Wetlands and Climate Change

Exploring collaboration between the

Convention on Wetlands (Ramsar, Iran 1971)

and the

UN Framework Convention on Climate Change

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Executive Summary

This discussion paper examines the scientific and institutional linkages between climate change and the conservation and wise use of wetlands. Following the introduction, the second section of the paper reviews the state of knowledge concerning the impact of climate change on wetlands including freshwater resources, coral reefs, and other coastal and marine wetlands. These impacts 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 (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions, is also explored, as well as the potential options to reduce greenhouse gas emissions through wetlands conservation and wise use practices. Finally, the section addresses strategies to mitigate the adverse effects of climate change, and the capacities and constraints within societies and institutions to cope with these.

The third section examines the institutional linkages between the Convention on Wetlands (Ramsar, Iran, 1971) and the UN Framework Convention on Climate Change (UNFCCC). It provides an overview of the relevant programmes of work being undertaken by the two Conventions. It also discusses the related work of the Intergovernmental Panel on Climate Change (IPCC), the Convention on Biological Diversity (CBD) and the Global Environment Facility (GEF). The fourth, and final, section outlines a set of proposed actions that could be carried out between the UNFCCC and the Convention on Wetlands. These proposed actions could involve cooperation across various levels of implementation of the two Conventions, ranging from the Convention secretariats, the scientific and technical advisory bodies, the Conference of the Parties, financial mechanisms, as well as increased coordination at the national level. The proposed actions are presented under four broad themes:

i) promoting linkages between the two Conventions
ii) predicting and monitoring the impacts of climate change on wetlands
iii) the role of wetlands in adapting to, and mitigating the impact of, climate change.
iv) the role of wetlands in reducing greenhouse gas emissions.

1. Introduction

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, expected in June 2001, will further clarify 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) is currently being prepared by the IPCC. That Report, which is expected to be completed in May 2000, will primarily focus on carbon dioxide, but will also address 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.

Against this background, there is a need to further explore ways to strengthen collaboration in the implementation between the Convention on Wetlands and the UN Framework Convention on Climate Change. 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, which was adopted by the Ramsar Contracting Parties at COP6 in March 1996. That need was further reinforced by Resolutions VII.4 and VII.9 adopted by the Contracting Parties of the Ramsar Convention at COP7 in May 1999. The key challenge in moving this effort forward is to clearly identify the value-added of strengthening cooperation between the two Conventions. Strategic linkages need to be explored among various aspects of the two Convention processes, ranging from the two Convention secretariats to the respective scientific advisory bodies, and Conference of the Parties, financial mechanisms, as well as increased coordination at the national level.

This paper covers three topics: (1) a review of scientific information related to climate change for wetland conservation and wise use; (2) an overview of the institutional linkages between the UNFCCC and the Convention on Wetlands. The work of the IPCC, the CBD, and the GEF is also addressed; and (3) a proposed set of joint actions that could be carried out between the UNFCCC and the Convention on Wetlands.

2. Wetlands and Climate Change: Challenges and Opportunities

2.1 Background

Wetlands provide globally significant social, economic and environmental benefits. Important wetland functions include water storage, groundwater recharge, storm protection, flood mitigation, shoreline stabilization, erosion control, and retention of carbon, nutrients, sediments and pollutants (Dugan 1990). Wetlands also produce goods that have a significant economic value such as clean water, fisheries, timber, peat, wildlife resources and tourism opportunities. The loss and degradation of wetlands is driven by several factors. Increased demand for agricultural land associated with population growth continues to be a significant cause of wetland loss in some parts of the world. Infrastructure development and river flow regulation constitutes another major cause of wetland degradation and loss, as well as the invasion of non-native species and pollution.

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.

2.2 Climate change impacts on wetlands

Wetlands are broadly defined as a variety of shallow water bodies and high groundwater environments that are characterized by permanent or temporary inundation, soils with hydric properties, and plants and animals that have adapted to life in saturated conditions (Lewis 1995). Wetlands include, for example, floodplains and areas along rivers and lakes that are seasonally inundated, upland areas that are covered with peatlands, tundra areas in upper Russia, Canada and Alaska, and coastal areas affected by the daily sea level fluctuations. 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 provide several critical functions that are essential for sustainable development in many

areas. Ecosystem functions are defined as 'the capacity of natural processes and components of natural or semi-natural systems to provide goods and services that satisfy human needs" (de Groot 1992). Wetland functions can generally be grouped into four types: regulation, provision of habitats, production, and provision of information.

Wetlands are important regulators of water quantity and water quality. Several types of wetlands are known to act as hydrological buffers. For example, floodplain wetlands store water when rivers over-top their banks, reducing flood risk downstream. The value of these services may be considerable and often technical alternatives to regulate the quantity of flow are much more expensive. Wetlands not only regulate the quantity of water flow but also regulate its quality (Baker and Maltby 1995). Reedbeds and other wetland plants, for example, are known as important regulators since they remove toxins and excessive nutrients from the water. The maintenance of many, complex, biological processes involving soils, water, plans, animals, and micro-organisms, is necessary to sustain these ecosystem services. 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. The harvesting of wetland goods, while respecting the production rate and the regenerative capacity of each species, can provide significant benefits to society. In many areas fisheries rely heavily on healthy wetland ecosystems. In many rural areas, the amount of water available depends largely on water extracted from shallow boreholes or local springs. If areas of recharge are maintained and protected, aquifers and springs can provide a sustained amount of water resources for communities (Acreman and Hollis 1996).

Wetland ecosystems also provide opportunities for recreation, aesthetic experience and reflection. 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.

In sum, there is a broad and growing consensus that wetlands are critically important ecosystems that provide globally significant social, economic and environmental benefits. Costanza et al. (1997) estimated the total global value of services provided by coastal areas and wetland ecosystems to be 15.5 trillion USD y^{-1} being 46% of the total value of services that global ecosystems are estimated to provide.

It is generally understood, however, that increases in temperature, sea-level rise, and changes in precipitation will degrade those benefits and services. These changes will likely affect waterfowl that are dependent wetlands as habitats, and may contribute to desertification processes. It is important to realize, though, the degree of uncertainties associated with projections of the consequences for wetland ecosystems resulting from climate change. For most regions the projections for changes in precipitation and temperature, are highly uncertain. The range of change in precipitation from pre-industrial levels are for example estimated for North America to be + /– 20% for precipitation, +/– 10% for evaporation and +/ – 50% for runoff (Frederick 1997). Further uncertainty includes the increase in frequency and intensity of extreme events, such as storms, droughts, and floods. The ability of wetland ecosystems to adapt will be highly dependent on the rate and extent of these changes.

