DAC GUIDELINES ON AID AND ENVIRONMENT

The OECD Development Assistance Committee (DAC) seeks to improve and co-ordinate Member policies which will integrate development and environment imperatives. Through its Working Party on Development Assistance and Environment, the DAC is preparing a series of Guidelines on subjects relating to Aid and Environment. These Guidelines are designed to help policy makers and practitioners in donor agencies and developing countries to devise strategies to address serious national, regional and international environmental concerns.

In December 1991, OECD Ministers of Environment and Development Co-operation endorsed the first set of guidelines adopted by the DAC:

1. *Good Practices for Environmental Impact Assessment of Development Projects;*
2. *Good Practices for Country Environmental Surveys and Strategies;*
3. *Guidelines for Aid Agencies on Involuntary Displacement and Resettlement in Development Projects ;*
4. *Guidelines for Aid Agencies on Global Environmental Problems;*

In 1993, the DAC adopted the *Guidelines No 5 on Chemicals Management*, and in 1994 the *Guidelines No 6 on Pest and Pesticide Management*, and the *Guidelines No 7 on Disaster Mitigation*. 1995 saw the adoption of *Guidelines No 8 on Global and Regional Aspects of the Development and Protection of the Marine and Coastal Environment.*

This volume, *Guidelines for Aid Agencies for Improved Conservation and Sustainable Use of Tropical and Sub-Tropical Wetlands*, is ninth in the series. It provides an overview on wetlands issues, as well as policy orientations for aid donors and information for those seeking a more in-depth understanding of wetlands issues. Included are descriptions of wetlands types and functions, their potential uses, and details on the importance of wetlands and the threats to their viability from different types of development projects. The Guidelines also suggest a range of measures which can be taken to mitigate damage and to manage the wetlands sustainably.

The Guidelines are only one aspect of the DAC activities which bear on sustainable development. Current activities include work on capacity development in the field of environment; environmental assessment; technology co-operation; trade, environment and development co-operation; and national planning for sustainable development.

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GUIDELINES FOR AID AGENCIES FOR IMPROVED CONSERVATION AND SUSTAINABLE USE OF TROPICAL AND SUB-TROPICAL WETLANDS

INTRODUCTION

Wetlands are places where dryland meets, or is inundated by, water. They are amongst the most productive areas on earth; their soils are often extremely fertile, they support extensive fisheries and wildlife and they perform vital hydrological functions such as groundwater recharge. Many civilisations developed near wetlands and were dependent upon their fertility. However, until recently wetlands were seen as wastelands, and their very important functions and benefits were not appreciated, especially by planners and developers. Drainage of the wetland allowed access throughout the year, and more intensive cultivation. Wetlands are also associated with many diseases, such as malaria and schistosomiasis, and many areas near to human habitation have been drained to improve public health.

With the pressure for development increasing, the loss of wetlands has reached alarming proportions, initially in the developed countries over the last century, but also, over the last forty years, in the tropics and sub-tropics [1]. Wetlands are now recognised as one of the most fragile and threatened ecosystems on the planet. In addition, the major strategic issue of water resource security has put wetland conservation and sustainable use high on the international agenda.

On many occasions in the past, development assistance has contributed to the loss of wetlands, for instance, through drainage for agriculture, dam construction and irrigation, port and industrial development and the development of policies and programmes which directly or indirectly damage wetlands. DAC members have an important responsibility in assisting countries in the tropics and sub-tropics to develop in ways which do not destroy the natural capital to which their wetlands contribute, but to use them sustainably, for the benefit of present and future generations.

A number of internationally recognised conventions and documents highlight the importance of wetlands. The *Ramsar Convention on Wetlands of International Importance*, adopted in 1971, was the first global, inter-governmental conservation treaty dealing with one specific type of ecosystem. It provides the framework for international cooperation for the conservation of wetland habitats, and aims to stem the loss of wetlands and to ensure their conservation and wise use. *Caring for the*

Earth, published after much international consultation in 1991, identified priority actions for sustainable use of freshwater; it made the important link between the development of water resources, the management of the drainage basin and the conservation of aquatic ecosystems. Section 18.8 of *Agenda 21,* coming out of the UNCED process in 1992, states that "Water resources have to be protected taking into account the functioning of aquatic ecosystems ...". The conservation of wetlands is identified as a priority "owing to their ecological and habitat importance for many species and taking into account social and economic factors". The *Convention* on *Biodiversity* also stresses the importance of conserving biological diversity from all sources including aquatic ecosystems.

The obligation to carry out environmental assessments of proposed developments is stressed. The first Guidelines on Environment and Aid published by OECD in 1991 was on *Good Practices for Environmental Impact Assessment of Development Projects,* which highlighted the need for assessments of projects in very fragile environments, including wetlands and mangrove swamps. The present guidelines provides more details on the importance of inland and coastal wetlands (freshwater and saline), the threats to their viability from different types of development project and the measures which can be taken to mitigate damage and to manage the wetlands sustainably. Complementary information can also be found in the OECD DAC Guidelines No. 8 on *Global and Regional Aspects of the Development and Protection of the Marine and Coastal Environment.*

The guidelines are intended to increase awareness of wetlands amongst policy makers, programme and project designers in development agencies and the governments receiving development assistance. They aim to assist the making of ecologically sound development decisions which pay greater attention to wetland conservation and sustainable use in the tropics and sub-tropics.

The guidelines are divided into four parts:

- **Introduction:** including a brief background on wetlands, their importance and causes of loss;
- **Part 1**: policy orientations for donors — principles and practice for development assistance taking wetlands into account;
- **Part 2**: descriptions of wetland types, their functions, uses and threats to their existence;
- **Annexes:** references and contacts.

Readers requiring direction on the design of policies and projects which impact on wetlands can find the most direct advice in Part 1. This is cross-referenced with Part 2. Readers who want a greater understanding of wetland issues should read Part 2 first.

Background on Wetlands

A. Tropical and sub-tropical wetlands

Wetlands occupy about 8.6 million km^2 or 6.4 per cent of the world's land surface. Of this almost 56 per cent (4.8 million km^2) lie in the tropics and sub-tropics. The humid areas of both tropics and sub-tropics contain by far the largest proportion of this — 48 per cent (2.3 million km^2) and 22 per cent (1.1 million km^2) respectively. The remaining 30 per cent of tropical and sub-tropical wetlands occur in the arid and semi-arid regions.

The contribution of wetlands to primary productivity, hydrological balance and the general environmental quality of the surrounding lands is as important as the total area of wetlands. In humid areas, the wetland contribution to overall primary production may be about three times that of the surrounding dryland and many times more in arid and semi-arid areas. This greater productivity is a significant indicator of the importance of wetlands in relation to the surrounding lands, most obviously demonstrated in desert wetlands. Wetlands in arid and semi-arid climates are often more ecologically important and sensitive than in humid climates. As the total wetland area has decreased, so the need to conserve the quality, functions and benefits of the remaining wetlands has increased.

B. Different types of wetland

The Ramsar Convention defines wetlands as *"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres"*. This deliberately broad definition has been agreed internationally, and is therefore used for these guidelines, but it does make the description of wetlands, and their uses and threats more complex. These guidelines focus on the freshwater and brackish water wetlands including mangroves, but it must be realised that open coasts and shallow coral reefs are also considered as wetlands under this definition.

Wetlands can be divided into three categories:

— **marine and coastal wetlands** — these include the open coasts, coral reefs, estuaries, tidal flats, mangrove forests and coastal lagoons (see also OECD/DAC Guidelines No. 8) [2]**;**

— **inland wetlands —** these include permanent and seasonal rivers, inland deltas and floodplains, permanent and seasonal lakes and ponds, marshes, freshwater swamp forests and peatlands;

— **artificial wetlands —** these include reservoirs, barrages and dams, aquaculture ponds, excavations and borrow pits, wastewater treatment ponds and irrigation canals, ditches and rice fields.

A fuller description of some of these wetland landscape units is given in Part 2.I. Often these wetland types are interlinked hydrologically and ecologically; they merge into one another and into the landscape. Wetlands should therefore be considered as part of a wider river basin or coastal zone.

C. Importance of wetlands

Wetlands provide a wide variety of important benefits to the local people, downstream populations and to the nation as a whole. Some of these wetland values are shown in Table 1.1. The range of goods and services which wetlands provide have usually been taken for granted, so that it is only when a wetland is altered, drained or degraded that people become aware of what they have lost; they invariably incur costs or have to make alternative arrangements. Usually the people closest to the wetland bear the brunt of these costs, such as increased flooding or loss of water resources, increased storm damage, increased pollution, or loss of fisheries, forest or forage resources. Often the losses outweigh the benefits derived from the development causing the wetland changes.

D. Causes of wetland loss

Wetlands are dynamic ecosystems; they are continually changing naturally due to subsidence, sea level rise, drought, erosion and siltation. Natural change is normal and expected, but direct or indirect human activities have considerably altered the rate of wetland loss. Some examples of the human activities which cause wetland loss are shown on Table 1.2. A more detailed discussion of the direct threats and impacts of development projects is given in Part 2.II.

