought. Rising sea levels are likely, resulting in freshwater losses in river delta systems in countries such as Bangladesh, Egypt and Thailand. Some 150,000 people a year are now dying as a result of climate change, as diseases spread faster at higher temperatures (this is with the current rise of 0.6 degrees C). The ‘Stern Review’ carried out by the UK government on the economics of climate change calculated that the dangers of unabated climate change would be equivalent to at least 5% of global GDP each year for a narrow range of direct effects, and about 20% of global GDP if a wider range of impacts on the environment and poor people are taken into account.(*DWC (2003), IPCC (2007), Scholze et al (2006), UK-Treasury (2006), UNDP (2006), WHO (2003)*).

The Intergovernmental Panel on Climate Change (IPCC) forecasts that rainfall will become less predictable over time – particularly in parts of Asia, sub-Saharan Africa and Latin America. Greater variations in rainfall, combined with rising sea levels and higher sea temperatures, are likely to lead to more frequent and more extreme weather events – such as storms, floods and droughts. These circumstances put great stress on the institutional, governance and market-related processes for fresh water and watershed management and use.

Climate change will cause decline in water runoff in many regions

Climate change impacts will vary greatly by region and Africa will be hard hit.

Many promising solutions to the problems exist: Much is known about how water resources can be managed under conditions of change. Indeed the MA itself reviewed a wide catalogue of ‘response options’, and highlighted many viable ways forward. Key fields in which good work lies include poverty-oriented surface and groundwater management and provision, integrated water resource management and payments and negotiation for watershed services.

Governance is the key to making most promising solutions work. A target of halving the number of people who cannot access safe drinking water by 2015 is the only explicit water-related MDG. However, the full range of freshwater ecosystem services will come into play, directly or indirectly, in most actions aimed at achieving the many other ambitious MDG targets on poverty reduction, human nutrition, education, health and environment. Governance frameworks need to recognise this.

Key questions: Our aim in this work is to discover: [A] the key research areas and knowledge for improving the sustainability and equity of water provision and water gaps ecosystem services management in the context of climate change in developing countries; and, [B] the most effective means by which research and its delivery can contribute to achieving more sustainable and equitable water services and ecosystems management.

14. *Climate Change: Past and current research at IWMI (Written note):*

Several on-going projects (e.g. African wetlands), focusing on wetland assessment and management, develop research on adaptation to CC through the medium of water. They are looking at it from both an environmental and food production perspective aiming to find adaptation mechanisms that do not entail a conflict between the two. Part of the on-going research focuses on how changes in ecosystems as a consequence of CC compound existing feedbacks (e.g. or spread of invasive species or water quality changes) on agriculture and potentially constrain local and institutional adaptation. IWMI leads a theme "Integrated Basin Water Management Systems" of the Challenge Programme on Water and Food. The theme's research agenda focuses on how basin water and land resources could be better managed to enhance agricultural output, productivity and profitability in a sustainable way. Issues on climate variability, CC and adaptation to them that are addressed by the theme include: understanding climate variability (particularly floods and droughts), assessing vulnerability of the poor to these extreme events and identification of coping strategies.

IWMI developed World Water and Climate Atlas, which provide information on climate and moisture availability for agriculture and is of direct relevance to CC researchers, planners and those carrying out adaptation activities.

15. *AquaFed: The international federation of private water operators, press release, "Women need water and sanitation more access-to-water and sanitation projects must be launched" Brussels, 8 march 2007*

Today, almost half the world's women still have no adequate drinking water and sanitation at home or nearby (in developing countries, more than 1 out of every 2 family -3 billion people). Everyday, women must carry water from distant sources (deprives opportunity of jobs).

Section E - Information on government-regional responses

16. *European symposium: Dresden communication on Flood Risk Management Research, dresden (Germany), 7th February 2007*

Symposium statement (I): the symposium urges the inclusion of climate change assessment in all actions under the proposed EU directive on the assessment and management of flood risks.

Preamble (III): Flood risks are dynamic, driven by climate change and growing vulnerability. The IPCC WG1 summary report of February 2007 indicates that over the 21th century, increased heavy precipitation events and heightened sea levels are very likely and likely respectively.

Integrated Water resources Management – a key to cope with effects of climate change- Freistaat Sachsen. See figures: Uncertainties of climate change+water cycle

17. *Time to adapt: Climate change and european water dimension (vulnerability-impacts-adaptation- Berlin, 12-14 February 2007, Berlin. http://climate-water-adaptation-berlin2007.org/*

Climate change is of critical importance to the water industry everywhere. Everyone has to take full account of climate change in water planning and investment.

CC affects all aspects of water services. More, the quality of water in the encvironment will be affected. When we are making Water and CC legislation we need to recognise the possible conflict between ever higher environmental stabndards and the impact on the CC of using more energy to meet these standards.

Answers for water might make the wider debate on CC more relevant.

Adaptation will require much more efficient use of water. Did you know that growing animal feed for the production of a single hamburger requires 2,400 litres of water –doesn't include water used in processing, packaging, or transport-. One of the few certainties is that the climate change is becoming more and more uncertain.

We have to prepare for potential changes in wastewater infrastructure, in agricultural practice, in the impact of new infrastructure on biodiversity and wetlands. And more generally regulation and policy must reflect the broad social implications of CC. Good communication on all aspects of the climate will be essential. EU Emissions Trading schemes are important, but will not work if we don't consider the global picture. There is an international communication need here. If we don't get water right, we will not be able to get right any other sector.

Impacts of CC on the water industry, "Towards an EU policy framework for adaptation" by Peter Grammeltoft, Speech 13 February :

"Water is life!" Climate change is especially affecting the water cycle. Existing and upcoming EU water legislation are the:

- Water framework Directive,

- Marine Strategy Directive,

- Floods Directive,

- Water scarcity and drought (CC may due to temporal distribution of precipitation- lead to the paradoxical situation that in some places, there will be both floods and droughts).

Key messages: Impacts on water resources will significantly affect on key economic activities such as agriculture (which can make a stronger contribution to adaptation), hydropower and energy production (which have an important role in adaptation and mitigation), tourism and navigation + serious adverse impacts on biodiversity and ecosystems. EU water and marine policy provides a solid basis for integrated water management (in particular Water Framework Directive integrate impacts from all water-related sectors). Adaptation starts with using water more efficiently in all sectors and water dependant sectors need to be involved.

Scientific evidence suggests that climate change will result for example in more frequent and severe extreme events (floods and droughts) and that it will have long term effects on the availability of water in different regions in Europe as well as on the quality of water and water related ecosystems. Water management needs to take these effects into account, and long term strategies for water dependent economic sectors need to be designed with a view to their vulnerability and their options for adaptation.

Concluding remarks (Time to adapt): The need for action is more urgent than ever before. Impacts of CC on the processes of the water cycle across the whole world have potentially disastrous effects, especially in developing countries. Disputes about water, almost in regions under water stress. When rivers fall dry, people have to move elsewhere. Research priority: water cycle reaction to climate change, quantification of economies and social impacts of Climate Change.

18. *Climate change and coastal waterbirds: the United Kingdom experience reviewed, Mark M. Rehfisch & Graham E. Austin, British Trust for Ornithology, The Nunnery, Thetford, IP24 2PU ,UK, 2006.*

To help guide UK conservation policy, the MONARCH project (Monitoring Natural Resource Responses to Climate Change) was established to attempt to predict how biodiversity will change with climate change. The first set of MONARCH predictions, based on a bioclimatic approach, took no account of plant and animal dispersal capabilities, geographical impediments to movement, and changing socio-economic conditions with a warming climate (Harrison et al. 2001). Subsequent regional predictions have addressed some of these factors, but the dispersal capacity of the organisms and phenological disjunction that may occur between interdependent species remain to be considered.