Wetland responses to climate change are still poorly understood and are often not included in global models of the effects of climate change (Clair et al. 1997). As a wide range of wetland types exist, it is difficult to accurately predict whether they will continue to function as hydrological buffers for extreme events or provide other important ecological, social, and economic services. Therefore, only a general assessment of the relationships between wetlands and climate change can be given.

KEY POINTS

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

2.2.1 Effects of sea level rise

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). Examples of particularly sensitive areas include small island states, Bangladesh and other states in southeast Asia, north-western Europe, the southern Atlantic coast and the Gulf of Mexico in the United States. Coastal erosion is considered to be one of the main impacts of sea level rise. (Boorman 1990, IPCC 1996). 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).

Coastal wetland flora and fauna generally respond to small, permanent changes in water levels. However, the degree to which they are able to adapt to these changes will depend to a great extent on the ability for species to ‘migrate’ to alternative areas. 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.

2.2.2 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. Restoration of these coral communities can require several centuries. A rising sea level and increasing storm surges also could harm coral reefs. Many available studies indicate that even slow-growing corals can keep pace with the "central estimate" of sea-level rise (approximately 0.5 cm per year). These studies do not take account of other pressures on coral populations, such as pollution or enhanced sedimentation (Bijlsma, 1996). However, recent research suggests that increasing concentrations of carbon dioxide in the atmosphere negatively affect coral reef growth (Kleypas, J.A. et al., 1999). Coral reefs are further effected by runoff and sediments from land based activities that could possibly increase under a changing climate. 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).

2.2.3 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.

Climate change is projected to intensify the global hydrological cycle and to have major impacts on regional and temporal water distribution and availability. One of the areas most vulnerable are those where precipitation currently is mainly in the form of winter snowfall and stream-flow comes largely from spring and summer snowmelt. In these areas, a temperature increase is likely to induce an increased winter runoff and a reduced spring and summer flow (Kwadijk & Middelkoop 1994, Sealthun et al. 1998). For some of these areas, this would mean an increased risk for late winter flooding and the likelihood of reduced availability of irrigation water during periods of high demand (Frederick 1997). The changes in runoff would, however, not only depend on changes in precipitation, but also on the physical and biological conditions within the catchment.

The quantity and quality of water supplies is already a serious problem today in many regions, including in some low-lying coastal areas and small islands making these regions particularly vulnerable

to a reduction of local water resources. The recharge of acquifers through seasonal inundations of floodplain wetland areas represents an important process for the maintenance of these water resources, upon which many of the societies in these arid and semi-arid regions depend.

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).

2.2.4 Changing temperatures of wetland water bodies

Increasing temperatures globally are likely to result in a warming of water temperatures in lakes and rivers. The greatest effect would be at high latitudes where biological productivity would increase and in low-latitude boundaries of cold- and cool-water species ranges and where extinction would be greatest (IPCC 1996). Rare and endangered plant and animal species with sensitivity to small temperature changes often have no alternative habitat, especially in isolated areas such as those in montane and alpine wetlands. Besides the warming effect, Talling and Lamoalle (1998) have pointed to the possibility of increased mixing of stratified water bodies due to increased storm activity, which could result in the large-scale die-off of fish species.

2.2.5 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.

2.2.6 Indirect impacts on wetlands – the interaction of climate change 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. To address this problem, many countries will need to continue efforts to increase reservoir storage capacity to meet the increasing demands for irrigation.

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. In China, dam construction for hydropower is already expected to increase by 6% annually (Fulton, 1999). 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.

KEY POINTS

Climate change will effect wetlands through:

- Sea level rise
- Increased sea temperatures
- Changes in hydrology
- Increased temperature of wetland water bodies
- Increased temperature in tundra and polar areas
- Land use change and water consumption patterns will accentuate climate change impacts on wetlands.

A future pressure to increase water storage capacity through dam construction will increase this amount, causing further coastal area and delta erosion. Gradual compaction of delta peatland soils and delta wetlands drainage will induce land subsidence, causing deltas and island to fall below sea levels. The combination of sea-level rise and land subsidence could place human populations in the deltas and the coastal zone at additional risk.

2.3 Wetlands as greenhouse gas stocks, sources and sinks

Wetlands cover about 8-10% of the world's land surface (depending on how they are defined), and contain 10-20% of the global terrestrial carbon. They therefore play an important role in the global carbon cycle (Sahagian and Melack 1998, IPCC 1996). When coastal wetlands and peatlands are included, wetlands represent the largest component of the terrestrial biological carbon pool (Dixon and Krankina, 1995). The carbon pool contained in wetlands is estimated to amount up to 230 gigatons (Gt) out of a total of about 1943 Gt. Peat deposits are estimated to hold 541 Gt of carbon in total (Immirizi and Maltby, 1992).

Table 1. Greenhouse gas stores and flows in wetlands (GACGC 1998).

a. Carbon stocks and flows of peatlands

	Carbon stores ($t\ C\ ha^{-1}$) Soil	**Biomass**	**Carbon absorption ($t\ C\ ha^{-1}yr^{-1}$)**
Global	1,181–1,537	no data	0.1–0.35
Tropics	1,700–2,880	500	No data
Boreal / temperate regions	1,314–1,315	120	0.17–0.29

b. Release of methane from natural wetlands and rice cultivation, expressed as carbon dioxide (CO_2) equivalent

	Methane emissions ($t\ C\ ha^{-1}yr^{-1}$)	**Equivalent CO_2 emissions (t C) Global Warming Potential – GWP (factor / time horizon in years)**			**Region**
Methane emissions	0.05–0.21	2.8–4.4	1.1–4.4	0.3–1.4	Global
From natural wetlands	0.26–0.28	14.6–15.7	5.5–5.9	1.7–1.8	Tropic
	0.08–0.15	4.5–8.4	1.7–3.2	0.5–1	Boreal/temperate
Methane emissions	0.13–0.89	7.3–49.8	2.7–18.7	0.85–5.8	Global
From rice cultivation					

c. CO_2 emissions from the conversion of wetlands (swamps and bogs only)

	CO_2 emissions	
	Drainage [$t\ C\ ha^{-1}yr^{-1}$]	**Agricultural use [$t\ C\ ha^{-1}yr^{-1}$]**
Global	0.23–0.26	1–10
Boreal / temperate regions	0.1–0.32	1–19

Table 1 summarizes greenhouse gas stores and flows in wetlands. Table 1a outlines the significant amount of carbon stored in peatland soils, particularly in tropical peatland soils, and biomass. Table 1b makes note of the release of methane emissions from natural wetlands and rice cultivation. Table 1c illustrates the considerable amount of CO_2 emissions from swamps and bogs due to drainage and conversion to agriculture.