The drainage of wetlands has always been seen as a progressive, public-spirited endeavour which enhanced the health and welfare of society, to alleviate the dangers of flooding, improve sanitation, and reclaim land for agriculture. Some estimates show that the world may have lost 50 per cent of the wetlands that existed worldwide since 1900; whilst much of this occurred in the northern countries during the first 50 years, increasing pressure for conversion to alternative land-use has been put on tropical and sub-tropical wetlands since the 1950s. In northern countries, the consequences of this loss such as decline in fisheries productivity, greater intensity of major flooding, and loss of biological and landscape diversity, and amenity value has led to efforts to preserve and restore wetlands.

No figures are available for the extent of wetland loss worldwide, but drainage for increased agricultural production is the principal cause; by 1985 it was estimated that 56 - 65 per cent of the available wetland had been drained for intensive agriculture in Europe and North America; the figures for tropical and subtropical regions were 27 per cent for Asia, 6 per cent for South America and 2 per cent for Africa, making a total of 26 per cent worldwide. Future predictions show the pressure to drain land for agriculture intensifying in these regions. Wetlands may be lost completely by drainage or infilling, but many of the benefits can be lost even if the wetland itself remains, but in a degraded state. Pollution or the overuse of wetland products (e.g. by deforestation) are examples of this.

The direct causes of wetland loss often result from social and economic forces, and political decisions. Population growth coupled with inequitable distribution of resources and access rights has increased the demand for land for agriculture, urban and industrial development, and has put the greatest pressure upon wetlands. However, policies and incentives in different sectors contribute by encouraging drainage, or the cultivation of a particular crop at the expense of wetlands; for instance, in Malaysia, where, despite a relatively low population density, large areas of wetlands have been destroyed for oil palm and rice cultivation. Similarly trade demands can alter the balance of production leading to loss of wetlands — a good example of this is the worldwide demand for high priced shrimps from aquaculture ponds in Thailand and Ecuador. Lack of legislation and its enforcement can also be a cause of wetland loss, particularly inadequate water pollution laws. The underlying causes of wetland loss are discussed in Part 2.III.

On many occasions, development assistance has contributed to wetland loss in the past, either directly by funding projects which have damaged wetlands, such as hydro-electric dams and irrigation projects, or indirectly, by not taking wetlands into account during project design and implementation. The basic reason for this has been the lack of awareness of the importance of wetlands generally throughout society and especially amongst decision makers and project managers.

Table 1.1. Wetland values

Adapted from Dugan, P. (1990)

Key: ❍ = absent or exceptional; ● = present;
■ = common and important value of that wetland type

	Estuaries	Man-groves	Open coasts	Flood plains	Fresh-water marshes	Lakes	Peat-lands	Swamp forest
Functions								
1. Groundwater recharge	❍	❍	❍	■	■	■	●	●
2. Groundwater discharge	●	●	●	●	■	●	■	■
3. Flood control	●	■	❍	■	■	■	●	■
4. Shoreline stabilisation/ Erosion	●	■	●	●	■	●	❍	❍
5. Sediment/toxicant retention	●	■	●	■	■	■	■	■
6. Nutrient retention	●	■	●	■	■	●	■	■
7. Biomass export	●	■	●	■	●	●	❍	●
8. Storm protection/windbreak	●	■	●	❍	❍	❍	❍	●
9. Micro-climate ecosystem	❍	●	❍	●	●	●	■	●
10. Water transport	●	●	❍	●	❍	●	❍	❍
11. Recreation/Tourism	●	●	■	●	●	■	●	●
Products								
1. Forest and other plant resources	❍	■	❍	●	❍	❍	■	■
2. Wildlife resources	■	●	●	■	■	■	■	■
3. Fisheries\aquaculture	■	■	●	■	■	■	❍	●
4. Forage resources	●	●	❍	■	■	❍	❍	❍
5. Agricultural resources	❍	❍	❍	■	●	●	●	❍
6. Water supply	❍	❍	❍	●	●	■	●	●
Attributes								
1. Biological diversity	■	■	●	■	●	■	●	●
2. Uniqueness to culture/heritage	●	●	●	■	■	■	●	●

Table 1.2. The causes of wetland loss

Adapted from Dugan, P. (1990)

Key: ❍ = absent or exceptional; ● = present but not a major cause of loss; ■ = common and important cause of wetland degradation and loss

HUMAN ACTIONS	Estuaries	Man-groves	Open coasts	Flood plains	Fresh-water marshes	Lakes	Peat-lands	Swamp forest
Direct								
Drainage for agriculture, forestry, and mosquito control	■	●	■	■	■	●	■	■
Dredging and stream channelization for navigation and flood protection	■	■	❍	❍	●	❍	❍	❍
Filling for solid waste disposal, roads, and commercial, residential and industrial development	■	■	■	■	■	●	❍	❍
Conversion for aquaculture/ mariculture	■	■	●	●	●	●	❍	❍
Construction of dykes, dams, levels, and seawalls for flood control, water supply, irrigation and storm protection	■	■	■	■	■	●	❍	❍
Discharges of pesticides, herbicides, nutrients from domestic sewage and industrial waste waters, agricultural runoff and sediment	■	■	■	■	■	■	❍	❍
Mining of wetland for peat, coal, gravel, phosphate and other materials	●	❍	●	●	❍	■	■	■
Logging and shifting cultivation	●	■	❍	■	●	❍	■	■
Groundwater abstraction	❍	❍	❍	●	■	❍	❍	❍
Fires	●	●	❍	■	●	❍	■	■
Indirect								
Sediment diversion by dams, deep channels and other structures	●	■	■	■	■	●	❍	❍
Hydrological alterations by canals, roads and other structures	■	■	■	■	■	■	●	●
Subsidence due to extraction of groundwater, oil gas and other minerals	■	❍	●	■	■	❍	❍	❍
Natural causes								
Subsidence	●	❍	●	❍	❍	●	●	●
Sea-level rise	■	■	■	❍	❍	❍	❍	■
Drought	■	❍	■	■	■	●	●	●
Hurricanes and other storms	■	■	■	❍	❍	❍	●	●
Erosion	■	■	■	●	❍	❍	●	❍
Biotic effects	❍	❍	❍	■	■	■	❍	❍

PART 1.

GUIDELINES AND COURSES OF ACTION

I. Guidelines

As their two main wetland policies, development agencies (p. 16) should:

* Promote the formulation and implementation of national wetland policies and strategies.
* Ensure that wetland conservation and sustainable use is incorporated into sectoral policies, programmes and projects.

National wetland policies (p. 17) should:

* Address legislation and government policies which affect wetlands.
* Strengthen wetland institutions and organisational arrangements.
* Increase the knowledge and awareness of wetlands and their values.
* Review the status and identify the priorities for all wetlands in the national context.
* Identify actions to address problems at nationally significant wetland sites.

Development agencies should ensure that wetland conservation and sustainable use is integrated into the planning process (p. 19). Assistance may be provided at the following levels:

* Sectoral and economic policy planning — identifying policies which adversely affect wetlands and determining trade-offs which may have to be made; developing scientifically sound policies in line with conservation, socio-economic and technology changes;
* Sectoral programme planning; especially in sectors which can adversely affect wetlands such as agriculture, environment, energy, forestry, fisheries, public health, transport, water pollution control, water resources and flood control;
* Land-use planning; especially using ecosystem or catchment area boundaries and integrated resource management planning techniques; the full uses and values of wetland networks in the areas concerned should be identified.

* Site-specific project planning; considering upstream and downstream effects upon wetlands in the area; using the full involvement of local communities and resource user groups.

Development agencies should prepare their own internal policies for the conservation and wise use of wetlands (p.27). These should include:

* A commitment to support wetland wise use projects and to discourage support of any activities likely to damage wetlands and their users without adequate compensation;
* Actions to promote greater awareness and understanding of wetland issues, threats and sustainable use amongst their own staff;
* Ensuring that wetland issues identified during the Environmental and Health Impact Assessment process are adequately addressed during project planning and implementation.

Development agencies should ensure that wetlands which may be affected directly or indirectly by projects are adequately considered in the environmental assessment process (p. 29). In particular, the projects supported by Development Agencies: i) should preserve the hydrological regime of the ecosystem and ii) should ensure the preservation of the ecological species and genetic resources within the area. In applying this guideline, Development Agencies should:

* Use wetland inventories and conservation priorities for identifying critical wetlands likely to be affected. They should insist upon an EIA if there is an important wetland in the area or hydrologically connected to the project area.
* Use environmental economic analysis to assess wetland values, the true costs of wetland loss to society and the trade-offs which may have to be made if the project goes ahead;
* Consult with wetland user groups to assess wetland uses and to develop joint mechanisms for sustainable management of wetlands affected by the project;
* Consider alternatives or redesign projects which are shown to have a significant adverse impact upon wetlands. If they can not be changed substantially, Development agencies should withdraw their support from such projects;
* Ensure adequate compensation for the loss of wetland benefits and the implementation of sustainable management for the remaining wetlands to optimise wetland functions.

Development agencies should consider support for particular wetland focussed projects (p. 33) which may include the following components:

* Ecological and hydrological studies.
* Socio-economic studies of wetland user communities.
* Joint management measures with wetland users and communities.
* Wetland monitoring activities.
* The development and implementation of wetland management plans.