19. *Terry P.Dawson, Pam M.Berry & E. Kampa. 2003. Climate change impacts on freshwater wetlands habitats, Journal of the Nature Conservation*. 11, 25–30.

    Wetlands are an important part of the British and Irish landscape covering almost 10% of the terrestrial land area, including a diverse range of habitats such as marshes, fens, bogs, wet grasslands, floodplains and mudflats. They also support distinct plant communities, breeding and wintering birds, amphibians and invertebrates, including many species that are threatened or endangered. Wetland plants, which comprise 20% of all nationally rare and 40% of nationally scarce vascular plants in the UK (Jefferson & Grice 1998), are particularly vulnerable to climate change because of the delicate balance between the rainfall, temperature and evapotranspiration that governs their physiology.

20. *Annual report card 2006, UK Marine CC Impacts Partnership (MCCIP)*

    Large changes observed in marine environment. David Attenborough: "I'm not longer sceptical. Now I do not have any doubt at all. I think that CC is the major challenge facing the world".

21. *M Acreman, D Booker, C Stratford, R Harding, N Reynard, Mountford, J.O. 2007. Climate change implications for GB freshwater wetland ecosystems. Centre for Ecology and Hydrology, UK.*

    Overall summary of impacts: Wetlands are likely to suffer negative impacts of climate change through increased evaporation and reduced rainfall, resulting in lower soil water table levels in late summer/autumn. With regard to monthly mean values, these changes range from minor in northern Scotland and Wales, to significant in south east England. Rain-fed wetlands are likely to be more significantly impacted than river-fed wetlands. Minimum water table levels in wetlands fed by sandstone and limestone may be less impacted by climate change than those fed by chalk aquifers. Increased variability of climate in the future may have additional impacts on all wetlands.

22. *UK Prime Minister's speech to the 10 anniversary of the Prince of Wales' Business and the Environment Programme Banqueting House, September 14, 2004*

    I want to concentrate on what I believe to be the world's greatest environmental challenge: climate change. A recent opinion survey by Greenpeace showed that 78% of people are concerned about climate change. However, our efforts to stabilise the climate will need, over time, to become far more ambitious than the Kyoto Protocol. Kyoto is only the first step but provides a solid foundation for the next stage of climate diplomacy. If Russia were to ratify that would bring it into effect. We know there is disagreement with the US over this issue. In 1997 the US Senate voted 95-0 in favour of a resolution that stated it would refuse to ratify such a treaty. I doubt time has shifted the numbers very radically.

But the US remains a signatory to the UN Framework Convention on Climate Change, and the US National Academy of Sciences agree that there is a link between human activity, carbon emissions and atmospheric warming. Recently the US Energy Secretary and Commercial Secretary jointly issued a report again accepting the potential damage to the planet through global warming.

Conclusion - The situation therefore can be summarised in this way:

If what the science tells us about climate change is correct, then unabated it will result in catastrophic consequences for our world. We have been warned. On most issues we ask children to listen to their parents. On climate change, it is parents who should listen to their children.

Section F - Regional responses

23. Stern Review: The economics of Climate Chang. Executive Summary

The scientific evidence is now overwhelming: climate change presents very serious global risks, and it demands an urgent global response.

Warming will have many severe impacts, often mediated through water.

Melting glaciers will initially increase flood risk and then strongly reduce water supplies, eventually threatening one-sixth of the world's population, predominantly in the Indian sub-continent, parts of China, and the Andes in South America.

Declining crop yields, especially in Africa, could leave hundreds of millions without the ability to produce or purchase sufficient food. At mid to high latitudes, crop yields may increase for moderate temperature rises (2 – 3°C), but then decline with greater amounts of warming. At 4°C and above, global food production is likely to be seriously affected.

In higher latitudes, cold-related deaths will decrease. But climate change will increase worldwide deaths from malnutrition and heat stress. Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place.

Rising sea levels will result in tens to hundreds of millions more people flooded each year with warming of 3 or 4°C. There will be serious risks and increasing pressures for coastal protection in South East Asia (Bangladesh and Vietnam), small islands in the Caribbean and the Pacific, and large coastal cities, such as Tokyo, New York, Cairo and London. According to one estimate, by the middle of the century, 200 million people may become permanently displaced due to rising sea levels, heavier floods, and more intense droughts.

Ecosystems will be particularly vulnerable to climate change, with around 15 – 40% of species potentially facing extinction after only 2°C of warming. And ocean acidification, a direct result of rising carbon dioxide levels, will have major effects on marine ecosystems, with possible adverse consequences on fish stocks.

The damages from climate change will accelerate as the world gets warmer.

Higher temperatures will increase the chance of triggering abrupt and large-scale changes.

Warming may induce sudden shifts in regional weather patterns such as the monsoon rains in South Asia or the El Niño phenomenon – changes that would have severe consequences for water availability and flooding in tropical regions and threaten the livelihoods of millions of people.

A number of studies suggest that the Amazon rainforest could be vulnerable to climate change, with models projecting significant drying in this region. One model, for example, finds that the Amazon rainforest could be significantly, and possibly irrevocably, damaged by a warming of 2 – 3°C.

The melting or collapse of ice sheets would eventually threaten land which today is home to 1 in every 20 people.

While there is much to learn about these risks, the temperatures that may result from unabated climate change will take the world outside the range of human experience. This points to the possibility of very damaging consequences.

Rising sea levels and other climate-driven changes could drive millions of people to migrate: more than a fifth of Bangladesh could be under water with a 1m rise in sea levels, which is a possibility by the end of the century.

Developed countries in lower latitudes will be more vulnerable – for example, water availability and crop yields in southern Europe are expected to decline by 20% with a 2°C increase in global temperatures. Regions where water is already scarce will face serious difficulties and growing costs.

24. *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*

Avoiding the unmanageable and managing the unavoidable will require an immediate and major acceleration of efforts to both mitigate and adapt to climate change (including efforts to maintain biodiversity and water resources).

Impacts by region:

Europe: More intense winter precipitation;

Arctic: Significant retreat of ice; disrupted habitats of polar flooding, and other hazards; increased summer heat mega fauna; accelerated loss of ice from Greenland Ice Sheet;

North America: Reduced springtime snowpack; waves and melting of mountain glaciers; greater water mountain glaciers; shifting of fisheries; replacement of most tundra changing river lows; shifting ecosystems, with stress in southern regions; intensifying regional climatic by boreal forest; greater exposure to UV-radiation loss of niche environments; rising sea level differences; greater biotic stress, causing shifts in flora; and increased intensity and energy of Atlantic tourism shift from Mediterranean region hurricanes increase coastal flooding and storm damage; more frequent and intense heat waves;

Central and Northern Asia: Widespread melting of and wildfires; improved agriculture and forest permafrost, disrupting transportation and buildings; productivity for a few decades greater swampiness and ecosystem stress from warming; increased release of methane; coastal erosion due to sea ice retreat;

Central America and West Indies: Greater likelihood of intense rainfall.