Due to their anaerobic character and low nutrient availability, wetland carbon stocks increase continuously. Consistent with Table 1a, Gorham (1991), estimates that bogs are a greenhouse gas sink globally, absorbing about 0.1 Gt C yr^{-1}. However, when peatlands are drained, mineralization generates considerable emissions, ranging from between 2,5 and 10 t C ha^{-1} yr^{-1}. Drainage of tropical swamp forest can amount to 40 t C ha^{-1} yr^{-1}. Consistent with Table 1c, total carbon emissions from wetland conversion to agricultural land is estimated to range between 0.05 and 0.11 Gt C yr^{-1} (Maltby and Immirzy 1993).

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. Wetlands and rice fields produce up to 40% of the global source of methane emissions to the atmosphere as a result of the anoxic conditions occurring in their flooded soils and their high primary production (Bartlett and Harriss, 1993). Boreal and tropical wetlands are another important source of methane emissions (Table 1). When wetlands are converted to agricultural land, large quantities of CO_2 and N_2O are released while methane emissions are sharply

reduced (GACGC 1998). *Recently, Kasimir-Klemedtsson et al. (1997) showed that wetlands in northern Europe accumulate between 0.16 - 0.25 t C* ha^{-1} yr^{-1} *but if methane emissions are taken into account these wetlands become a net source of 0.43 - 1.1 t C* ha^{-1} yr^{-1}.

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.

2.4 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, CO_2 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 CO_2 and other emissions.

Wetlands currently contain approximately 10% of the total global carbon store (IPCC 1996). Wetlands are under continual threat of degradation due to infrastructure developments and conversion to agricultural land and other uses, making the conservation of wetlands a potentially important strategy to prevent increases in greenhouse gas emissions. Wetlands conservation and their sustainable use as natural habitats includes management strategies that prevent destruction, degradation, fragmentation, and pollution of these ecosystems. These strategies may include a multitude of activities related to innovative natural resources exploitation, legislation, enforcement, incentive measures, impact assessment, capacity building and awareness raising.

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.

KEY POINTS

- Though wetlands cover only a small portion of the world's land surface, they are significant carbon stores globally.
- Conversion and degradation of wetlands releases carbon and methane into the atmosphere in large quantities
- Conserving, maintaining, and restoring wetlands avoids human-induced greenhouse gas emissions.

2.5 Adaptation strategies to adverse effects

Management of natural resources is characterized by the need to *continuously* adapt to changing circumstances through a learning-by-doing approach. In this sense, adapting to a changing climate has many similarities with other aspects of natural resources management.

Adaptation in the context of climate change can be defined as a deliberate management strategy to minimize the adverse effects of climate change, to enhance the resilience of vulnerable systems, and to reduce the risk of damage to human and ecological systems from changes in climate. Wetland rehabilitation can be a viable alternative to flood control and dredging efforts designed to cope with larger and more frequent floods, possibly associated with climate change.

The vulnerability of societies to climate change, and the vulnerability of specific types of wetlands, play a decisive role in the degree to which the development of adaptation strategies is needed. With respect to wetland and water resources, managers have given less attention, thus far, to strategies that cope with increasing variations and changes in climate. Elements of an adaptation strategy should not only involve physical alterations in the management system, but also technological and institutional changes that can deal with changing conditions.

The ability to adapt will vary from country to country depending on the available human and financial resources. Adaptive capacity is further a function of socio-economic, political and legal conditions that vary widely between countries. Due to limited human and financial resource availability poorer countries will have lower adaptive capacities to cope with the effects of climate change. They may benefit, though, from having introduced a lesser degree of alteration in their natural systems.

2.5.1 Infrastructure development and alternatives

An important element in of climate change adaptation is the need to acquire more water storage capacity to buffer adverse effects. Boting (1999) considers the construction of storage dams designed to control increased flooding a high priority in China. The effectiveness of reservoirs to reduce peak discharges that might increase due to climate

change remains doubtful. In many cases, reservoirs are often entirely filled by the time an extreme flood event occurs, meaning they have no storage capacity to reduce the flood peak in height or duration.

The construction of other infrastructure to prevent large flooding such as levees and dikes, and straightening of channels to enable rapid drainage are increasingly seen as counter productive management interventions. An alternative management strategy is the restoration and rehabilitation of riverine wetland areas to enable large areas of land to be flooded. In reaction to the floods of 1992 and 1993, the Netherlands, for example, has started with the rehabilitation of floodplain areas along the River Rhine to allow flooding of controlled areas during extreme discharges. In Napa Valley, California, the US Army Corps of Engineers have recently started with the development of alternatives to traditional flood prevention infrastructure, focussing partly on wetland restoration.

In the light of climate change, it is particularly important to protect coastal and estuarine wetlands that could be further reduced or adversely affected. An important adaptation strategy is the prevention of additional stress that can reduce the ability of wetlands to respond to climate change. Reducing pollution, avoiding vegetation removal, and protecting wetland biological diversity and integrity are, therefore, viable activities to maintain and improve the resiliency of wetland ecosystems so that they continue to provide important services under changed climatic conditions (Kusler et al. 1999). Another important adaptation strategy is preventing the fragmentation of wetlands. Connectivity between ecosystems allows migration of species to occur in response to climate change and therefore the maintenance of migration routes constitutes a wise approach. Maintaining river flow characteristics, including low flows also represents an important approach to maintain wetland systems.

2.5.2 Assessment and selection of adaptation strategies

Water and wetland resources managers have conventionally assumed that the future resource base will not substantially differ from that in the past. Techniques applied to determine medium and long-term availability of resources, especially water, have not explicitly considered changes in climate.

The impact of climate change on wetland and water resources adds a further uncertainty to the natural multi-decadal variability of these resources. In many cases, the extent and rate of change is not well known. Climate change is a major issue for management decisions concerning major coastal, river, irrigation and water supply infrastructure development and maintenance projects.

Water and coastal zone managers have typically not considered climate change scenarios in water resource forecasts. To the extent that they have, different organizations use different scenarios to determine the uncertainty arising from climate change, for example, related to yields from wells or shoreline erosion. Some organizations use the ‘average’ as an indicator of climate change, others focus on the ‘worst case’ or ‘best guess’ scenarios. Generally, the emphasis has been on predicting future climate uncertainties rather than developing a management approach that can deal with the presence of uncertainty in general. Such management approaches could include, for example, adjustments in infrastructures that allows these to be managed in various ways or to be upgraded when needed. Dams, for example, can be designed and constructed with outlets at various heights to allow for releases to maintain river flow characteristics. With a change in climate, more emphasis needs to be placed on these aspects of water and coastal zone management.