* Strengthening of wetland institutions.
* Providing wetland training, and wetland education and awareness programmes.
* Development of mechanisms for the long-term financing of wise use of wetlands.

II. Policy and Planning for Wise Use of Wetlands

Two fundamental policies are useful for development agencies for assisting governments in the conservation and sustainable use of their wetlands:

— **Promote the formulation and implementation of national wetland policies and strategies.** Concerted and planned action is often necessary to improve the knowledge base and awareness of wetlands so that conservation measures can be tailored to the conditions of the country. A national wetland policy is the best way of getting wetlands onto the national development agenda. However, the formulation of wetland policies should not be an isolated environment-related action, but should also be an integral part of spatial and economic development planning.

— **Ensure that wetland conservation and sustainable use is incorporated into sectoral policies, programmes and projects.** Wetland conservation must be a part of environmental and natural resource management strategies. Wetlands are influenced by virtually all other sectoral policies (e.g. agriculture, industrial development, transport, health and education). Wetland policies should be included in national environmental strategic frameworks, such as National Environmental Action Plans and National Conservation Strategies.

The principles to be used in developing wetland policies, programmes and projects are outlined in Box 1.1 (p. 21).

A. National wetland policies

The details of each country's national wetland policy, or the wetland section of its environmental/sustainable development strategy, will differ, but the components will be similar. They should include actions to:

i) Address legislation and government policies by:

— reviewing existing legislation, policies, subsidies and incentives which affect wetland conservation;

— applying, where appropriate, existing legislation and policies relevant to wetland conservation;

— adopting new legislation and policies;

— using development funds for projects which permit sustainable use of wetland resources.

ii) Strengthen the institutional and organisational arrangements by:

— establishing institutional arrangements to facilitate wetland conservation and to integrate wetland priorities into the planning process;

— establishing mechanisms and procedures for ensuring an integrated, multi-disciplinary approach to the planning and execution of projects affecting wetlands;

— establishing stakeholders' organisations to promote participation in the policy, planning and management processes;

— ensuring that agencies responsible for wetland conservation are adequately resourced to undertake these tasks.

iii) Increase the knowledge and awareness of wetlands and their values by:

— exchanging experience and information on wetland policy, and wise use between countries;

— increasing understanding of wetland benefits and values amongst decision makers and the public;

— reviewing traditional techniques and elaborating pilot projects which demonstrate wise use of representative wetland types;

— training of staff in disciplines which will assist implementation of wetland conservation policies.

iv) Review the status and identify priorities for all wetlands in a national context by:

— Carrying out a national inventory of wetlands which identifies and classifies sites showing their locations and boundaries. Many countries now have basic wetland inventories and there are directories of important wetlands in different regions (see Annex 3). To be useful, wetlands inventories should be periodically updated and the information made available. Regular monitoring of the status of wetland resources will provide warning of ecosystem changes;

— Making a preliminary assessment of wetland values and their socio-economic implications for each site to enable conservation priorities to be set. If necessary, more detailed environmental economic evaluation

can be made for specific sites. This would include an assessment of the current use and access to for wetlands;

— Defining the conservation and management priorities for each site, in a participatory way if possible, using negotiation, conflict management and the development of compromise solutions, such as zoning of different uses.

v) Action to address problems at particular wetland sites by:

— integrating environmental considerations in the planning of projects likely to affect the wetland;

— regulating the use of natural wetland resources so that they are not over-exploited;

— establishing, implementing and revising periodically, joint-management* plans which involve local people and take account of their needs (see Part 2);

— designating wetlands of international importance for the Ramsar List;

— establishing nature reserves at priority wetlands even if they are not included in the List;

— promoting the restoration of wetlands whose values have been diminished or degraded;

— monitoring the ecological condition of sites to assess the success of management and restoration measures; in sites where there are adjacent development projects, early warning indicators should be selected and monitored to identify problems before serious damage occurs.

B. Integrating wetlands into the planning process

A full wetland policy may take a long time to evolve, but immediate actions should be taken to stimulate wise use and the integration of wetlands into the planning process. In their assistance to national and provincial government planning, development agencies should ensure the inclusion of wetland conservation and sustainable use as appropriate at each level.

Sectoral and economic policy planning

Many sectoral policies and programmes have an impact upon wetlands. Assistance to governments in the development of sectoral and economic policies should include a review of their environmental effects. Policies which have adverse impacts upon wetlands should be replaced with those which have no effect or encourage wetland conservation (see Part 2.III.D.). Trade-offs between developments in the different sectors and wetland conservation may have to be made. Tools for determining such trade offs include cost-benefit analysis with environmental economic components, the systematic consideration of alternatives and the use of strategic environmental assessment.

Where appropriate, development agencies should support applied research into wetland/water resource management in order to provide a scientifically sound basis for policy development which keeps pace with changing conservation issues (e.g. global warming), socio-economic issues (e.g. techniques for environmental economic assessment, polluter pays charging systems), and technology.

A description of possible impacts of the different sectors is given in Part 2. Policies and programmes most likely to affect wetlands and which should be reviewed include:

- agriculture and food policies**,**
- environment**,**
- energy**,**
- forestry,
- fisheries,
- public health, especially on water-related dieseases,
- transport, especially ports and shipping, and motorways,
- water pollution control and water quality standards,
- water resources and flood control,
- economic and fiscal policies related to all of the above.

Box 1.2**.** (p. 22) gives a check list of questions to be asked when considering these policies and programmes.

Box 1.1. Principles for wetland policies

Principle of Wise Use, as formulated by the Ramsar Convention, is "their sustainable utilisation for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem".

- Wise use applies to all the wetlands in a country and not just to the few sites which have been internationally or nationally recognised as important.
- Wise use requires action at several levels of society and will take time to evolve.
- Social and economic issues are the main underlying reasons for wetland loss, and so need particular attention in wetland policies.
- Special attention should be paid to local communities, which are most affected by wetland loss and will benefit from improved wetland management.
- Sufficient weighting in economic evaluations should be attached to the security of people dependent upon wetlands for their livelihood.
- In the management of wetlands, control should be devolved to the lowest appropriate level of wetland users and should involve the active participation of local communities.
- Local people constitute a valuable source of knowledge, skills and labour to maintain a net flow of wetland benefits.

Principle of Interdependence. Wetlands can not be considered independently or as an isolated ecosystem. They should be managed on a wider ecosystem basis which may cross political and social barriers and different sectors.

Principle of Multiple Use. Sustainable wetland management means accepting and optimising the different uses for wetlands.

Precautionary Principle. "It is better to be safe than sorry". Avoid activities with an assumed negative environmental impact, even when scientific evidence can not yet prove them to be the cause.

No Net Loss Principle derived from North America. If a development destroys or impairs an area of wetland, the developer should make the best efforts to create, or restore the functions of, an equivalent area of wetland. The creation and restoration of wetlands is becoming technically and ecologically feasible for a few types of wetland (freshwater marshes, tidal marshes on low energy coasts). The Uganda National Wetland Policy states that there should be *"no net drainage of wetlands unless more important environment management requirements arise"*. Note that replacement wetlands often do not have equivalent functions and values to the areas destroyed. Preservation of existing wetlands is always preferable.

Principle of Restoration. Wherever possible, parts of the wetland should be restored, if it can be shown through reference studies that the actual situation is not optimal and that the original state can be re-established.

Box 1.2 Checklist of questions about the wetland implications of sectoral policies and programmes

If the answer is "YES" to any of these questions, the trade-offs should be carefully considered against possible wetland loss, and policies adjusted accordingly.

- Will the policy result in changes of land-use causing wetland loss, e.g. for intensive agriculture, forestry or aquaculture?
- Will the policy increase the rate of drainage of wetlands, e.g. price subsidies for agricultural production, public health?
- Will the policy increase water abstraction or use from ground or surface resources, causing depletion of water available for wetlands?
- Will pricing policies for water, electricity, fuel result in over-use and wastage of water?
- Will the policy result in changes in hydrology, e.g. flood control policies, electricity generation by hydropower?
- Will the policy lead to changes in the use of chemicals likely to damage wetland ecosystems, e.g. agricultural and forestry chemicals, and public health insecticides?
- Will the policy lead to changes in the quality of waters, e.g. legislation, standards and incentives for water pollution control?
- Will the policy lead to upstream changes in watersheds, e.g. upland forestry, soil erosion, flood control?
- Will the policy lead to introduction of exotic species?
- Will the policy increase the pressures on wetland flora and fauna, e.g. hunting and fishing policies?
- Will the policy result in loss of wetland benefits for local stakeholders and communities?
- Could the policy do more to increase awareness of wetland benefits?

Sectoral programme planning

Sectoral programmes should also consider their impacts upon wetlands, some of which are listed in Table 2.1 in Part 2. Development agencies assisting in planning these programmes should ensure that appropriate reviews or studies are carried out, asking the central question **"How will this programme affect wetlands in the country or district, and the people dependent upon them"**. If wetlands might be affected by sectoral programmes, then measures for their sustainable use and protection should be included. Environmental Assessment procedures should be used at the programme and policy level to minimise the wetland impacts of sectoral plans.