Southern Asia: Sea level rise and more intense cyclones and more powerful hurricanes; increase flooding of deltas and coastal plains; major increased coral bleaching; some loss of mangroves and coral reefs; melting of mountain inundation from sea level rise; glaciers reduces vital river lows; increased pressure, biodiversity loss, water resources with rising population and need for irrigation; possible monsoon perturbation;

Pacific and Small Islands: Inundation of low-lying coral islands as sea level rises; salinization;

Africa: Declining agricultural yields and diminished food aquifers; widespread coral bleaching;

Global Oceans: Made more acidic by increasing CO2 security; increased occurrence of drought and stresses powerful typhoons and possible intensification of concentration, deep overturning circulation possibly on water supplies; disruption of ecosystems and loss of ENSC extremes reduced by warming and freshening in North Atlantic biodiversity, including some major species; some coastal inundation;

<u>South America</u>: Disruption of tropical forests and significant loss of biodiversity; melting glaciers Australia and New Zealand: Substantial loss of coral reduce water supplies; increased moisture stress; and

<u>Antarctica and Southern Ocean</u>: Increasing risk of significant ice loss along Great Barrier Reef; significant diminishment of water in agricultural regions; more frequent occurrence of from West Antarctic Ice Sheet, risking much higher sea level in centuries resources; coastal inundation of some settled areas; intense periods of rain, leading to more lash floods

ahead; accelerating loss of sea ice, disrupting marine life and penguins increased ire risk; some early benefits to agriculture.

Recommendations on CEPA:

Improve communication to accelerate adaptation and mitigation by increasing education efforts and creating forums for dialogue, technology assessment, and planning. The full range of public- and private-sector participants should be engaged to encourage partnerships across industrial and academic experts, the financial community, and public and private organizations.

National governments and the UN system should take the following steps:

- Develop an international process to assess technologies and refine sectoral targets for mitigation that brings together experts from industry, nongovernmental organizations, the financial community, and government. The Technology and Economic Assessment Panel of the Montreal Protocol provides an effective model for assessing technological potential and effective, realistic sectoral mitigation targets.
- Enhance national programmes for public and corporate education on the needs, paths, opportunities, and benefits of a transition to a low-emission energy future.
- Enlist the educational and capacity-building capabilities of UN institutions to provide
- Information about climate change and the opportunities for adaptation and mitigation.
- Under the leadership of the Department of Economic and Social Affairs, the UN should complete an internal study to more effectively engage relevant UN agencies.

The Time for Collective Action is now. Governments, corporations, and individuals must act now to forge a new path to a sustainable future with a stable climate and a robust environment. There are many opportunities for taking effective early action at little or no cost. Many of these opportunities also have other environmental or societal benefits. Even if some of the subsequent steps required are more difficult and expensive, their costs are virtually certain to be smaller than the costs of the climate-change damages these measures would avert.

Two starkly different futures diverge from this time forward. Society's current path leads to increasingly serious climate-change impacts, including potentially catastrophic changes in climate that will compromise efforts to achieve development objectives where there is poverty and will threaten standards of living where there is affluence. The other path leads to a transformation in the way society generates and uses energy as well as to improvements in management of the world's soils and forests. This path will reduce dangerous emissions, create economic opportunity, help to reduce global poverty, reduce degradation of and carbon emissions from ecosystems, and contribute to the sustainability of productive economies capable of meeting the needs of the world's growing population. Humanity must act collectively and urgently to change course through leadership at all levels of society. There is no more time for delay.

25. *Arctic Climate Impact Assessment (ACIA)Cambridge University Press. 2004.*

Widespread melting of glaciers and sea ice and rising permafrost temperatures present additional evidence of strong arctic warming. (Cf. IPCC, 2001). These changes in the Arctic provide an early indication of the environmental and societal significance of global warming. Climate change is also projected to result in major impacts inside the arctic, some of which are already underway.

Section G - Peatlands

26. *The global Assessment on Peatlands, Biodiversity and Climate Change (interim findings re. climate change, 2006)*

Regarding climate regulation, peatlands are "the most efficient carbon stores of all terrestrial ecosystems" with at least 550 Gt of carbon in their peat, which is equivalent to 30% of the Carbon in soils, 75% in the atmosphere, equal to all terrestrial biomass, and twice the carbon stock in the forest biomass of the world. The importance of peatland has yet to be fully recognized by UNFCCC. The Ramsar Convention on Wetlands has given strong recognition to peatlands but more efforts are required by contracting parties to support implementation. Since peatlands are relevant to biodiversity, land degradation and climate change – integrated approaches between global environment conventions are essential to ensure synergy and avoid conflicts.

27. *Hooijer, A., Silvius, M., Wösten, H. and Page, S. 2006. PEAT-CO2, Assessment of CO_2 emissions from drained peatlands in SE Asia. Delft Hydraulics report Q3943 (2006)*

The current total peatland CO2 emission of 2000 Mt/y equals almost 8% of global emission from fossil fuel burning. Over 90% of this emission originates from Indonesia which put the country in the 3rd place (after USA and china) in the global CO2 emission ranking.

It is concluded that deforested and drained peatlands in SE Asia are a globally significant source of CO2 emissions and a major obstacle to meeting the aim of stabilizing the greenhouse gas emissions, as expressed by the international community (Summary).

Peatlands cover 3% (some 4million Km2) of the Earth's land area and store a large fraction of the Worlds terrestrial carbon resources: up to

528,000 Megatonnes, equivalent to one third og global soil carbon and to 70 times the current annual global emissions from fossil fuel burning (approximately 7, 000 Mt/y in 2006 in carbon equivalent or 26, 000 Mt/y in CO2 equivalents). This carbon store is now being released to the Earth's atmosphere through 2 mechanisms: drainage of peatlands and fires in degraded peatlands.

28. *National Science foundation, Arctic Thaw May Release Greenhouse Gases from Siberian Peat Bogs, July 27, 2004*

A key finding of the research, unrelated to modern climate change, is that the bogs themselves came into being suddenly about 11,500 to 9,000 years ago -- much earlier than previously thought -- and expanded rapidly to fill the niche they now occupy.

But the researchers also point out that the bogs -- which collectively cover an area of roughly 603,000 square kilometers (233,000 square miles) -- have long absorbed and held vast amounts of carbon dioxide, while releasing large amounts of methane in the atmosphere.

"Traditionally, we had thought these areas were simply a gradually varying source of methane and an important sink for atmospheric carbon," he said. "They've been viewed as a stable thing that we always count on. The bottom line is Siberian peat lands may be a bigger player in climate change than we knew before[...]they would release a lot of the carbon they have taken up for centuries."

29. *Peatland degradation fuels climate change: an unrecognised and alarming source of greenhouse gases, UNFCCC Article, November 2006.*

Government representatives from almost all countries of the world gather at the UN-FCCC 2006 summit in Nairobi to discuss actions regarding climate change and the use of fossil fuels. Recent investigations by Wetlands International and Delft Hydraulics present new and shocking information on the huge emissions from a totally different source: degraded peatlands, mostly in South-east Asia. These new figures show that annual peatland emissions in South-east Asia far exceed fossil fuel contributions from major polluting countries and overshadow the reductions being sought under the Kyoto Protocol. Almost nothing is being done to address this problem even though there are cost-effective solutions and opportunities to do so.

Actions needed:

• Individual countries, regional authorities (like the EU) and international conventions should establish legislation and practice to curtail the problems of imports of products from vulnerable peatland areas, e.g.: - Timber from illegal logging, - Biofuel from oil palm plantations on peatlands, - Pulp wood and related products from pulp plantations on peatlands.

• Contracting Parties of The Climate Convention (UN-FCCC) should ensure that the CO_2 emissions from peatland degradation are taken into account in climate change mitigation strategies.

• An alternative finance mechanism should be developed to trigger and support peatland protection and restoration as an urgent action by nations within their suite of climate change strategies.

• Linked to this, a Global Peatlands Fund should be established to restore peatlands world wide, but with a priority on South-east Asia. Development here should have a pro-poor approach and be based on principles of sustainable use of these vulnerable areas. Local people should be paid for restoring and conserving these globally important areas.

• Methods and support mechanisms for improved water management in agricultural and conservation peatland areas is needed.