2.5.3 Adaptive capacities within societies and institutions

The degree to which societies and institutions can adapt to climate change will depend on their ability to manage water resource supply *and* demand. Water management has traditionally focused much on supply side management through the extension of infrastructure for water delivery. Only recently has demand side water management become a viable alternative strategy. Water pricing and other incentive measures are important mechanisms to implement such a strategy.

Resources other than water need to be managed along similar lines. Coastal zone use, for example, needs to be managed through management of supply of fish landings, and the management of demand (e.g. tourism demand for development), to enable adaptation to conditions altered due to climate change. Societies that are able to implement both resource supply side and demand side management strategies are likely to be more adaptive to climate change than those societies that are unable to do so.

Increasing uncertainty regarding the resource base requires the development of strategies that reduce uncertainty. For example, single type reservoir water systems are extremely sensitive: a

reduction of the reservoir beyond a critical level will directly effect water users. Such systems generally lack the flexibility to adapt to climate change and can significantly increase the risk for seasonal flooding or extreme droughts. Generally integrated systems are much more robust and resilient, as allocations can be made from multiple resources for multiple purposes, depending on the conditions. The operationalization of such systems will require the integrated management of different types of resources, including freshwater availability, irrigation, fisheries, and tourism.

The ability to adapt to climate change also depends much on the institutional capacity to develop and implement such strategies, and is largely a function of the socio-economic, political, legal and institutional setting in which such institutions operate. Countries that invest in maintaining and strengthening their capacities to integrate and manage uncertainty are likely to be much more able to adapt to climate change than others. Worldwide, there is a need for assessments of and research into the development and implementation of alternative management strategies within different settings. However, in many cases more awareness is needed at many levels before such investments will take place.

KEY POINTS

- Preventing additional stress on wetlands from pollution, for example, is an important adaptation strategy for climate change.
- Climate change is a major challenge for water resource management but the tools for decision making are not yet developed.
- Capacity to adapt will vary considerably across countries, and will depend on institutional capacity to a great extent.

2.6 Conclusion

Wetlands are critically important ecosystems that provide globally significant social, economic and environmental benefits. Climate change is likely to have a severe impact, and compromise their ability to provide these benefits. Sea-level rise, coral bleaching, changes in hydrology and in the temperature of water bodies will lead to reduction in the goods and services provided by these wetlands. Further, efforts to respond to climate change may have equally negative, and compounding, effects on freshwater and coastal zone ecosystems.

The goals of wetland conservation and wise use are unlikely to be achieved without taking climate change into account. Information about the consequences of climate change on specific wetland types and river basin is sorely needed to allow water resource and wetlands managers to integrate changes in climate into their planning and management efforts. It is generally understood, though, that removing the existing pressures on wetlands, and improving their resiliency is the most effective method of cope with the adverse effects of climate change.

Wetlands play an important role in the global carbon cycle, and are a significant storehouse of carbon. When wetlands are converted, they emit large quantities of carbon dioxide and other greenhouse gases. Conserving, maintaining, or rehabilitating wetland ecosystems can be a viable element to an overall climate change mitigation strategy. Nevertheless, more information on specific wetland types and their role in regulating global and local climates is needed to facilitate efforts to conserve and wisely use wetland ecosystems.

3. Exploring Linkages between the UN Framework Convention on Climate Change and the Convention on Wetlands (Ramsar, Iran 1971)

Based on the previous analysis, this section discusses the institutional overlaps between the UNFCCC and the Convention on Wetlands. It outlines the relevant work programmes being implemented by the two Conventions. It also addresses the related work of the Intergovernmental Panel on Climate Change, the Convention on Biological Diversity and the Global Environment Facility.

3.1 Relevant work of the UN Framework Convention on Climate Change

There are at least four items in the UNFCCC work programme that are relevant to the implementation of the Convention on Wetlands: Land Use, Land Use Change and Forestry; Implementation of Articles 4.8 and 4.9 of the Convention (adverse effects); Mechanisms pursuant to Articles 6, 12, 17 of the Kyoto Protocol; and Technology Transfer. These items are briefly described below.

3.1.1 Land Use, Land Use Change, and Forestry (LULUCF)

Article 3.3 of the Kyoto Protocol allows developed (Annex I) country Parties to utilize a set of *"direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990,*

measured as verifiable changes in carbon stocks," to meet their quantified emissions limitations and reduction commitments (QELRC). Article 3.4 allows Parties to decide which additional human-induced land use change and forestry activities should be added to, or subtracted from, the assigned amounts of Annex I Parties listed in the Protocol. This decision, which would take place at the first meeting of the Parties to the Kyoto Protocol after it has entered into force, would apply to the second commitment period, though, Annex I Parties may choose to apply such a decision to the first commitment period. There is no explicit mention of human activities related to wetlands or other biome types in either Article 3.3 or 3.4 of the Protocol.

The UNFCCC Subsidiary Body on Scientific and Technical Advise (SBSTA) and the COP continue to deliberate on land use change and forestry issues related to the UNFCCC and its Kyoto Protocol. At the request of the SBSTA, the UNFCCC Secretariat has hosted two technical workshops on land use change and forestry issues. The first workshop (October 1998, Rome, Italy) considered definitions for the activities listed in Article 3.3 of the Protocol – afforestation, reforestation, and deforestation – used by Parties and international organizations, and the implications of those definitions. The second workshop (April 1999, Indianapolis, USA) addressed additional activities for consideration under Article 3.4 of the Protocol, including methodologies, uncertainties, and research needs. At UNFCCC COP5 (Bonn, Germany, 25 October – 5 November, 1999) Parties are expected to further consider a work programme on land use, land use change, and forestry. At COP6 (The Hague, The Netherlands, Dates: TBD), draft decisions on land use change and forestry activities will be formulated for adoption by the first Meeting of the Parties to the Kyoto Protocol, once the agreement has entered into force. These will include decisions related to definitional issues concerning Article 3.3, rules, modalities, and guidelines concerning Article 3.4, and guidelines for supplemental information on Articles 7.1 and 7.4 (emissions inventories and national communications).

3.1.2 Implementation of Articles 4.8 and 4.9 of the Convention

UNFCCC Article 4.8 calls on Parties to give full consideration to necessary actions, including those related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures. A number of country-types directly relevant to the Convention on Wetlands are listed, in particular small island countries; countries with low-lying coastal areas; countries with arid and semi-arid areas, forested areas and areas liable to forest decay; countries with areas prone to natural disasters; countries with areas liable to drought and desertification; and countries with areas with fragile ecosystems. Article 4.9 calls on Parties to take full account of the specific needs and special situations of the least developed countries, including those that possess wetlands, in their actions with regard to funding and transfer of technology.