Wetlands are affected by many different sectors, and the dangers of one sector damaging another sectoral programme are very relevant, especially when water abstraction is involved, e.g. irrigated agriculture may affect downstream fisheries. Wetlands are often forgotten; if there is significant impact from a sectoral programme, a specific institution should be given the responsibility to safeguard the interests of wetlands and the people who use them. In sectoral programme planning responsibility for environmental effects in general and wetlands in particular should be clearly assigned.

Development agencies should ensure that, in the development of sectoral programmes, there is adequate consultation with institutions, local people and non-governmental organisations (NGOs) which have a responsibility or an interest in wetlands.

Many programmes which interact with local people and communities will have extension and training components. If there are special wetland concerns in any sectoral programme, extension materials and training modules on the wise use of the wetlands affected should be developed.

Land-use planning

The wetlands in an area are often key units to be incorporated into land-use plans. The character of a wetland depends upon the land use patterns in their catchments. Each wetland should be identified, and its characteristics, uses and threats assessed; greater emphasis on catchment management as a means of sustaining wetlands as integrated landscape units. Wetland inventories are invaluable for identifying these units. They provide a baseline of the status of wetlands in the area.

Trade-offs may have to be made between different land-uses and sustainable use of the wetland. After consultation with local stakeholders, informed decisions can be taken by planners and developers on the priority wetlands to be conserved and the less important ones to be put to other uses, or even drained. The value of such wetlands in terms of direct financial products and other benefits should be used in deciding land-use priorities. Land-use plans should strive to optimise multiple uses of the wetland resources in an area. Box 1.3 gives a check list of questions to be asked in assessing such trade-offs.

Ecosystem boundaries or catchment areas should be used, wherever possible, for deciding the boundaries of a land-use plan. Internal divisions within a land-use plan should also be based upon such natural boundaries. Artificial or political boundaries should be avoided, since these often cut across natural boundaries making land use management more difficult. If joint land-use plans can not be prepared between different administrative areas, then at least agreements on the approaches towards natural features, such as wetlands, should be made between the different planning agencies involved in a coastal zone or river basin. (Boxes 1.4 and 1.5 on Integrated River Basin and Coastal Zone Management). See also OECD DAC Guidelines No. 8[2].

Although single large wetlands will stand out as discrete land-use types, small wetland areas connected through a network of ground and surface waters must not be overlooked. If such a network of small wetlands exists in an area, the control of drainage through permits may be introduced as part of the planning regulations. Whilst a small wetland may not be important in itself, losses of a number of small wetlands may be significant because of their interdependence.

Conventional land-use planning has not been very successful in making the benefits of wetlands fully apparent and often of wetland priorities and needs of local users have been overlooked. Land use plans have failed because of lack of resources, use of inappropriate methods, collection of irrelevant data, and lack of institutional capacity. More locally driven approaches should be explored which draw on participatory planning techniques.

Box 1.3. Checklist for assessing wetland trade-offs

- What are the current wetland uses and benefits?
- What will be the remaining wetland uses and benefits after the project is implemented?
- How many people are stakeholders (users, owners, beneficiaries) of the wetland?
- How many people would be affected by changes to the wetland e.g. loss/gain of income or subsistence, loss/gain of water access and availability, reduced/increased flood risk?
- What is the monetary value of the uses lost/gained compared to the value of the project?
- Are there any other significant benefits lost or gained which can not be given a monetary value?
- What would be the cost of providing alternative sources of income, water and food supply, flood protection, biodiversity and amenity value? Is compensation required?
- Can the wetland functions and values be retained, if alternative projects are implemented and what are the costs of these?

Integrated resource management planning should be applied where possible, to ensure that the uses of the different resources found in an area are compatible. Consultation of different resource user groups, as well as the government agencies, is essential to resolve potential conflicts and to integrate management practices. Development agencies should support integrated projects rather than sectoral ones, and ensure that several developments in the same specific area are not counterproductive to sustainable use of the wetlands there.

If training in land-use planning is part of the assistance package, trainees should learn about wetland types, values and management options.

Box 1.4. Integrated river basin management

Adapted from Dugan, P. (1990)

Integrated river basin management (IRBM) tries to make the best use of the resources within a river basin, whilst satisfying the needs of different groups depending upon the resources of the river and its surrounding catchment area or flood plain. Such groups may be rural communities reliant upon the fish, fuel and forage resources; farmers reliant upon irrigation water; and urban communities reliant upon the water supply and the national requirement for hydro-electricity.

IRBM should normally require the following**:**

- **An understanding of the hydrological balance of the river basin**, including quantity and quality of surface, underground and coastal waters, during conditions of drought, spate and average conditions.
- An assessment of the **values of the major ecosystems** in the river basin and the biophysical processes on which they depend.
- An **inventory of the products and services** of the river basin and the minimum requirements for their sustainable use.
- An assessment of the **short- and long-term environmental impacts** of the planned changes to the system and of the appropriate mitigatory measures.
- An **analysis of the socio-economic conditions** of the various community groups, including cultural and traditional behaviour, and the distribution of natural and economic resources.
- A **strategic analysis** of existing and future **water development projects.**

While the collection and analysis of the data are relatively straightforward, it is more difficult to **allocate and manage the water resources** equitably to maintain the critical hydrological balance. This requires political decisions and, perhaps, diplomatic negotiations with neighbouring states about upstream and downstream water rights. Within a country, the active participation of communities in the water management is a key element for success.

Box 1.5. Integrated coastal zone management
Adapted from Dugan, P. (1990)

Integrated coastal zone management (ICZM) relies upon an understanding of ecological and resource use constraints. The boundaries of the coastal zone may not be so obvious as a river basin; but they must be clearly defined at the outset using the following:

- **Biophysical boundaries** — geological formation, substrates, ecosystem processes, chemistry, hydrology and oceanography, species distribution.
- **Socio-economic boundaries** — the areas in which resource extraction, pollution, over-fishing and landfill etc. have an impact. The ICZM may also evolve out of an environmental impact assessment.
- **Legal and administrative boundaries** — including national borders, jurisdiction over landward and seaward sides of the area.

ICZM programmes should have the following principal characteristics:

- **pro-actively initiated**; however, they are more usually started in response to resource degradation and multiple use conflict;
- **strong commitment for long-term** government, NGO and community involvement;
- specific mandate for development of **ICZM legislation;**
- **specific geographical area**, including both landward and seaward components;
- **recognised institutional identity or network** of organisations linked by functions and management strategies;
- **integration of two or more sectors**, recognising the complex natural and human interactions occurring in the coastal zone;
- long-term, **iterative and adaptive** process, involving consultation with communities, industries and other coastal zone users and their participation in management;
- commitment of government to act as a **tough referee between powerful interest groups**.

Site-specific project planning

When planning development projects located in a specific area, the effects upon wetlands both up- and down-stream, as well as within the area, must be considered. A checklist of wetland questions for site-specific project planning is given in Box 1.6. This should be covered by the Environmental Impact Assessment (EIA) process (see next section), but a pro-active awareness of the wetlands likely to be affected, and their values, can stimulate initiatives to conserve and make the best use of those wetlands as an integral part of the project.

Participatory techniques for planning and resource management (e.g. Participatory Rural Appraisal) may highlight wetlands affected, their uses and values. Communities using wetlands often have detailed knowledge and may have developed sustainable uses for the wetland resources. Development agencies should encourage the full involvement of local communities and resource user groups in project planning. Such methods can help to find the balance between multiple uses of a resource, and to agree compensation if those uses are lost or diminished. As with programme planning, if wetland use and management are an important part of the project or are seriously affected by it, public awareness and education components should be included.

Box 1.6. Checklist of wetland questions for site-specific project planning

If the answers to these questions are "YES", an EIA is indicated and wetland trade-offs should be assessed.

- Are there wetland sites within the project area?
- Are there wetlands upstream or downstream of the project area?
- Are these wetlands of international or national importance?
- Do they play a significant role in the regional or local water resources, economy and community life?
- Do these wetlands have significant value for biological or landscape diversity?
- Will the project affect the hydrology of these wetlands?
- Will the project affect the water quality of these wetlands?
- Will the project affect the incidence of water related diseases?
- Will the project affect the extent of these wetlands?
- Will the project affect the wetland ecosystem, and its flora and fauna, especially migratory species?
- Will the project affect the wetland functions and uses?

C. Internal wetland policies for development agencies

All the member states of OECD are either Contracting Parties to the Ramsar Convention or are in the process of becoming so. By this, they undertake to support the aims of the convention in their own countries. In addition, the 5th Meeting of the Conference of the Contracting Parties at Kushiro, Japan (1993) recommended that conservation and wise use of wetlands should be included in multilateral and bilateral development cooperation programmes [3].

This has implications for the internal administration of development assistance. The Kushiro recommendation proposes that representatives of

ministries responsible for the granting or receipt of development assistance should be included in the delegations of the Contracting Parties to the Ramsar Conferences. If Development Agencies are to adopt coherent wetland policies for their work, a much greater awareness of the importance of wetlands and of the mechanisms of sustainable use needs to be promoted within them. Many already have briefing publications about environmental effects of development assistance projects; they have developed procedures for applying EIAs to projects and have run training courses on these procedures for appropriate levels of staff; a number have been active in funding wetland focused projects. The US Treasury's Voting Standards for wetland related projects are a reflection of internal policies in support of wetlands [4].