Peatlands and climate change: Under natural circumstances peatlands act as carbon sinks, slowly lowering the amount of greenhouse gases in the atmosphere by storing organic materials. They act as a long-term or even permanent store of carbon.

Drainage and oxidation: All over the world the role of peatlands as carbon sinks is threatened by drainage, leading to emission of the greenhouse gas CO_2; either slowly due to decomposition or fast in the case of fires. Just the process of decomposition (i.e. excluding fire) leads to a global emission from peatlands of 800 $MtCO_2$/yr; 600 originate from South-east Asia as shown in the pie-chart below. Currently, millions of hectares of peatlands are drained and are decomposing. This is especially the case in Indonesia and Malaysia. The oxidation of the desiccated peatland top soil results on average in emissions of about 65 tonnes of CO_2 per hectare per year. If current land-use development trends continue, predictions are that the annual emissions from South-east Asian peatlands will have increased in 2030 by at least 80%.

Indonesia emits 6.5 times as much CO_2 from degraded peatlands as it does by burning fossil fuels every year. In a ranking of countries based on their total CO_2 emissions, Indonesia comes 21st if peatland emissions are excluded. However, if peatland emissions are included, Indonesia is already the third-largest CO_2 producer in the world.

Many other areas in the world are facing similar problems, albeit of another scale. But this could change. For example, in Russia there are also regular and extensive peat fires. Moreover, with increased global warming, the huge areas of peat in the permafrost of the northern hemisphere are under threat. As long as the soil is frozen, the organic material in these peatlands is stored. However, the melting of the peat soil may result in huge emissions of greenhouse gases, including release of methane.

International agreement on climate change: The Kyoto protocol, the international agreement on climate change, sets the western countries that signed the agreement a reduction target for 2012. The agreement allows western countries to reach their emission targets by helping to reduce the emissions in the third world countries (Clean Development Mechanism). However, the Protocol excludes the emissions from soil and (degraded) vegetation and limits itself to reducing emissions from industry, housing, traffic and agriculture. As a result there is little or no attention for peatland degradation, a huge cause of global warming.

Consequences: Indonesian peatland fires have been the cause of thousands of hospitalizations.Last but not least, the drainage and fires are also destroying the precious biodiversity of the tropical peat swamp forests forever.

Projects in the region: Wetlands International is implementing several projects to protect the remaining peatswamp forests and restore the degraded peatlands in Indonesia. As well as preventing and fighting peatland fires, the projects take action to benefit biodiversity conservation and local community livelihoods. We work with the support of local communities and governments. Wetlands International collaborates with Delft Hydraulics in the PEAT-CO2 Initiative which aims to strengthen the scientific basis of the quantification of CO2 emissions from peatlands, to develop support tools for improved water management and conservation in peatlands.

Low-cost ways to tackle this massive problem: Investments in the conservation and restoration of peatlands should be an essential part of any strategy to mitigate climate change. Relatively minor investments can have significant impacts in terms of reducing green house gas emissions. In addition, investments in peatland restoration will also contribute to improved mitigation of droughts and floods, biodiversity conservation and poverty reduction.

30. *UNEP-WCMC (23 February) 2007. Reducing Emissions from Deforestation: A Key Opportunity for Attaining Multiple Benefits. UNEP World Conservation Monitoring Centre, Cambridge, U.K*

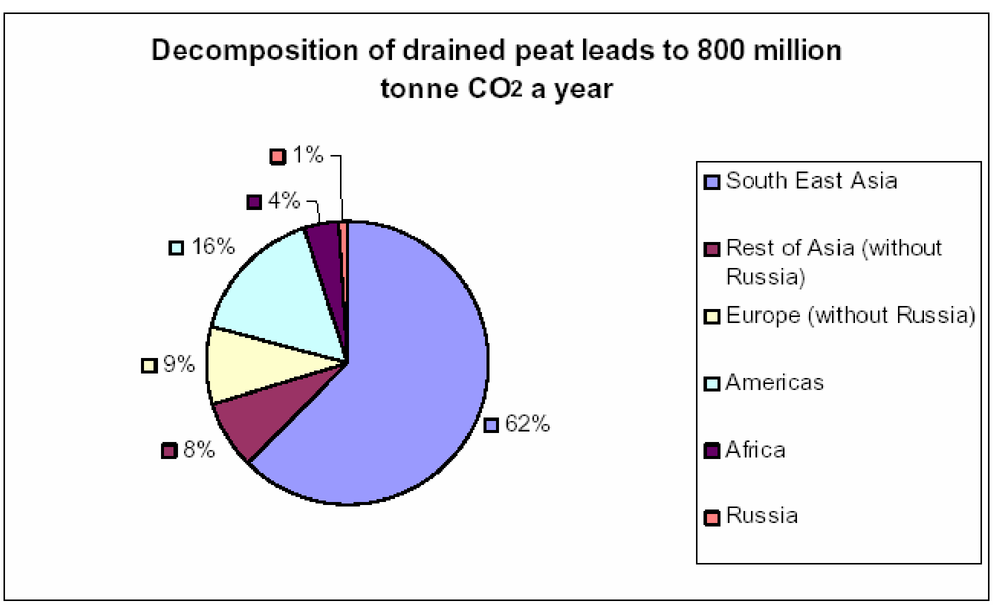
Forests account for almost half of the global terrestrial carbon pool[10]. The total carbon content of forest ecosystems in 2005 was estimated at 638 Gt, including stores in biomass, soils and dead wood (FAO 2006a). Tropical forests play a particularly important role in the global carbon budget (Melillo *et al*. 1993; Dixon *et al*. 1994; Schimel *et al*. 2001, Houghton 2005) because of the large amount of carbon stored in their biomass. Depending on the method of forest removal and the subsequent use of the felled trees and the land, deforestation not only releases the carbon stored in the above ground biomass, but leads to decomposition of root mass and mobilization of soil carbon. Global carbon emissions (CO_2 and other

[10] This statement is not correct if recent figures for peatlands are taken into account

greenhouse gases) from changes in land use, including tropical deforestation are estimated to be between 18% (Stern 2006, IPCC 2007) and 25% of annual global emissions from all sources (Santilli *et al*. 2005).

Therefore, discussions are underway to consider policy mechanisms and incentives to effect reductions in this important source of emissions. Reducing emissions from deforestation (RED) is distinct from carbon sequestration, which aims to immobilise CO_2 from the atmosphere and thus concerns sinks rather than sources of emissions. While details of RED mechanisms have yet to be worked out, it is clear that they will have to focus on the avoidance or reduction of CO_2 emissions rather than on deforestation *per se*. Thus, one currency in which they must be considered is tonnes of CO_2 as distinct from hectares of forest. There is no simple linear relationship between these two sets of units because forests and other ecosystems vary in both the amount of carbon per hectare they store in their biomass (carbon density) and the carbon immobilised in other compartments of the ecosystem, such as the soils (FAO 2006a). Therefore, there is no clear correlation between net loss of forest cover and the quantity of CO_2 emitted through deforestation. Furthermore, the degree to which deforestation releases stored CO_2 from biomass and other ecosystem compartments depends on the methods used for deforestation (e.g. whether fire is involved) and the land use in the newly converted forest areas. For example, in the peat swamp forests of Southeast Asia, deforestation, fire and drainage are estimated to generate at least 2000 Mt CO_2 emissions annually (Hooijer *et al*. 2006).

31. *Peatland degradation fuels climate change, an unrecognised and alarming source of greenhouse gases, Wetlands International, November 2006.*



Source: Wetlands International and Delft Hydraulics

32. *Peatlands and Climate Change (contributed summary by Marcel J. Silvius, Wetlands International)*

World wide there are about 400 million ha of peatlands, covering 3% of the land and freshwater area of the world and 40% of all wetlands. They are present in all climate zones, in 126 countries. The countries with the largest peatland resources, covering a total 320 million ha, are Russia, Canada and the US. Indonesian peatlands cover about 60% of all tropical peatlands (27 million ha).