Articles 2.3 and 3.14 of the Kyoto Protocol call upon Annex I Parties to implement the policies and measures, as well as commitments articulated in the Protocol, in a manner that minimizes the adverse effects of climate change and the impacts of response measures, such as impacts on international trade, and social, environmental and economic impacts on Parties.

At UNFCCC COP4 (Buenos Aires, Argentina, 2-14 November 1998), Parties decided to adopt and implement the programme of work on this topic. The UNFCCC Secretariat hosted an expert workshop (21-24 September, 1999, Bonn, Germany) to give consideration to the implementation of these provisions. According to the programme of work, decision on initial actions to address the implementation of Article 4.8 and 4.9 of the Convention, as well as of Articles 2.3 and 3.14 of the Kyoto Protocol, is expected at UNFCCC COP5, and that any further actions will be taken at UNFCCC COP6.

3.1.3 Mechanisms pursuant to Articles 6, 12, and 17 of the Kyoto Protocol

The Kyoto Protocol establishes three mechanisms to facilitate the implementation of developed country (Annex I) Parties to achieve their commitments to reduce greenhouse gas emissions: international emissions trading (Article 17); joint implementation among Annex I Parties (Article 6); and the Clean Development Mechanism (Article 12). Article 6 explicitly allows for projects aimed at reducing emissions or enhancing removals in the land use change and forestry sector. However, the scope of such activities has not yet been decided. The Clean Development Mechanism is not so explicit, and the role of land use change and forestry activities in the mechanism, if any, has yet to be clarified by the UNFCCC Parties, as well as the role of any other mitigation option/strategy.

At UNFCCC COP4, the Parties agreed to a work programme for the design and implementation

of the three mechanisms with priority given to the development of modalities and procedures for the Clean Development Mechanism. Issues relevant to the Convention on Wetlands that are under consideration in the work programme include the climate change effectiveness, provision for adaptation, and maximizing the environmental benefits of mechanisms. It is expected that draft decisions on all the mechanisms (Articles 6, 12, 1 7 of the Kyoto Protocol) will be formulated at COP6 for adoption at the first Meeting of the Parties to the Kyoto Protocol, which will meet once it has entered into force.

3.1.4 Development and Transfer of Technology

Article 5 of the UNFCCC calls upon developed country (Annex I) Parties to take practical steps to promote, facilitate, and finance the transfer of, or access to, environmentally sound technologies to developing country Parties, to enable them to implement the Convention. At UNFCCC COP4, the Parties requested the SBSTA to establish a consultative process to consider a list of issues and questions and to make recommendations to achieve "meaningful and effective action(s)" on the development and transfer of technology. The consultative process could include regional meetings, regional workshops and a SBSTA workshop. The COP4 decision requests developed country (Annex I) Parties to provide assistance to developing country Parties to build capacity for sustainable management, conservation and enhancement of sinks and reservoirs including forests and oceans as well as other terrestrial, coastal and marine ecosystems, including wetlands. It further requests Annex I Parties to assist developing country Parties to build capacity to adapt to the adverse effects of climate change. It is expected that a decision on technology transfer will be adopted at COP5.

The UNFCCC Secretariat was specifically requested to continue work on synthesizing and disseminating information on environmentally sound technologies and know-how to mitigate and adapt to climate change The Secretariat has been asked to give priority to this work in its next biennium, and to further strengthen its activities to support capacity building in developing country Parties with regard to the transfer of environmentally sound technologies and know-how.

3.2 Relevant work of the Convention on Wetlands

The Contracting Parties to the Convention have adopted several Resolutions and/or Recommendations that are directly relevant to the UNFCCC. These are briefly described below. Other related provisions of the Convention on Wetlands and its Strategic Plan are also described.

A distinguishing characteristic of the Convention on Wetlands is the adoption of the concept of "wise use" as a part of the idea of nature conservation (Article 3.1). The central importance of the "wise use" concept has been increasingly recognized in the Convention's implementation since 1971. At Ramsar COP3 in Regina, Canada, 1987, the Contracting Parties adopted the following definition of "wise use" in an annex to Recommendation 3.3: *"The wise use of wetlands is their sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the* ecosystem." The term "sustainable utilization" was clarified as: "*Human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations."*

In subsequent Conference of the Parties, the Contracting Parties to the Convention on Wetlands have adopted the *"Guidelines for the Implementation of the Wise Use Concept"* (Ramsar COP4, Montreux, Canada, 1990) and the *"Additional Guidance for the Implementation of the Wise Use Concept"* (Ramsar COP5, Kushiro, Japan, 1993). Both documents are intended to assist wetland managers in the Contracting Parties to meet their countries' obligations under the Convention.

3.2.1 Resolutions and/or Recommendations

The need to further develop links with the UN Framework Convention on Climate Change, in view of the potential impacts on wetlands of climate change, is clearly articulated in Action 7.2.7 of the Ramsar Strategic Plan (1997-2002), which was adopted by the Ramsar Contracting Parties at COP6 (Brisbane, Australia, 19-27 March 1996). Subsequently at Ramsar COP7 (San Jose, Costa Rica, 10-18 May 1999), three decisions were adopted which make reference to the UNFCCC and the issue of climate change.

Resolution VII.4 on partnerships and cooperation with other Conventions requests the Ramsar Bureau (secretariat) to give priority in its programme of work for the next triennium to the development of a Memorandum of Cooperation with the UNFCCC. It further requests the Ramsar Bureau to encourage the involvement of the secretariats of the UNFCCC, among other

Conventions, in efforts to harmonize information management.

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. The Contracting Parties endorsed the *Draft Global Action Plan for the Wise Use and Management of Peatlands* (See below) and invited the Ramsar Convention's Scientific and Technical Review Panel and Ramsar International Organization Partners to assist Contracting Parties to evaluate this *Action Plan* with a view to developing:

i) further national and regional development, wise use, and management guidelines for peatlands;
ii) initiatives to transfer peatland development and restoration technology to developing countries and countries with economies in transition.

Recommendation 7.2 on small island states notes the direct and urgent interests of Small Island Developing States in the impacts of climate change and the important role of wetlands in addressing these threats. The Recommendation strongly endorses the development of a Memorandum of Cooperation between the Ramsar Convention and the UNFCCC articulated in Resolution VII.4.

3.2.2 Draft Global Action Plan for the Wise Use and Management of Peatlands

Annexed to Recommendation 7.1, the *Action Plan* recognizes peatlands as a significant component of the world's carbon sink and a valuable economic resource. It lists various action items of potential relevance to the UNFCCC and climate change. In particular, the *Action Plan* recommends that Ramsar Contracting Parties ensure that international mire and peatland sustainable development, wise use, and management and conservation issues are included in the discussions at, and the resolutions prepared for, meetings of the Convention on Wetlands and other international environmental treaties, such as the UNFCCC, the Convention on Biological Diversity and the UN Convention to Combat Desertification. The *Action Plan* also identifies as a research priority the need for further information on greenhouse gas implications of the utilization of peatland resources.