The principal policy for development agencies should be a commitment to support wetland wise use projects and to discourage support of any activities which are likely to damage wetlands in the absence of adequate compensation measures. As stated in the US Treasury's Voting Standards, "projects should preserve the hydrological regime of the ecosystem and they should ensure the preservation of the ecological, species and genetic resources within the area". In fulfilment of this policy, development agencies should make the best effort to cover wetland issues in the following ways:

- review existing environmental assessment and project appraisal guidelines to ensure that wetlands are adequately considered at all stages of the project cycle;
- include a section on wetland issues, values and conservation methodologies in publications concerning development and the environment;
- include a section on wetland issues in environment and development profiles/strategies of the countries to which the agency provides assistance;
- include a module on the conservation and sustainable use of wetlands in environmental training and orientation courses;
- ensure that all specialist environmental staff within the organisation receive detailed wetland awareness training;
- ensure that wetland issues identified during Environmental and Health Impact Assessments for projects be adequately addressed during project planning and implementation; if wetland issues are significant, ensure that expatriate and national project staff are fully aware and receive the necessary training to deal with them;
- consider the allocation of a certain proportion of environmental funds specifically for wetland conservation.

III. Wise Use of Wetlands in Projects

A. Integrating wetlands in the environmental assessment process

Many development agencies have produced guidelines and manuals for carrying out EIAs of development projects. Such guidelines focus on the type of project, and the potential impacts, and identify those which require a full EIA. The OECD Council in 1985 recommended that "in-depth" environmental impact assessment should always be carried out in certain very fragile environments such as wetlands, especially peat swamps, mangroves and coral reefs; and in 1989 the OECD also urged its members to pay attention to off-site effects (up- and down-stream) of projects [5].

The existence of an important wetland in or near a project area should be a criterion for determining the need for an EIA, especially if it is downstream of the project. Development Agencies should insist upon an EIA being carried out if a project area includes or is hydrologically connected to any significant wetland ecosystems. Box 1.7 shows criteria for wetland conservation. EIAs should be called for if the wetland falls into any of these categories.

Box 1.7. Criteria for wetland conservation

Wetlands of international or national significance:

Criteria:
a) Prime or scarce habitat for migratory species
b) Unique or rare and irreplaceable ecosystem or scenic landscape
c) Critical habitat of endangered, threatened or endemic species

(N.B. Ramsar Recommendation C.4.2 contains more detailed criteria for identifying wetlands of international importance.)

Wetlands of regional significance:

Criteria:
a) Valuable habitat becoming scarce for fish and wildlife
b) Regionally uncommon ecosystem or scenic landscape
c) Valuable functional services for the region (flood control, water supply)

Wetlands of local significance:

Criteria:
a) Abundant habitat for fish and wildlife
b) Regionally common ecosystem or scenic landscape
c) Valuable functional services to the locality (e.g. water supply, wastewater treatment, recreation)
d) Important source of wetland products for local communities (fish, timber, reeds, wildlife)

The development of wetland inventories and their priorities for conservation are critical for thisprocess. The preliminary EIA, initial environmental examination or EIA scoping exercises should draw upon existing baseline information where available, including data from wetland inventories. Note that wetland inventories may not be up to date, and so additional information may have to be gathered as part of the detailed environmental examination.

EIAs should be carried out for any development which could result in the following:

- changes in the hydrological regime (timing, flow rate, periodicity and duration of water flows and/or floods);
- changes in water quality (turbidity, sediment, chemical purity and temperature);
- changes in the health risks resulting from hydrological or water quality changes (e.g.malaria, schistosomiasis);
- loss or disturbance of flora and fauna from the wetland;
- the prevention of dispersal or migration of flora and fauna;
- loss of valued wetland products or functions.

For particularly sensitive areas, it may be useful to carry out strategic environmental assessments and predict the carrying capacity of the area for cumulative impacts of future developments.

Environmental economic evaluation of wetland benefits and its use in cost benefit analyses of projects should be a part of conventional EIAs. This should reflect the true costs of the project to society and the environment. Comparison of multi-criteria objectives for benefits which, can not easily be evaluated economically, may also be used. However, the practicability and usefulness of environmental economic evaluation depends upon a comprehensive and reliable data base, which may not exist. More research is needed in this area and development agencies are encouraged to fund projects to improve the environmental economic techniques in wetland situations. Some methods for wetland economic evaluation are described in Part 2.I.

The importance of threatened wetlands to local communities and their value in terms of goods and services must be included in an EIA. Studies should include the value to specific groups within those communities, such as women (using the wetland as a water source, or for other wetland products), fishing families, livestock owners etc. Where possible, the EIA should include a process of consultation of these groups. Mitigation and wetland management measures should be developed in participation with the affected communities. Development agencies should ensure that EIAs involve communities affected by loss of wetland benefits and relevant NGOs in the process as much as possible.

An EIA does not end with the production of a report or statement of the environmental impacts it is a process which includes the development of alternatives and mitigation measures; it includes the agreements with the affected communities and the monitoring of the implementation of the project itself and the mitigation measures. It should also include evaluations of the effectiveness of the mitigation measures and any necessary follow-up measures. Development agencies

should ensure there are sufficient resources available as part of the project to follow-through the monitoring and evaluation, and implementation of the mitigation measures of the EIA process. Further monitoring and evaluation of the mitigation measures may be necessary after the project has ended; this should be the responsibility of the recipient country.

If a project is shown to have a major adverse impact upon wetland ecosystems, attempts should be made to support redesign of the project to avoid impacts and to develop alternative projects. If this can not be done, then the development agencies should withdraw assistance from the project. A number of development agencies have done this, e.g. the German agency Kreditanstalt für Wiederaufbau (KfW) withdrew support for a water-supply project for Maun in Botswana due to the likely environmental impacts on the Okavango delta. In one case of explicit policy, the US Treasury Department has issued "voting standards" to the US Executive Directors to the multilateral banks and to the Administrator of US Agency for International Development (USAID)[4].

Development agencies should develop specific policies and mechanisms to prohibit the support of projects which can be shown to cause significant damage to wetlands and their benefits, especially those which are listed under the Ramsar Convention or national protected areas, unless adequate compensation measures are implemented.

Box 1.8 gives a checklist of action points in the EIA process which ensure that wetlands are considered. Early awareness of the environmental impacts in the design of a project can avoid the need for costly corrective measures after the EIA has been completed.

B. Mitigating the impacts of projects upon wetlands

In some cases, the decision may be taken to go ahead with a project which is known to damage or destroy the wetlands in an area. The national interest may be better served in implementing the project rather than preserving the wetland intact. Such decisions should only be taken after the full implications and long-term costs and benefits have been evaluated, and possible alternatives considered. Where possible, protective and mitigating measures should be built into the project. The application of the "No Net Loss" principle and the principle of restoration may be considered in such situations. If a wetland in an area has to be unavoidably damaged or lost as a result of a development project, compensation should be

Box 1.8. Checklist of wetland action points within the project cycle & EIA process

PROJECT CYCLE	ENVIRONMENTAL ASSESSMENT PROCESS	WETLAND ACTION POINTS
PROJECT IDENTIFICATION * Pre-feasibility study	PRELIMINARY ENVIRONMENTAL ASSESSMENT * Initial screening * Potential impacts identified * Possible mitigation measures * Final screening	* Follow national wetland policy * Consider national water and wetland issues * Consult wetland sites inventory * Address lists of potential project impacts upon wetlands
PROJECT FORMULATION * Feasibility study * Project planning and detailed design	EIA PREPARATION * Scoping and public consultation * Terms of reference and EIA team selection * Identification of development alternatives * Detailed impact identification * Baseline studies * Impact prediction * Impact interpretation * Planning environmental mitigation * Identify monitoring needs	* Consult wetland specialists * Include wetland specialists in team * Describe water & wetland issues in project area * Describe wetlands in area (base line survey) * Assess wetland functions, uses and values * Consult communities, wetland users and NGOs * Assess impacts of project on wetlands * Identify wetland indicators
PROJECT APPRAISAL	EIA REVIEW * Review EIA report * Public consultation	* Consult communities, wetland users & NGOs
PROJECT APPROVAL * Negotiation * Approval	* Incorporate environmental provisions into project documents	* Consult wetland and environmental law specialists
PROJECT IMPLEMENTATION * Implementation and supervision * Implementation of mitigation and enhancement measures * Monitoring project performance	ENVIRONMENTAL MONITORING * Monitoring of mitigation & enhancement measures * Monitoring of environmental indicators * Monitoring of socio-economic indicators	* Develop joint-management measures for wetland with wetland user communities, if appropriate * Develop mechanisms for wetland management, training and financing * Strengthen wetland institutions * Prepare & deliver wetland awareness, education, training campaign, if appropriate * Monitor wetland management indicators * Monitor wetland ecosystem status indicators * Monitor wetland user group socio-economic status indicators
PROJECT EVALUATION * Project performance audit * Recommendations for sustainable follow-up	ENVIRONMENTAL AUDIT * Effectiveness of mitigation & enhancement measures * Recommendations for follow-up	* Carry out wetland ecosystem surveys * Carry out wetland users socio-economic surveys
FOLLOW-UP ACTIVITIES * Design new project activities, if needed	* Adjust mitigation and management measures	* Sustain wetland conservation & wise use * Ensure institutional and financing mechanisms for continued wetland management

offered by, for example, the restoration or improvement of other wetlands in adjacent areas.