Peatlands are very important for water management. They hold 10% of all fresh water of the world and are the source areas of many rivers and streams. They play an important role in water storage and supply and in many areas they are crucial for mitigation of droughts and floods.

About 30% of terrestrial carbon is stored in peat, or about 550 giga ton. Some 70% occur in northern climate zones and 30% in the tropics. Worldwide this is equivalent to 75% of all carbon in the atmosphere, or an equivalent of 100 year emissions of fossil fuels.

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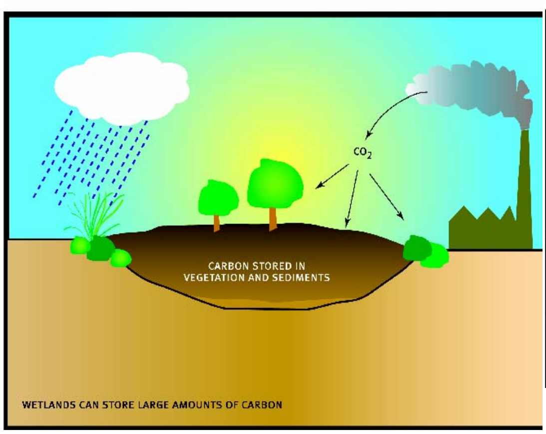


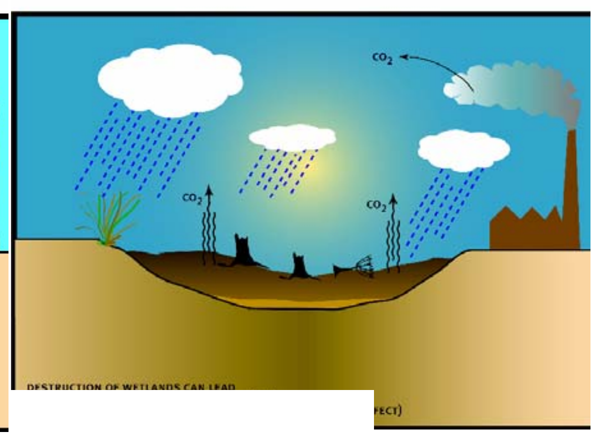


Table 1: Peatland area and loss of mires in some central and eastern European countries

Country	Peatland area (ha)	Present extent near-natural mire (ha)	Estimated loss of mire (%)
Slovakia	26,000	2,575	90
Poland	1,254,800	201,938	84
Lithuania	352,000	75,000	79
Estonia	1,009,100	300,000	70
Latvia	672,204	316,712	53
Czechia	27,000	14,742	45

However, also in many other parts of the world peatlands have been degraded and lost. Western European countries have lost over 90% of their natural peatlands. European countries that originally used to have the least peatlands have lost most. Only 5 countries have retained more than 50% of peatlands under relatively natural conditions, but most other countries have lost between 70% and 99%. The Netherlands (original peat area 15000 km^2) lost virtually all its natural peatlands as a result of agricultural and economic development. Most of the 96,000 km^2 of natural peatlands in Finland are impacted by drainage for forestry. Ireland (original peatland area 14,000 km^2) lost 93% of its raised bogs and 82% of its blanket mire resource.

Once drained and degraded, the oxygen can enter into the peat soil and links through oxidation to the peat carbon, creating the greenhouse gas CO_2. The total of about 200,000 ha of agricultural land on Dutch peats contribute 4% of the total carbon emissions in the Netherlands or 7,5 million tonnes CO2. In monetary terms and assuming a price of 10 to 20 Euro/tonne (which is the general range under the Clean Development Mechanism of the Kyoto Protocol), this is equivalent to 75 – 150 million Euro/year.

Importance of tropical peat swamp forests: Tropical peat swamp forests have a very high biodiversity compared to peatlands in the temperate and arctic zones. In addition, they are of course also important for carbon storage (sinks & sequestration). Peatlands in South-east Asia probably include the deepest peats in the tropics, reaching depths of over 20 meters in for instance Riau province in Sumatra. As a result, whereas Indonesia holds 60 % of the tropical peats, it may hold over 90% of the total carbon store presented by these areas.

Table 2: Peatland loss in Indonesia between 1987 and 2000.

No	Region	Original size (ha)	Remaining (ha)	Protected (ha)
1	Sumatera	7,282,000	4,613,000	341,000
2	Kalimantan	4,413,000	3,531,000	257,000
3	Sulawesi	44,000	34,000	-
4	Maluku	48,000	42,000	1,000
5	Irian Jaya	8,910,000	8,753,000	1,882,000
	Total	20,697,000	16,973,000	2,481,000

Source: Wetlands International-Indonesia

The SE Asian tropical peatlands also have many other values or potential uses, such as tourism, sustainable forestry (including many non-timber forest products). The total value of these are estimated at US$950 / ha / year, particularly from fish (70%), construction materials and fire wood (23%) as well as rattan (1%) and wild animals (1%). Another interesting product is the latex from the Jelutung tree (Dyera sp.), indigenous to the SE Asian peat swamp forests - which is used in the chewing gum industry. This can provide an attractive alternative species for sustainable plantation development that would not require drainage and as such would help to maintain the carbon store.

In Indonesia over 3.7 million ha of peat soil has disappeared between 1987 to 2000 as a result of conversion and fires. The main drivers behind this are the wide scale illegal deforestation, unsustainable development of agriculture, pulpwood and palm oil plantations in peatland areas.

Peatland deforestation: Deforestation of Indonesian peat swamp forests occurs at a faster rate than deforestation of its other remaining tropical forest habitats. Since 1985 deforestation rates were 1.3%/yr, and since 2000 the rate has been 1.5%/yr. This is double the rate for non-peatlands. Currently about 45% of all Indonesian peatlands are deforested. For peat swamp forest conservation less than 5% of total peatland area has been set aside, and even these areas are significantly disturbed by illegal logging (and linked drainage by logging channels), poaching as well as impacts of illegal conversion to agricultural lands and drainage of adjacent lands.

Fig 2: Deforestation rates in tropical peat swamp forests in Indonesia

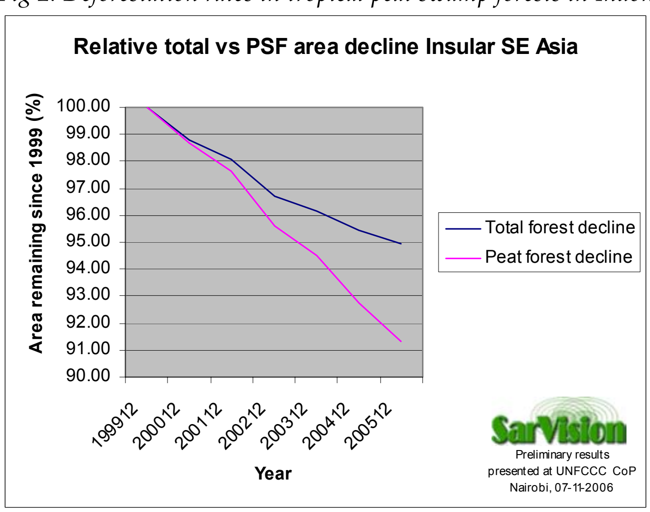
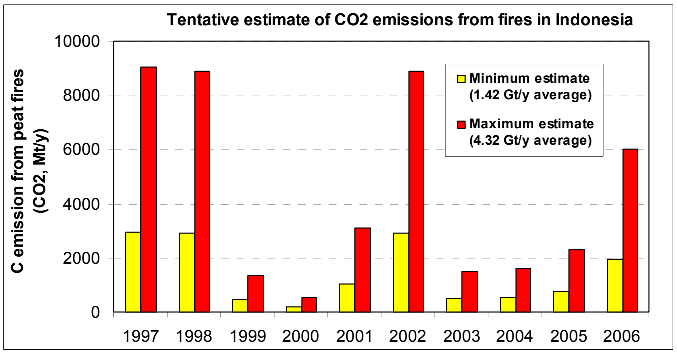