3.2.3 Wetland Risk Assessment Framework

Resolution VII.10 adopted the *Wetland Risk Assessment Framework* to assist the Ramsar Convention Contracting Parties with predicting and assessing change in ecological character of the sites included in the List of Wetlands of International Importance and other wetlands. The Framework provides guidance on how to go about predicting and assessing change in the ecological character of wetlands and promotes, in particular, the usefulness of early warning systems.

Five broad categories of adverse change in the ecological character of a wetland have been identified: changes to the water regime; water pollution; physical modification; exploitation of biological products; and introduction of exotic species. At the moment, there are no assessment approaches to predict or forewarn adverse effects associated with changes in climate. However, Operational Objective 5.1 of the Ramsar Convention Work Plan 2000-2002 approved at COP7 urges Contracting Parties to maintain the ecological character of Ramsar sites. Action Item 5.1.6 calls upon the Ramsar Convention Scientific and Technical Review Panel (STRP) to prepare with the Ramsar Bureau and International Partners by COP8 "*a comprehensive review of the potential impacts of climate change on wetlands and the roles that wetlands can potentially play in mitigating the effects of climate change and sea-level rise.*"

3.2.4 Guidelines for Integrating Wetland Conservation and Wise Use into River Basin Management

Resolution VII.18 of Ramsar COP adopted *Guidelines for Integrating Wetland Conservation and Wise Use into River Basin Management*, and all Contracting Parties are urged to give priority to their application.

At Ramsar COP6, the Contracting Parties recognized "*the important hydrological functions of wetlands, including groundwater recharge, water quality improvement and flood alleviation, and the inextricable link between water resources and wetlands and…the need for planning at the river basin scale which involves integration of water resources management and wetland conservation*." Operational Objective 2.2 of the Strategic Plan 1997-2002 approved at COP6 urges Parties "*to integrate conservation and wise use of wetlands . . . into national, provincial and local planning and decision making on land use, groundwater management, catchment/river basin and coastal zone planning and all other environmental management*". The guidelines were

conceived to assist the Contracting Parties with pursuing this goal.

The guidelines note that an essential component of river basin management is knowledge of both current and future supply and demand upon water resources in a river basin, *taking into consideration the possible impacts of climate change.* They also recognize that the greatest damage to the environment, in particular water resources, may occur during extreme events that could be associated with changes and variations in climate. The guidelines refer to the need to undertake assessments of current and potential future water supply and demand for water resources within the river basin to meet both ecological and human requirements and identify areas of potential shortage or conflict.

Through Resolution VII.18, the Contracting Parties directed the Ramsar Bureau to ensure that these guidelines, and other related guidelines under the Convention on Wetlands, are brought to the attention of the relevant international conventions including the UNFCCC, with a view to ensuring that the aspirations of the Convention on Wetlands are reflected in the activities of these other initiatives. Close coordination at the national level between the Ramsar Administrative Authorities and the focal points for other international conventions and agreements related to these subjects is also recommended.

3.3 Relevant work of the Intergovernmental Panel on Climate Change (IPCC)

The IPCC, the body responsible for assessing the scientific, technical and socio-economic information relevant to understanding the risk of human-induced climate change, is currently engaged in three activities directly relevant to the interface between the Ramsar Convention and the UNFCCC: the *Third Assessment Report*, the *Special Report on Land Use, Land Use Change, and Forestry*, and the *Special Report on Technology Transfer*.

3.3.1 Third Assessment Report

Following on the 1995 Second Assessment Report, the IPCC is currently preparing the Third Assessment Report (TAR). The TAR will assess the policy-relevant scientific, technical, and socio-economic dimensions of climate change, and will consist of the reports of the three IPCC working groups.

Working Group II will assess the scientific, technical, environmental, economic, and social aspects of the vulnerability to climate change. It will review the state of knowledge of climate change impacts on hydrology and water resources, including changes to the hydrological cycle, and the effects on water demand and supply. It will also examine the state of knowledge of climate change impacts on natural and managed ecosystems, such as lakes, streams, freshwater fisheries and wetlands, and address climate change impacts on coastal zones and marine ecosystems, including sea-level rise. Regional assessments of vulnerability will be prepared for Africa, Asia, Australasia, Europe, Latin America, North America, the Polar Regions, and Small Island States.

Working Group III will assess mitigation measures in response to climate change, in particular the technological and economic potential of options to enhance, maintain and manage biological carbon reservoirs. The TAR will undergo an initial external review in September-October 1999, followed by two government reviews in the year 2000. The Report will be completed in June 2001.

3.3.2 Special Report on Land Use, Land Use Change, and Forestry (SRLUCF)

This Report was requested at the eighth session of the UNFCCC SBSTA in June 1998, in response to the uncertainties regarding implementation of the forest and land use change provisions of the Kyoto Protocol to the UNFCCC. The scope of the Report is to provide scientific, technical, economic, and social information on carbon sequestration activities in the land use and forestry sectors that can reduce atmospheric concentrations of greenhouse gases. It will also assist governments in operationalizing Article 3.3 and Article 3.4, and other relevant provisions of the Kyoto Protocol. The Special Report will primarily focus on carbon dioxide, but will also address methane and nitrous oxide emissions from wetlands, for example. The Report underwent an initial review in July-August 1999, and will be subject to two further reviews over the course of the next 9 months. The Report will be completed in June 2000.

3.3.3 Special Report on Technology Transfer

This Report was requested by the UNFCCC SBSTA to identify and assess potential effectiveness of options to accelerate the development and diffusion of technology, for reducing greenhouse gas emissions and adapting to climate change though various mechanisms. The Report will focus on energy demand and supply, agriculture, forestry, and coastal adaptation technologies; as well as practices related to

capacity building, information networks, and training, which are designed to facilitate the application of technologies. The Report will analyze obstacles to successful transfer and application, as well as promising approaches for overcoming these obstacles. The Report is now undergoing its final government review, and will be completed early in the year 2000.

3.4 Relevant work and decisions of the Convention on Biological Diversity

There are two elements of the work programme of the Convention on Biological Diversity (CBD) that are closely related to both the Convention on Wetlands and the UNFCCC: the joint workplan between the CBD and the Convention on Wetlands; and the Marine and Coastal Work Programme.