In these instances, the role of the development agency should be to:

- ensure that all the project alternatives are considered in the design phase and during the EIA process;
- make sure that the decision makers realise the full costs of the loss of the wetland and its functions;
- ensure that adequate compensation for the loss of the wetland has been agreed with wetland users;
- consider whether the wetland functions can be provided or created elsewhere (rehabilitation possibilities);
- develop wetland management components for remaining wetlands to optimise the residual functions and benefits.

Table 2.1 in Part 2 shows some of the mitigation measures which should be considered to counteract the impacts of different projects. The following areas are described: natural resource development; infrastructure, utilities and public works; settlements, urban development, health; industry and mining; tourism development.

C. Developing wetland focused projects

A number of development agencies assist projects which focus on specific wetlands. They are especially concerned with the management or rehabilitation of a wetland area — in other words, its wise use, or wetland components designed to mitigate the impacts of major development projects. The principles guiding a national wetland policy and some of the components will apply in such projects, even if a formal policy has not been drawn up.

Components of wetland focused projects

In designing and implementing such wetland focused projects, the following aspects have been found to be fundamental to success:

- **Ecological and hydrological studies** to increase the understanding of the specific ecological conditions and how they are influenced by the physical and human forces. The studies also lay the base-line for future monitoring work.
- **Socio-economic studies** to assess the extent of human use of the natural resources, of their and the alternatives open to the communities surrounding the wetlands. The studies can also be a base-line for monitoring changes in these communities. Participative techniques may be used.
- **Joint-management measures** may have to be developed between different agencies and communities to manage the resources (see Box 2.2). These include:

- national and local government agencies to advise, regulate and enforce where necessary;
- NGOs to manage the resources or support and advise;
- local communities and user groups to manage, harvest and control the resources.

Such measures might include the development of improved techniques for resource use, increasing the market value of wetland products and development of viable alternatives so that pressure on the resources can be reduced. They might also include agreements on quotas, close seasons or control of water abstraction.

— **Monitoring** activities to enable the wetland management measures to be tested and changed where necessary. Monitoring should cover both environmental and socio-economic changes, including the perceptions and reactions of the local communities. Local NGOs and universities can be used to carry out both the initial studies and the monitoring.

Wetland management plans

Wetland management involves identifying the critical factors, developing a set of management practices, monitoring changes in the situation and then adjusting the management practices appropriately. The Ramsar Conference in Kushiro (June 1993) adopted guidelines for management plans of wetlands . There are several types of change to be monitored and managed:

— **Changes due to human use**. Management of human activities is more important than control of natural forces. Control and enforcement of resource use have a role, but are often less effective management tools than agreements for community-based management. The participation of the local people in the design and implementation of sustainable resource use is critical to success.

— **External changes** such as upstream changes (upland land-use change, alterations of flow regimes, siltation and pollution). Institutional mechanisms may need to be put in place for wetland managers to influence decisions taken about upstream changes.

— **Climate change** is a major external change over which very little control can be exerted at the local level. It may seriously affect the regional and local hydrological cycle. Wetland management projects should consider the predictions of climate change and develop strategies to manage the risks. OECD DAC Guidelines No. 8[2] contain an appendix on climate change and its impact upon the coastal and marine environment.

— **Natural changes** characteristic of the wetland, e.g. natural siltation, may result in the decline of wetland benefits. Projects would have to identify such processes and decide how to counteract them, if appropriate. Some ecosystem changes may occur as a result of

stopping previous management measures or even the removal of human activities, e.g. the banning of reed cutting or of livestock traditionally grazing on the wetland.

Institutional arrangements

Institutional coordination is critical in wetland focused projects since a number of different ministries and institutions may be involved. Cross-sectoral linkages at the appropriate level between the relevant (e.g. authorities responsible for water, agriculture, forestry, fisheries, national parks and wildlife and rural development) should be put in place to encourage collaboration. Non-governmental organisations and community representatives may be included in such arrangements. Careful design and negotiations will be needed to avoid duplication of responsibilities. A single co-ordinating agency should be designated.

Institutions associated with wetland planning and management tend to have a relative lack of appropriately trained wetland specialists compared to other forms of natural resource management. Three groups of professional staff will need to be developed:

- **resource specialists** trained in environmentally sound management of wetlands, capable of integrating wetland conservation with the needs of development;
- **planners sensitive to the multiple values of wetlands** who can design development programmes which incorporate wetlands as viable components of river basins and coastal zones, and who are able to work with wetland users and communities;
- **hydrologists and hydraulic engineers** who can take an integrated view of water management and seek to maximise the benefits of wetland ecosystems, especially for flood control, rather than simply transferring water most efficiently from one place to another.

Training, education and awareness

Training for wetland management will become increasingly important, if sustainable use is to be practised. Where training is an integral part of development assistance, attention should be given to developing these skills and a positive attitude towards wetlands. Skills to be strengthened include ecosystem description and understanding, hydrological management, protection for flora and fauna, pollution control, working with local communities and encouragement of participation, management of recreation and tourism, wetland education and awareness. Support for training should be preceded by a detailed analysis of training needs and the audiences to be addressed.

The inclusion of wetland benefits in more general environmental courses, e.g. for administrators and planners, will help to create an official awareness of wetland

issues and benefits. This will develop the necessary atmosphere of support for wetland managers in sustainable use of wetlands.

Wetland conservation has received little financial and popular support in the past, largely as a result of the poor understanding of wetlands. Education and awareness campaigns need to be targeted towards:

- the **local users and communities** needing practical training in improved resource use methods;
- the **NGOs and activists** interested in wetland management or community development;
- the **general public**, whose popular support creates a body of opinion for wetland conservation;
- **businesses and industries** whose activities may impact upon the wetland, to encourage them to manage these activities and to take responsibility for the area;
- **decision makers in government agencies**, who have to allocate the natural resources despite increasing pressure on resources and multiple use conflicts.

Long-term financing for wise use

Wetland focused projects should explore opportunities for financing if their activities are to be continued in the long term. Income and financial benefits may be derived from:

- charges for visitors;
- charges for fishing rights;
- return of profits from resource exploitation;
- environmental trust funds;
- debt for nature swaps.

The aim of these financial tools is to return some of the value of the wetland to the local communities using it. In this way, local people realise an incentive to manage their wetlands sustainably, rather than neglecting them.

PART 2.

WETLANDS ISSUES

I. Different Types, Functions and Benefits of Wetlands

A. Wetland landscape units

Amongst the three categories of marine and coastal wetlands, inland wetlands and artificial wetlands, there are a number of distinct wetland landscape units. Brief descriptions of the salient features of some of the more important wetland types follows:

Marine and Coastal Wetlands

(See also OECD DAC *Guidelines on Global and Regional Aspects of the Development and Protection of the Marine and Coastal Environment*[2])

- **Estuaries and tidal flats** occur where rivers enter the sea and there is a daily tidal cycle with intermediate salinity between the freshwater of the river and the saline waters of the sea. Some are dominated by grasses and salt tolerant herbs, whilst others are open expanses of mud flats. In addition to the daily tidal cycle there may be a distinct seasonal cycle of increased freshwater discharge due to heavy rainfall, followed by saline intrusion during the dry season. Estuaries and inshore marine waters are among the most productive ecosystems of the world and support a food web which permits rapid growth of young fish in estuarine nursery areas.
- **Mangroves and other tidal forests** are specialised ecosystems (often with very productive forests) found only in the tropics and sub-tropics and consist of plant communities adapted to living in the dynamic estuarine and coastal conditions. Mangroves are exceptional in that they are the only woody plants tolerant of salt waters. They typically occur in estuaries, coastal lagoons where they are protected from the full force of the waves. Mangrove forests cover at least 16 million hectares, of which about 45 per cent are in South East Asia, about 35 per cent in America and 21 per cent in Africa. Other tidal forests include the Nipa palm and Virola forests especially on the Pacific coast of South America.

- **Open coasts** are those not subject to the influence of river water and lagoon ecosystems. They can support a wide variety of wetland habitats where the coastal energy (from waves and currents) is low. These may include mudflats and mangroves. For instance in Mauritania, the Banc d'Arguin, Africa's largest system of tidal flats, receives no significant surface inflow of freshwater. Sandy beaches support important populations of wildlife, including migratory shorebirds and nesting marine turtles. Coastal zones may contain a complex of open shores, coastal lagoons, and mangrove areas interspersed with mudflats and sand banks, for example, the Bijagos Archipelago in Guinea Bissau.
- **Coral reefs** are the physical structures created by the growth of the reef community, especially corals, which are colonial animals producing a calcium carbonate skeleton. Although they extend to great depths and are truly marine ecosystems, coral reef flats start from the very shallow intertidal waters (i.e. less than 6 metres depth). They are an important part of the coastal wetlands and are very productive but fragile, being easily damaged by pollution, coral mining and tourism.