Figure 3: CO2 emissions from fires in Indonesia (from Hooijer et al 2006)

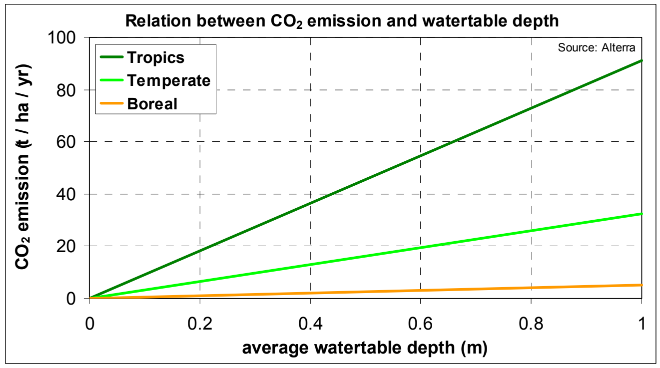


South-east Asian peatlands and carbon emissions: In 1997/98 there were over 60,000 fires in mainly degraded peatlands in Indonesia. The estimated carbon emissions through those peat fires: 0.81-2.57 giga ton C - equivalent to 15-40% annual global emission of fossil fuels (Page et al. 2002). This caused a major leap in atmospheric carbon concentrations. In total 1,5 – 2,2 million ha peat swamp forest burned, especially in Kalimantan & Sumatra. The dense smog forced airports in Sumatra & Kalimantan to be closed for extended periods and over 1100 flights were cancelled in Indonesia, Singapore and Malaysia. The economic damage by smoke was estimated to be in the order of 1.4 billion US$ and economic losses in the tourism & timber sectors were in the order of 7 billion US$. Many and large fires occur every year, and more so during el Niño periods. Last year (2006) there were over 40,000 fires.

Yet, no attention is paid to mitigating or avoiding these carbon emissions from peatlands and the destruction of these valuable areas is only increasing in pace.

A study by Delft Hydraulics and Wetlands International (Hooijer et al. 2006) has shown that the degraded peatlands in South-east Asia contribute significantly to global climate change. SE Asian deforested and drained peatlands cover 0.2% of the global land surface but conservative estimates show that they emit at least 2000 million tonnes of CO_2 annually, an equivalent of at least 8% of the global fossil fuel emissions. They cover 6% of the global peatlands area but are responsible for over 70% of CO_2 emissions from peatlands globally. This includes over 600 Mt from drainage and a minimum annual average of 1400 MT CO_2 from fires. These emissions put the industrial emissions of the western European countries in the shade.

Figure 4: Relation between drainage depth and CO2 emissions



Peatland degradation in SE Asia is directly linked to water management, particularly drainage, both for forestry (transport of logs) as well as for agriculture and agro-forestry purposes. In addition, millions of ha of peatlands have been deforested and drained without any successful follow-up development. Drainage to 1 meter depth results in an emission of 90 ton CO_2/ha/yr. The SE Asia drained peatlands cover some 12 million ha and contribute at least 632 MtCO2/yr (drainage only).

In response to the expanding international biofuel market, palm oil has become the top-one driver of peat swamp forest conversion and drainage. Billions of Euros have been granted in subsidies to support use of palm oil for green energy production, not taking into account the huge CO_2 emissions from the plantations on peat, and thus fueling climate change rather than stopping it. This has resulted in a major ongoing expansion of palm oil production in response to the international bio-fuel market. Currently about 25% of all SE Asian oil palm estates are on peatland, but over 50% of forest areas currently cleared or planned for palm oil are on peat. Plans are to develop 300,000 ha annually in coming 20 years with a targeted 60% of production for the bio-fuel market.

The role of western European countries:

The Netherlands is the largest importer of palm oil in Europe and the 4th largest in the world (after India, China, Pakistan). It granted over 1.5 billion Euro subsidies for palm oil over a ten period to reduce CO_2 emissions. The Netherlands' total CO emissions in 2005 was 80 Mt. Because 25% of palm oil plantations are on peatlands. Unfortunately, because CO_2 emissions when using palm oil for fuel are up to 10 times higher then with fossil fuels, the Netherlands' subsidies may actually have accelerated climate change. After the publication by Delft hydraulics and wetlands International, Essent - the Netherlands' largest Green Energy supplier - has stopped using palm oil until proper certification is possible. The Netherlands Minister for Environment has publicly stated regret about granting the subsidies.

Impact on local people: In addition to the international impacts, the peat fires also impacted on the livelihoods of local people. In 1997/1998 it resulted in thousands of hospitalizations; 500,000 people received outpatient treatment and millions had health problems. This caused the losses of many millions of working and school days and seriously diminished natural resource base of local economies and cultures. Over 30% of the children under 5 years of age living in degraded peatlands have respiratory diseases and resulting stunted growth (Ref: unpubl. data from CARE Indonesia).

Some cost-benefit examples:

1.	Shell + Statoil in Norway:	€ 1.5	billion for	2.5 Mt/y
2.	Germany:	€ 5	billion for	50 Mt/y
3.	World Bank in China:	€ 1.5	billion for	19 Mt/y
4.	UK:	€ 3	billion for	88 Mt/y

Poverty in Indonesian peatlands is 2 to 4 times higher than in other habitat. Under the current socio-economic conditions the local people have no choice but to over-exploit remaining natural resources, leading to a vicious cycle of environmental degradation and over-exploitation which further affects the environmental, economic and food security of the poor.

Ecosystem approach: To resolve the problems and stop the further degradation of peatlands in Indonesia it would be wise to adopt in peatland management the ecosystem approach, looking at peatland management in the full hydrological context in view of their hydrological sensitivity, their ecological relationship with surrounding areas and land-use, their place in the catchment/river basin and the potential impact on up- and down-stream areas. Large scale developments in peatlands should be contemplated only after thorough research, a full cost-benefit analysis, and after trials in small-scale pilot projects.

In addition, it is essential to search for and support alternative development of jobs and income for the local people, to boost them out of the vicious cycle of poverty and environmental degradation. This requires the translation of the international values of peatlands (biodiversity, carbon storage) into funding for poverty reduction.

Sustainable development will also require a proper balance and combinations of sustainable (non-drainage!) forestry, agriculture, fisheries and service sectors. There is an immediate need for access to credit facilities for the local stakeholders. Social and financial security is of utmost importance to enable local poor to change their livelihood strategies. Such long-term securities may require the establishment of multi-donor trust funds and will need the long-term commitments of the international donor community. It will also require the establishment of transparent mechanisms for planning and financial management.

Crops that require (deep) drainage, such as palm oil but also pulp (Acacia plantations) or *Aloe vera*, should not be planted on peatlands. Alternative sustainable developments, involving improved water management, are required and currently piloted in Indonesian peatlands.

Carbon economics and carbon trade: Globally huge investments are made to decrease CO_2 emissions. These investments range between € 34 to € 600, and are on average about 69 Euro per avoided ton CO_2 emission. Prices under the Clean Development Mechanism for avoidance of one ton CO2 fluctuates between € 10 to € 20.