3.4.1 Joint Work Plan between the CBD and the Convention on Wetlands

At Ramsar COP6 in Brisbane, Australia, the Contracting Parties adopted Resolution VI.9, which 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. In reciprocating fashion, at CBD COP3, the Parties adopted Decision III/21 that called on the Convention on Wetlands to act as a "lead partner" of CBD on wetland biodiversity issues.

Based on a review of the areas of common interest and possible cooperation between the two Conventions, a Memorandum of Cooperation between was signed between the two Convention secretariats, and a joint work plan developed. At CBD COP4 (4-15 May 1998, Bratislava, Slovakia), the joint work plan was fully endorsed. The joint work plan calls for cooperation in implementation on a number of topics such as:

i) Transboundary watersheds;
ii) Small island developing states;
iii) National strategies, policies, and plans
iv) Integrated watershed and coastal zone management;
v) Appropriate technologies;
vi) Identification and monitoring;
vii) In-situ conservation;
viii) Sustainable (wise) use of resources;
ix) Financial mechanisms;
x) Research and training;
xi) Public education and awareness;
xii) Impact assessment and minimizing adverse impact;
xiii) Exchange of information; and
xiv) Technical and scientific cooperation.

3.4.2 Marine and Coastal Work Programme

At CBD COP4, the Parties adopted Decision IV/5 on the conservation and sustainable use of marine and coastal biological diversity, including a programme of work. Both the decision and the programme of work are directly relevant to the UNFCCC and the Ramsar Convention. In the case of the Convention on Wetlands, it may be recalled that the Convention defines wetlands to include coastal and marine ecosystems, such as coral reefs, sea grass beds and mangroves (Article 1.1).

In Decision IV/5, the CBD Parties expressed their deep concern at the recent extensive and severe coral bleaching, such as that reported by the African countries, caused by abnormally high water temperatures experienced since January 1998. They recognized the potentially severe loss of biological diversity and consequent socio-economic impacts, and noted this occurrence as a possible consequence of global warming. The Parties then requested the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) to make an analysis of this phenomenon and provide information to COP5 (May 2000, Nairobi, Kenya) for its consideration, and invited the United Nations Framework Convention on Climate Change to urgently address this issue in its deliberations.

In order to assist the CBD SBSTTA in addressing this issue, the Secretariat of the CBD has proposed organizing an expert consultation on coral bleaching, tentatively scheduled for October 1999. The objectives of the consultation are to:

i) provide an opportunity to further integrate different types of knowledge on the issue (e.g. ecological, socio-economic, etc.)
ii) further understanding of the impacts of coral bleaching on the biodiversity of coral reefs and surrounding ecosystems
iii) analyze consequent socio-economic impacts of biodiversity loss due to coral bleaching
iv) identify the most suitable prevention and mitigation measures
v) analyze the impacts of coral bleaching on biological diversity using an ecosystem approach
vi) identify crucial gaps in information about, and the knowledge of, the problem and suggest measures to fill those gaps

The envisaged outcome of the expert consultation is a report which will provide the scientific consensus on the coral bleaching phenomena, its causes and ecological effects; the impacts of coral bleaching on biodiversity; as well as socio-economic impacts. The report will

conclude with recommendations and research priorities for addressing the coral bleaching issue. It will be submitted to the attention of the SBSTTA at its fifth meeting (January 2000, Montreal, Canada).

Operational Objective 1.3 of the Programme of Work on Marine and Coastal Biological Diversity, adopted at CBD COP4 urges Parties to develop guidelines for ecosystem evaluation and assessment, including indicators that distinguish between natural and human-induced effects. This would include human-induced climate change. Activity 1.3(c) urges Parties to promote the identification of key habitats for marine living resources on a regional basis, including coral reef habitats, with a view to further develop policies to prevent the destruction of these habitats, and pursue restoration of degraded habitats.

3.5 Relationships with the Global Environment Facility (GEF)

As adopted by the GEF Council in October 1995, the GEF has ten Operational Programs in the four focal areas: biodiversity, climate change, international waters, and ozone depletion. The Operational Programs dealing with biodiversity include arid and semi-arid zone ecosystems; coastal, marine, and freshwater ecosystems; forest ecosystems; and mountain ecosystems. The Operational Programs dealing with climate change include energy efficiency and conservation, renewable energy, and other low greenhouse gas emitting energy technologies. The relevant Operational Programs dealing with international waters include waterbodies, and integrated land and water management. This section briefly reviews the relationship of the Global Environment Facility to the UNFCCC and the Convention on Wetlands.

3.5.1 United Nations Framework Convention on Climate Change (UNFCCC)

At COP4 in November 1998, the Parties decided that the Global Environment Facility shall be ***an*** entity entrusted with the operation of the financial mechanism referred to in Article 11 of the Convention. Further guidance was provided requesting the GEF to provide funding to developing country Parties to implement adaptation measures to countries vulnerable to the adverse effects of climate change. The guidance also requested the GEF to assist in identifying state-of-the-art environmentally sound technologies for addressing climate change and minimizing its adverse effects; and to build capacity for observational networks to reduce scientific uncertainties relating to the causes, effects, magnitude and timing of climate change.

3.5.2 Convention on Wetlands

Although the Global Environment Facility is not a financial mechanism of the Ramsar Convention, the role of the GEF in supporting biodiversity conservation in inland water ecosystems (in the context of the CBD-Ramsar joint work plan on inland water ecosystems) has been noted in decisions by the Contracting Parties to the Convention. Specifically, Ramsar COP Resolution VII.4 refers to Decision IV/4 of CBD's COP4 that urges Contracting Parties, when requesting support from the Global Environment Facility, to give priority to:

i) identifying inland water ecosystems taking into account the Ramsar criteria for Wetlands of International Importance,
ii) preparing and implementing integrated watershed, catchment and river basin management plans for these, and
iii) investigating the processes contributing to the loss of biological diversity of inland water ecosystems

GEF-supported projects of this nature are relevant to the UNFCCC to the extent that they provide funding to developing country Parties of both Conventions to identify state-of-the-art environmentally sound technologies and know-how and implement adaptation measures to address the adverse effects of climate change.

3.5.3 Elements of an Operational Programme on Carbon Sequestration

Related to both the UNFCCC and the Ramsar Convention are efforts by the Global Environment Facility to develop an operational program to promote carbon sequestration and other global benefits of integrated ecosystem use. As part of the GEF Operational Strategy, approved by the GEF Council in October 1995, the GEF was directed to explore an operational program on carbon sequestration. Subsequently, the GEF Secretariat undertook a consultative process to prepare elements for an operational program in this area. At the GEF Council meeting in May 1999, the document GEF/C.13/14, *Elements of an Operational Program on Carbon Sequestration*, was reviewed. The elements were approved and the GEF Secretariat was requested to conduct further consultations on the development of an operational program with concerned partners and stakeholders, including the Secretariats of the Convention on Biological Diversity, the UN Framework Convention on Climate Change, and the Convention to Combat Desertification.