Inland wetlands

- **Floodplains and deltas** occur where rivers swell with seasonal rainfall, or meltwaters* from mountain snow, above the river channel and flood naturally over the neighbouring plains. The annual cycle of inundation and desiccation of the world's floodplains have made them particularly productive both as wetlands and agricultural areas. Floodplains are found in coastal lowlands where they end in estuarine deltas — a complex of marine, brackish and freshwater habitats. They also spread far inland covering vast areas that include grassy marshes, flooded forest, oxbow* lakes etc. Half of Africa's wetlands consist of forested, savannah flood plains; examples of this include the Inner Niger Delta in Mali and the Okavango in Botswana. In S. America the Pantanal of the Paraguay River floods from 10-14 million hectares of seasonal wetland in some years. In Indonesia, the major freshwater floodplains occurring in South Sumatra are slightly acidic and very productive.

  Floodplains will have a much smaller area of permanent water during the dry season, but have a much larger area of seasonal lakes, pools and marshes by the end of the wet season. Lake Chad in the Sahel, for example, is rarely more than 7m deep and can cover 25 000 km^2 when the Chari and Logone rivers are in flood, but will recede to less than 10 000 km^2 in times of drought. Some floodplains will include areas of swamp forest as well as open marshes.
- **Freshwater marshes and swamps** occur wherever the groundwater, surface springs, streams or run-off cause frequent or seasonal flooding

or permanent areas of shallow water. Freshwater marshes are dominated by herbaceous plants such as grasses, sedges and rushes and are among the most widespread and important wetland type. In arid areas, wetlands may be formed at low lying areas where run-off or ground waters collect but have no outlet; the water evaporates. Swamps are marshy areas with water lying above ground level for some part of the year, and with emergent vegetation over 1 metre.

- **Lakes and ponds** occur in many different types resulting from geological processes, such as the faulting in the Earth's crust, crater lakes from extinct volcanoes, lakes caused by impeded flow in rivers, such as ox bow and alluvial fan lakes. The margins of large lakes may contain marshes and swamps, whilst the open waters may be more like inland seas with important lake fisheries. Some lakes may be saline or sodic.
- **Peatlands** in the tropics typically form in the hot lowlands under conditions of high to moderate rainfall, high acidity, low nutrient supply, waterlogging and oxygen deficiency. The breakdown of plant material is retarded and so accumulates as peat. Peatlands in the tropics tend to form in association with marsh and swamp around lake margins and coastal regions and are often forested. Up to about 10 per cent of all peatlands are found in the tropics (some 50 million hectares) of which 75 per cent are found around the western, southern and eastern margins of the South China Sea. Many of the comments on swamp forests also apply to peatlands.
- **Swamp forests** form in areas of still water around lake margins and in parts of floodplains where water rests for long periods. In much of South East Asia natural swamp forests contain mixed species, but where there is repeated disturbance, e.g. from burning, they may become dominated by paper-bark trees (Melaleuca sp.). Logging of commercially valuable species and conversion to other land-uses, such as irrigated agriculture are the main causes of loss, giving rise to problems of acid-sulphate* soils, erosion, compaction and flooding. In Indonesia where about 20 per cent of the land area is wetland, about half is swamp forest. Similar resources are found in the Amazon basin. In Africa the most extensive areas are found in the Congo basin.

Artificial wetlands

- **Artificial wetlands** are usually designed with a single purpose and may involve the destruction or damage of a natural wetland. They rarely have the full set of wetland benefits which a natural wetland might have. They include aquaculture ponds, irrigation lands and channels, ponds for agriculture and livestock, salt pans, flooded excavations, wastewater treatment areas including sewage farms,

settling ponds and oxidation basins, and dammed rivers and reservoirs for water supply, irrigation or hydro-electric power-generation.

B. Wetland benefits

The following functions, products and attributes are some of the benefits derived from wetlands.

Hydrological balance

Wetlands provide the mechanisms for hydrological balance. Depending on the geological and hydrological conditions, wetlands can recharge groundwater resources, for instance, by allowing run-off water to infiltrate the ground; this provides water resources for surrounding areas. In arid lands this is a critical function. Discharge of groundwaters can occur when rivers and streams drain off excess water from the land and reduce waterlogging. Wetlands may also provide storage for flood waters, so that the force of flooding is spread out and reduced. Drainage of wetlands and urbanisation has tended to increase the risk of flooding, and flood embankments increase the risk of catastrophic floods when the flows are too great to be contained. Retention of wetlands for flood control is a becoming a recognised management tool.

Protecting the land

Wetland vegetation stabilises shores and banks of coasts, rivers and lakes by reducing the energy of currents, waves, storm surges, and the erosion effects of wind and rainfall. The roots of wetland plants help to retain soils and sediments, reducing erosion of valuable agricultural land and property. Mangroves, in particular, are valuable for dissipating the force of hurricanes and coastal storms, e.g. the Sundarbans in Bangladesh. Shoreline stabilisation, erosion control and storm protection reduces the damage to land and property. Wetlands provide such functions at much lower cost than engineered structures. Wetlands also play a significant role in modifying the climate of the surrounding lands, reducing ambient temperatures and raising humidities, particularly in arid climates. Wetland loss can lead to degradation of surrounding drylands.

Water purification

The storage of water and the growth of water weeds, rushes and grasses slow down a river's flow allowing sediments to settle out. Retaining sediments in the wetlands at the head of a reservoir can lengthen the lifespan of dams, reservoirs and channels and reduce maintenance costs.

Wetlands serve a useful purifying function as the ecosystem "kidneys". Natural or engineered wetlands can also be used to reduce the organic materials

from sewage whilst toxic materials such as agricultural chemicals and some industrial wastes may be adsorbed onto sediments or removed from the water by wetland plants. If the capacity of the wetland to remove such wastes is exceeded, the water will remain polluted and the wetland will degrade. Some wetlands actively remove dissolved nutrients (especially nitrates and phosphates) from water and so improve its quality for water supply.

Productivity and biomass export

The productivity of tropical and sub-tropical wetlands is far greater than that of temperate and polar wetlands, and make up a substantial proportion of the primary production of these areas, especially in arid climates. High productivity and cycling of nutrients means that there are ample food supplies to maintain complex wetland food chains. Wetlands are important breeding, and nursery and feeding areas for fish. Some fish remain within the wetland, others move away as adults. This is especially true for estuaries, deltas and mangroves which support marine fisheries far out to sea. Without the protection and food supply available in the wetlands, the fisheries might collapse.

Wetland products

Wetlands are “biological supermarkets”. The highly productive nature of many wetlands means that they support dense populations of fish, cattle, wildlife and wildfowl; depending upon the type of wetland, many products can be harvested from wetlands and are often the most direct economic benefit. They range from forest resources for timber, fuelwood, tan-bark, resins, medicines and honey. Forage resources for domestic animals come from the grasses and foliage of trees found in wetlands. Building materials are obtained from wetland grasses, and reeds, especially in Africa where timber may be less important than thatch, mats and screens. Fish resources provide both a local protein source and a major export product, especially shrimps and shellfish. Animals and wildfowl resources are used as a protein source and for recreation such as hunting and tourism. Whilst many wetlands have been drained for agricultural purposes, some wetlands can be used for agriculture in their natural form, especially during the dry season. Use in this way preserves their other functions.

Water and energy resources

Wetlands provide many communities with a direct source of water for human and animal consumption, agriculture and industry; they also provide a means of filtering and purifying water for later human consumption (see above). The storage of water in wetlands allows its later use as drinking water during dry seasons.

Some wetlands have the potential for energy resources from the plant biomass, e.g. fuelwood and grasses. Alternative forms of energy could be obtained from wetland biomass. Peat built up within the wetland has been used as an energy

source. Peat can be used carefully on a small-scale without damaging the integrity of the whole wetland but large-scale peat extraction destroys the ecosystem and its functions. Peat lands especially perform the function of carbon sequestration,* i.e. removing carbon dioxide from the atmosphere and incorporating the carbon into the stored organic material. The value of peatlands to green-house gas regulation has often been neglected.

Human services

Wetlands provide many communities with vital communication links. Some fishing communities are only accessible through rivers and channels. Other wetland channels provide the means for transporting people and goods to different parts of the country. Because of their wildness and productivity, many wetlands are becoming important areas for recreation such as hunting and fishing. The scenic beauty of the landscape and wildlife also attract people — visitors and tourists — to spend time in the wetlands. The value of wetlands to the tourist economy is often significant.

Biological and cultural diversity

Biodiversity includes ecosystems, vegetation, fish, and invertebrates as well as mammals. Many wetlands support spectacular populations of wildlife, both in terms of numbers and diversity of species. Often wetlands, because of their inaccessibility attract and shelter animals which have lost their original habitats. Wetlands are also an important reservoir of genetic material for plants, e.g. disease resistant varieties of rice. A number of traditional cultures of the world have evolved out of an interaction and dependence upon wetlands, which often have lessons for their sustainable use.

C. Valuing wetland benefits

In the past decisions have often been taken to drain wetlands or implement projects which damage them, based upon information which is incomplete or incompatible. Environmental information has often been left out in the decision making process. If it has been included, qualitative descriptions of the impacts have been used, which are not able to counter powerful economic arguments. Some economic values, which are directly comparable, such as agriculture and fisheries benefits, may have been included.