With these prices peatland degradation in South east Asia causes between 20 to 140 billion Euros to literally go down the drain and up in smoke. Voluntary carbon trade mechanisms are currently in development to create markets in options that may result in strong financial incentives for peatland restoration and sustainable development.

	Impacts:	**Business of:**
Win 1	**Climate change**	**UNFCCC**
Win 2	**Land degradation**	**UNCCD, World Water Forum**
Win 3	**Loss of biodiversity**	**CBD, Ramsar**
Win 4	**Poverty**	**CSD**

A win4all: In order to effectively address the huge environmental and socio-economic issues related to the degradation of peatlands, (and particularly peatlands in SE Asia) improved coordination of the relevant international policy platforms will be essential to provide the necessary powerful policy mandate.

What is needed: Most of all sustainable development. Without development restoration of the degraded peatlands will be impossible, and similarly conservation of remaining peat swamp forests. Any peatland conservation and restoration efforts must have a Pro-Poor Approach with a priority on alternative development of jobs and income.

Root causes of peatland degradation (e.g. illegal logging, oil palm – including biofuel, pulp plantations) should be addressed.

Successful schemes will require long-term commitments from the global community, necessary to establish the required social and financial security for local stakeholders. Systems must be

Good governance and transparency of any international and local mechanisms.

As avoided carbon emissions from peatlands are not eligible under CDM, an alternative financial mechanism to CDM is required to address the need for urgent action: E.g. Establish a Global Peatlands Fund. The international values of peatlands in terms of carbon storage and biodiversity need to be monetarised. This can be done through voluntary carbon trade systems as well as through Bio-rights, PES, etc.

There are good options to link in to new emerging mechanisms such as avoided deforestation as well as reforestation funds, using indigenous peat swamp forests tree species for wet (undrained) agro-forestry plantation development. These can be linked to other economic incentive measures and complementary developments (e.g. fisheries in blocked drainage channels).

Current initiatives: There are many small projects ongoing in Indonesia and elsewhere that bring together knowledge (e.g. UNEP-GEF project on Peatlands, Biodiversity and Climate Change; WI/WL Delft PEAT-CO2) and are experimenting innovative ways to address the issues (e.g. Climate Change and Forests Project Indonesia, Central Kalimantan Peatlands Project, Berbak-Sembilang Wetlands and Poverty Reduction Project), EU Carbo-Peat project, EU Fire Fighting projects, SarVision peatlands monitoring, etc etc. These all provide useful pilots and lessons learned that future larger schemes can build on. There are also groups working on identification of innovative mechanisms for free trade in avoided carbon emissions, and new funding mechanisms for peatland conservation. There is a strong interest from industry, particular the energy sector, to get involved.

Vision of the Ramsar Coordinating Committee on Global Action on Peatlands (CC-GAP; meeting of 29 July 2006): Development of a Global Peatlands Fund (with a Board consisting of major shareholders) under policy mandate of a multi-convention CC-GAP and with the Global Peatland Initiative as operational mechanism working through Calls for Proposals.

This will require close engagement of a group of lead Contracting Parties from these conventions and policy platforms to prepare the necessary initiatives, supported by IOPs and GPI. Potential candidates would be Indonesia, Malaysia, Singapore, Netherlands, United Kingdom and Germany.

New developments: Could a Global Peatlands Fund from the outset be construed as a Public-Private Partnership (related also to MDG 8), receiving funding from bi- and multi-lateral donors as well as industry and foundations?

Could the GPF be linked to CDM and/or a Voluntary Carbon Trading scheme, in which a fixed % of the funding raised through carbon credits would be going into the GPF?

What are the options for additional fundraising mechanisms such as interest funds at 'Green' banks?

Section H - Linkages between biodiversity, wetlands and climate change

33. *Commentary prepared by Dirk Roux and Peter Ashton (CSIR, Natural Resources and Environment, South Africa), 22 February 2007*

A common strategy to deal with wetland management, aquatic biodiversity conservation and climate change measures, depends on a critical degree of coherence between sectors that are responsible for water resource protection and management, biodiversity conservation, land use management (including agricultural resources), and integrated development planning. Importantly, this cooperation has both horizontal and vertical dimensions. Vertical coherence refers to the need for coordination and harmonisation between spheres of governance (global, regional, national, state/provincial and local), as well as between political and operational levels. Horizontal coherence refers to coordination and harmonisation, at any one (or all) of these levels, across sectors.

Environmental governance takes place in a complex environment where decision-making is typically associated with limited information, low levels of certainty and potentially high levels of disagreement among stakeholders. In this environment, active and respectful negotiations are required to ensure that organisations, departments and agencies with different professional identities and mandates can successfully agree to, and achieve, shared objectives related to managing and conserving ecosystems.

Ironically, with the current focus of many governments on service delivery and tangible outcomes, effective cooperation requires intangible inputs; for example, people need to spend time together developing relationships and learning to communicate with, respect, and trust one another. An overall recommendation is, as a matter of urgency, to develop a clear understanding of cooperation as a strategy: when is it appropriate; what does it cost; what conditions are necessary for it to exist; and what benefits can it realistically generate.

34. *Wetlands and Climate Change Exploring collaboration between the Convention on Wetlands (Ramsar, Iran, 1971) and the UN Framework Convention on Climate Change October 1999 by Ger Bergkamp, Water Resources Specialist and coordinator of the Freshwater Initiative at IUCN – The World Conservation Union and Brett Orlando, Climate Change Programme Officer, and coordinator of the Climate Change Initiative at IUCN.*

Impacts of CC include sea-level rise, coral bleaching, hydrological effects, changes in water temperature, and alterations in water availability and quality. The role of wetlands as biological sources and sinks of greenhouses gases, in particular carbon dioxide, methane (CH4), and nitrous oxide (N2O) emissions.

Wetland ecosystems provide fundamental ecological functions including the regulation of water regimes as well as providing habitats for flora and fauna. Wetlands -- which as defined by the Ramsar Convention (Article 1.1.) include coastal and marine ecosystems, such as coral reefs, sea grass beds and mangroves - also provide invaluable services and benefits for human populations around the world including the regulation of global and local climates.

According to the IPCC Second Assessment Report, changes in climate will lead to an intensification of the global hydrological cycle and could have major impacts on regional water resources. Climate change may also lead to shifts in the geographical distribution of wetlands and an increase in the severity and extent of coral reef bleaching and mortality. Further, sea-level rise and increases in storm surges associated with climate change could result in the erosion of shores and habitat, increased salinity of estuaries and freshwater aquifers, altered tidal ranges in rivers and bays, changes in sediment and nutrient transport, increased coastal flooding, and in turn, increase the vulnerability of some coastal populations.

The IPCC Third Assessment Report, clarified the state of knowledge of the potential impacts of climate change on wetlands, coral reefs, and water resources. Yet, there is a growing scientific understanding that the conservation and wise use of wetlands can no longer be achieved without taking climate change into account. The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to reduce greenhouse gas emissions in a manner that will allow ecosystems to adapt naturally to climate change (Article 2). The UNFCCC also commits Parties to address the adverse effects of climate change, particularly on developing country Parties. The UNFCCC Parties are currently considering the necessary actions on this topic.

Wetlands, in particular peatlands, are significant carbon stores, and so the role of their conservation also needs to be considered in the development of climate change mitigation strategies. A Special Report on land use, land use change, and forestry (LULUCF) focuses on carbon dioxide, but also addresses methane emissions and nitrous oxide emissions, such as those from wetlands. Based on the outcomes of this Special Report, the Parties to the UNFCCC will take key decisions on the role of land-use, land-use change and forestry in the implementation of the Kyoto Protocol.