There is no explicit mention of wetlands in the *Elements of an Operational Program* document, however, it is relevant to the implementation of the Ramsar Convention to the extent that the program seeks to provide benefits to watershed protection, control of land degradation, and the conservation of marginal ecosystems, such as wetlands. The GEF convened an expert consultation in September 1999 to review the document. It is anticipated that draft operational program will be considered by the GEF Council at its next meeting in December 1999.

Table 2. Relevant bodies of the Ramsar Convention and the UNFCCC

Ramsar Convention	UNFCCC
Contracting Parties	Parties
National Committees/Administrative Authorities	National Committees
Conference of the Parties	Conference of the Parties
Standing Committee	Bureau
Scientific and Technical Review Panel (STRP) and its National Focal Points	Subsidiary Body on Scientific and Technology Advice Subsidiary Body on Implementation
Ramsar Convention Bureau (secretariat)	UNFCCC Secretariat
	Intergovernmental Panel on Climate Change
	Global Environment Facility
International Organization Partners (Wetlands International, BirdLife International, IUCN – The World Conservation Union, and the World Wide Fund for Nature – WWF)	Observer Organizations

4. Towards Collaboration: Proposing a Set of Joint Actions

Based on the above discussion, this section proposes a set of joint actions that could be undertaken between the UNFCCC and the Convention on Wetlands. The proposed joint actions are presented under four themes:

i) Promoting linkages between the two Conventions
ii) Predicting and monitoring the impacts of climate change on wetland areas
iii) The role of wetlands in adapting to, and mitigating the impacts of, climate change
iv) The role of wetlands in reducing greenhouse gas emissions.

The goal of these joint actions is to facilitate mutually supportive implementation of the UNFCCC and the Convention on Wetlands. These joint actions could be carried at various levels of implementation of the two Conventions. Table 2 outlines the relevant bodies of the two Conventions.

Theme 1: Promoting linkages between the Conventions

Action 1.1: Develop a Memorandum of Cooperation between the Convention secretariats to formalize and endorse and working partnership, and under this, develop and implement a Joint Work Plan based on this framework of cooperation.

Action 1.2: Strengthen the working links between the respective scientific and technical bodies under the Conventions – in particular between the Convention on Wetlands' STRP and its National Focal Points, the UNFCCC SBSTA and the IPCC – and ensure that these bodies are providing input to the reports and programmes of work being undertaken by the other.

Action 1.3: Ensure that the strategic documents of each Convention (such the Ramsar Convention Strategic Plan and deliberations at Conferences of the Contracting Parties (COPs) under the relevant Articles and themes of each Convention) include due recognition of the areas of common interest and provide endorsement and support for the joint actions proposed herein.

Action 1.4: Strengthen national level cooperation and coordinated actions between the Administrative Authorities of the Convention on Wetlands and the National Focal Points of the UNFCCC, and where they exist the National Committees for both Conventions

Action 1.5: Continue the current practice of inviting representatives of the secretariats to attend the COPs of the other Convention.

Action 1.6: Identify, and support, appropriate actions in the public awareness and outreach activities of both secretariats where sharing information or joint activities would promote the objectives of the two Conventions.

Theme 2: Predicting and monitoring the impacts of climate change on wetland areas

Action 2.1: Review the current understanding of the potential impacts of climate change on all wetland types in all regions, especially wetlands types such as corals to peatlands, and as necessary promote further modeling and research to clarify the scientific understanding of this topic.

Action 2.2: Review and further develop scenarios on social impacts that are expected to result from the impact of climate change on wetland resources

Action 2.3: Document actions which could be promoted by the UNFCCC to avoid the adverse effects of climate change, and, conversely, those actions which UNFCCC should avoid promoting due to the adverse impact on wetlands they would promote.

Action 2.4: Develop approaches for utilizing the Ramsar site network as a monitor for the determining the adverse effects of climate change, and ensure this information is provided to the IPCC and other appropriate bodies.

Theme 3: The role of wetlands in adapting to, and mitigating the impacts of, climate change

Action 3.1: Promote those elements of the Ramsar Convention 'toolkit' which are of most direct importance as means of mitigating the impacts of climate change such as the *Guidelines for Integrating Wetland Conservation and Wise Use into River Basin Management*, and support the sharing of this technology.

Action 3.2: Support the current work of the STRP to develop 'tools' and guidance on the restoration, rehabilitation and creation of wetlands, as well their work to develop guidelines for integrated coastal zone management with the purpose of protecting or rehabilitating wetlands areas.

Action 3.3: Review the state of knowledge concerning wetlands management as an adaptation strategy for climate change, and, as necessary commission further work to develop a 'toolkit' to support such actions.

Theme 4: The role of wetlands in reducing greenhouse gas emissions

Action 4.1: Review the current understanding of wetlands in the carbon cycle, and promote further research to clarify the function of different wetlands types (as defined by the Convention on Wetlands) as sources and sinks of greenhouse gases.

Action 4.2: Promote the implementation of the *Global Action Plan for the Wise Use and Management of Peatlands* as a measure for avoiding greenhouse gas emissions from peatland conversion and degradation.

Table 3. Parallel Activities of the Convention on Wetlands, the UNFCCC, and the IPCC (June 1999 – Spring 2001).

	Ramsar	**UNFCCC**	**IPCC**	**GEF**
Sept. 1999			*1 Sept. - mid Oct.:* IPCC conducts first expert review for the TAR.	
Oct. – Dec. 1999	*29 Nov – 3 Dec:* Standing Committee of the Ramsar Convention meets.	*25 Oct. – 7 Nov.:* UNFCCC SB-11 and COP5. Initial actions to implement Article 4.8 and 4.9 are identified.	*21 Oct. – 3 Dec.:* IPCC conducts government review of the SRLUCF.	*Dates TBD*: Consultation on Carbon Sequestration Work Programme
March – June 2000			*Mar. – Apr. 2000*: IPCC SRLUCF final gov't review *Apr.- June 2000:* Government review of the IPCC TAR *June 2000:* UNFCCC SB-12. IPCC SRLUCF is available.	
Fall 2000		UNFCCC Secretariat organizes a workshop, pending the availability of funds, to consider the IPCC SR on LUCF.		
Nov./Dec. 2000 / Spring 2001		UNFCCC COP6. The Hague, The Netherlands. Draft decisions on LUCF activities for adoption by the COP/MOP1 of the Kyoto Protocol formulated; and additional actions needed to address the implementation of UNFCCC Articles 4.8 and 4.9 will be identified.		
Spring 2001			IPCC TAR is due.	

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