There has been little attention given so far by policy-makers to the relationship between climate change and the conservation and wise use of wetlands. However, the projected changes in climate are likely to affect wetlands significantly, in their spatial extent, distribution and function. Current climate change scenarios predict an increase of 2 degrees Celsius globally and an a rise in sea level rise of approximately 1.5 meters within the coming half a century (IPCC 1996). Increasing temperatures, changes in precipitation, and sea-level rise, are the main aspects of climate change that will affect wetland distribution and function.

At the same time, wetlands and peatlands represent important carbon stores and contribute significantly to the global carbon cycle. (Patterson,1999). It is necessary to consider how the twin forces of lands use change and climate change may affect the role of wetlands in the global carbon cycle.

Wetlands cover nearly 10% of the earth's surface of which 2% are lakes, 30% bogs, 26% fens, 20% swamps and 15% floodplains. Mangroves further cover some 24 million hectares (ha) and coral reefs are estimated to cover 60 million ha. The largest remaining areas of wetlands are in the high latitudes and the tropics. Agricultural expansion and other developments have destroyed many wetlands in temperate regions (Ramsar 1998).

Wetlands are characterized by a large number of ecological niches and harbour a significant percentage of world's biological diversity. Wetlands are highly dependent on water levels, and so changes in climatic conditions that affect water availability will highly influence the nature and function of specific wetlands, including the type of plant and animal species within them. Wetlands are important regulators of water quantity and water quality. The functioning of a wetland ecosystem gives rise to a wide diversity of species as they support important levels of global biological diversity, including over 10,000 species of fish, over 4,000 of amphibians, and numerous species of waterfowl (McAllister et al. 1997; WCMC 1992). Many components of wetland ecosystems also provide resources for direct human consumption including: water for drinking, fish and fruit to eat, reeds for thatch roofs, timber for construction, peat and fuelwood for fire.

Recreational uses include fishing, sport hunting, birdwatching, photography, and water sports. Given that tourism is one of the leading income generating industries globally, the economic value of these can be considerable. Maintaining wetlands and capitalizing on these values can be a valuable alternative to more disruptive uses and degradation of these ecosystems.

Key Points: Wetlands are critically important ecosystems, providing significant social, economic and ecological benefits such as:

l- Regulation of water quantity and quality

2- Habitat for waterfowl, fish, and amphibians

3- Resources to meet human needs

4- Recreation and tourism

Climate change will degrade these benefits: IPCC (1996) estimates that sea levels will rise between 1, 5 and 9 meters in the coming decades due to thermal expansion of ocean water and melting of glaciers and ice caps. Even with a stabilization of greenhouse gas emissions, a rise in sea-level will not peak until 2025. Already since pre-industrial times, sea levels have risen globally between 1, 2, and 5 meters (IPCC 1996). Sea level rise would double the global population at risk from storm surges (from around 45 million up to 90 million). Increased coastal flooding, loss of habitats, an increase in the salinity of estuaries and freshwater acquifers, and changed tidal ranges in rivers and bays, transport of sediments and nutrients, patterns of contamination in coastal areas are amongst the main effects of coastal erosion. Accelerated rates in sea level rise will likely result in shifts in species compositions, a reduction in wetland productivity and function (Warren and Niering, 1993).

Increased sea levels will likely force wetland systems to migrate inland. However, this migration path could be obstructed by inland land uses or by the ability of these systems and their components to migrate in time sufficient to survive. For example, many coastal and estuarine wetlands will be unable to migrate inland due to the presence of dikes, levees or specific human land uses close to the coastal area (Kusler et al. 1999).

Higher sea levels and increased storm surges could also adversely affect freshwater supplies available from coastal wetlands due to salt-water intrusion (Frederick 1997). Salt water in delta systems would advance inland affecting the water quality available for agricultural and domestic and industrial use. In many delta and coastal areas the reduction of sedimentation due to sea level rise, dam construction and ground subsidence are already a threat to the livelihoods of many coastal communities.

Coral bleaching: Coral reefs are the most biologically diverse marine ecosystems, but are very sensitive to temperature changes. Short-term increases in water temperatures in the order of only 1 to 2 degrees C can cause "bleaching" of coral reefs. Sustained increases of 3 to 4 degrees C above average temperatures can cause significant coral mortality.

Recent research suggests that increasing concentrations of carbon dioxide in the atmosphere negatively affect coral reef growth (Kleypas, J.A. et al., 1999). Generally speaking, climate change will affect those coral reef systems that are already under stress due to a range of pressures such as over-fishing, pollution, destruction and disease (IUCN/UNEP, 1993).

Hydrological effects: Wetlands will be affected in different ways by shifts in the hydrological cycle. These include changes in precipitation, evaporation, transpiration, runoff and groundwater recharge and flow. These changes will affect both surface and groundwater systems and impact wetland requirements, domestic water supply, irrigation, hydropower generation, industrial use, navigation and water based tourism. Changes in flow regimes and water levels impacts largely on the status of inland wetlands. Arid and semi-arid areas are especially vulnerable to changes in precipitation as a decline in precipitation can dramatically affect wetland areas. The surface of Lake Chad, for example, has declined dramatically since the 1960s due to decreased rainfall and discharge from the Chari river (Talling and Lamoalle 1998).

Changes in the northern latitudes: The increase in temperature in tundra and polar areas are anticipated to result in melting of permafrost causing a reduction in its areal extent and depth. This will induce increased decomposition and lead to an additional flux of CO_2 into the atmosphere and induce changes in processes that contribute to methane (CH_4) emissions from these wetland areas (Clair et al. 1998). Changes in the tundra wetland ecosystems are further projected to cause migration of vegetation zone to the north.

Indirect impacts on wetlands– the interaction of climate changes with consumption patterns and land use: Direct effects of climate change on wetlands are likely to be accentuated by human induced changes that will increase stress to wetland ecosystems. Estimates of the loss of wetland in industrialized regions indicate that up to 60% of these have been destroyed in the last 100 years due to drainage, conversion, infrastructure development and pollution. These changes are estimated to be responsible for most of the loss in freshwater biological diversity in the United States in recent decades (McAllister et al. 1997). Water demand is projected to increase steadily during the coming decades. However, climate change is expected to lead to a decrease in water availability, especially in arid and semi-arid areas.

Response measures to address climate change, such as dam construction, could have implications for wetlands. For example, utilizing hydropower as an alternative to fossil fuel power plants would lead to more dam construction. The construction of dams will put additional stress on wetland ecosystems by increasing habitat fragmentation. Fragmentation prohibits plants and animals to 'migrate' to other locations over time in response to changes in temperature or water levels as exemplified above for coastal and estuarine wetlands. Dams also retain large quantities of sediments essential to the maintenance of deltas and coastal wetlands. Vörösmarty et al. 1997 estimate that at the global level 16% of sediments are already trapped by dams.

In order to properly assess the source and sink potential of natural wetlands and the conversion of wetlands, the flows of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have to be taken into account.

The role of wetlands in the global carbon cycle is poorly understood, and more information is needed on different wetland types and their function as both sources and sinks of greenhouse gases.

Mitigation of greenhouse gas emissions: Mitigation in the context of climate change can be defined as a deliberate management strategy to reduce greenhouse gas emissions from sources and enhance the extent and functioning of sinks and reservoirs of greenhouse gases. Wetlands store large amounts of carbon and when these wetlands are lost or degraded, CO2 and other greenhouse gases are released into the atmosphere in large quantities. Therefore, conserving wetlands is a viable way of maintaining existing carbon stores and avoiding CO2 and other emissions.

An additional mitigation strategy is the restoration of degraded wetlands and creation of human-made wetland ecosystems. Restoration and creation can compensate to some extent for the loss natural wetland functions, such as flood storage and water quality buffering (Kusler and Kentulla, 1990) and provide opportunities to store carbon.