Various methods are now being worked out, which seek to incorporate environmental economic values into the process. Either they give economic values to wetland benefits directly, which can then be included in conventional cost benefit analysis; or they identify the quantifiable (but not necessarily economic) criteria for judging development alternatives and comparing them as part of multi-criteria analysis. In both types of method the object is to provide the decision

makers with the necessary information of the advantages and disadvantages of a particular development in a readily assimilable form.

The attraction of reducing environmental benefits to a single dollar figure is its simplicity and ease of understanding. If economic values are attributed to wetland benefits, they can not be downplayed or considered "worthless". However, care should be taken since a single dollar figure can obscure a large range of assumptions which may not be apparent to decision makers relying only upon the "bottom line". Other difficulties with the approach include the reliability and comprehensiveness of data required to estimate the figures.

Development activities are seen to have substantial environmental and social costs. However, environmental economic valuations are full of difficulties, especially since many of the benefits have no direct market value; this is why policy makers have often neglected subsistence or informal uses of wetlands. Similarly, uses such as education and scientific research, or the future potential for commercial use of biodiversity resources are not easy to quantify. Biocentric values such as the right of ecosystems or species to exist beyond their present or future usefulness to humans are perhaps the hardest to quantify in economic terms.

Most methods of economic evaluation of wetlands identify the different component values individually and then sum them to produce the total economic value. However, there are three different degrees to which the valuation can be taken:

— **impact analysis value**, which assesses the damages inflicted on a wetland from a specific environmental impact, e.g. from pollution;

— **partial valuation** in which an assessment is made of different development options, so that the relevant functions and uses affected by the various options are compared;

— **total valuation** in which all the values of the wetland are assessed, e.g. for national income accounting or for determining its worth or priority as a protected area).

The example of wetland environmental economics, shown in Box 2.1. illustrates how even a partial valuation can result in some very significant values and costs if the wetland is damaged by development projects.

Box 2.1 Valuation of wetland benefits: Hadejia-Jama'are floodplain, Nigeria

The wetland and its benefits

In NE Nigeria, an extensive floodplain (730,000 ha) exists where the Hadejia and Jama'are rivers converge. The floodplain provides important economic and environmental benefits for both local populations (1 m inhabitants) and the economy of the region.

For local populations, the wetlands provide essential income and nutrition benefits in the form of agriculture, grazing, fuelwood and fishing. Wider regional economic benefits include dry season grazing for semi-nomadic pastoralists, agricultural surpluses for Kano and Borno states, groundwater recharge and "insurance" resources in times of drought. In addition the wetlands have important tourism, educational and scientific potential as a natural habitat for migratory and native bird species, and for assisting control of bird damage.

The developments

In recent decades the Hadejia-Jama'are floodplain has come under increasing pressure from drought and upstream water developments that are diverting water from the floodplain for wheat irrigation. Downstream water developments may also lead to the building of water channels to by-pass the wetlands. These developments are taking place without consideration of the impacts on the floodplain and the benefits it provides.

The environmental economic evaluation

A partial evaluation of the wetland benefits showed that the agricultural, fuelwood and fishing benefits to the local population are substantial on a per hectare basis and in terms of the minimum and maximum amount of floodwater required to sustain them, even considering the unsustainable wheat production in the area. The present worth of the aggregated benefits of agriculture, fishing and fuelwood were at least $ 32 per 1 000 m^3 of water, whereas the returns from crops grown on the Kano river project were only $ 0.15 per 1 000 m^3. When operational costs are included, this drops to only $ 0.0026 per 1 000 m^3. Conventional valuation of project benefits usually take the production per hectare as the standard, but since water is the limiting factor for development, calculations should be based upon this.

Furthermore this analysis did not include the other benefits of flooding, such as groundwater recharge or flows downstream to Lake Chad, and livestock grazing, but the sum total of these additional benefits may exceed the estimated returns from agriculture, fishing and fuelwood. These would make the allocation of water to the floodplain even more economically sensible.

Water developments that divert water from wetlands should not proceed unless it can be demonstrated that the net benefits gained exceed the net benefits forgone through wetland loss in the Hadejia-Jama'are floodplain. Artificial releases are now being made to increase flooding and stimulate wetland uses.

II. The Direct Threats — Impacts and Mitigations of Development Projects on Wetlands

In general the direct threats to wetlands result from physical, chemical or biological changes in the surrounding environment. The impacts which these three types of environmental change may cause are:

A. Physical changes

— **Water input reduced** as a result of drainage, groundwater abstraction and surface water diversion. The groundwater table is lowered causing wetlands to dry and the area to shrink. If prolonged, the vegetation will change with a loss of flora and fauna species and/or a reduction of population numbers of commercially important or other species. In peatlands, drainage will cause compaction, subsidence and erosion; generally, peatland can not be reconstituted upon subsequent re-hydrating. The inability to reabsorb moisture after drainage of a wetland impairs its flood control function. Certain types of wetland soils will also suffer from acidification as a result of drainage. In coastal wetlands the lowering of the water table may cause salt water intrusion from.

— **Water input increased** so that the groundwater table is raised, as a result of upstream impoundment. This may cause an increase in the area of wetland and deepening of existing wetlands with an increase of wetland productivity. In arid areas, however, the rising water table increases evaporation from soils leaving behind salts in the top soil and in standing waters. Salinisation *and alkalinization *may reduce the productivity of the soil or wetland and reduces its use as a source of water supply. Where the ground water reaches the surface, pools of stagnant water may form, causing a potential health hazard from water associated diseases.

— **Artificial stabilisation of water levels,** for instance of flood plain lakes, as a result of barrages and flood control measures. The natural productivity of the area will be reduced since the normal nutrient cycling, which normally occurs as the water level moves up and down, will be curtailed.

— **Wetland is flooded** as a result of impoundment. The water becomes deeper and there may be a loss of the marginal habitats. Fish production may be increased, at least initially when submerged vegetation is dying off. Regular or seasonal variations in water level may inhibit vegetation on the margins and reduce productivity and habitat availability. Water associated diseases may increase.

— **Sea level rise** is an extreme example of wetland flooding, resulting from climate change. Coastal wetlands, such as coral reefs, coastal lagoons, mangrove and tidal swamp forests are especially at risk, since

changes in the levels of mean sea level will produce ecosystem and productivity changes, increased coastal erosion and, if forests are lost as a result, decreased storm protection. There may also be increased saline intrusion.

— **Ground level is raised** as a result of infilling of the wetland usually for infrastructure or urban development, for health reasons and for increasing agricultural area. The wetland habitat is completely destroyed, together with its functions and products.

— **Sediment in the water is increased** as a result of deforestation, upstream soil erosion, construction or mining activities. Increased sediment in the water reduces the penetration of light and hence the primary productivity and too much sediment can cause problems for aquatic organisms, especially fish. The sediment will be dropped out when the flow of water reduces, e.g. in a reservoir or in lowland rivers, reducing the life of the reservoir and maybe increasing the risk of flooding when the river channel becomes blocked. Increased sediment falling on gravel beds and fish breeding areas may destroy such areas. Coral communities will be killed by reduced light penetration, and deposition of sediments.

— **Sediment in the water is reduced** as a result of upstream impoundment, causing increased bank erosion downstream. Net reduction in sediment reaching deltas will result in coastal erosion. In both cases there may be loss of property, habitat and productivity.

B. Chemical changes

— **Increased salt content of water** as a result of salinisation, seawater intrusion and the release of irrigation drainage water, certain industrial effluents and mine waters. This will cause ecological changes resulting in loss of salt sensitive species and their possible replacement by more salt tolerant species. In sudden or extreme cases this could cause habitat destruction. It will tend to reduce the use of the water for drinking or industrial use.

— **Increased organic loading of water** as a result of discharges from sewage and industrial wastes such as food processing, tanneries, refineries etc. This increases the Biochemical Oxygen Demand (BOD) of the water and may lead to de-oxygenation of the water with resulting kills of aquatic life. Lower levels of organic discharge may increase the productivity of certain fish species at the expense of more sensitive, or more preferred, species.

— **Increased nutrient content of water** as a result of discharges of both treated and untreated sewage, industrial effluents, livestock wastes and agricultural run-off etc. This causes eutrophication when the concentration of nitrates and phosphates reach levels which encourage the growth of algae. Certain species will be encouraged, some of them

undesirable, e.g. filamentous algae and red tides. Fish kills may result and biodiversity will decrease.

— **Increased levels of toxic materials**, such as heavy metals, organic chemicals, pesticides etc. as a result of agricultural practices, industrial and mining waste discharge and hazardous waste leachate. This causes mortality of aquatic life and, if persistent, destruction of the wetland habitat.

— **Oil pollution** as a result of accidental oil spillage is both toxic to aquatic life and physically damaging. It is particularly dangerous in enclosed wetland areas and mangroves where the turbulent effects of open sea can not break up the oil. Chemicals used for clean up may be toxic.

C. Biological changes

— **Over-exploitation of natural resources** such as wetland forests and vegetation, and fisheries can cause changes in the wetland habitat. Clear cutting of swamp or mangrove forests exposes the wetland to erosion, produces change in the soil structure, and causes loss of protection and food for juvenile fish species. Over fishing will change the species mix of the wetland, tending towards smaller and less commercially attractive species.

— **Changes in traditional practices** such as the decline of grazing patterns or cutting of reeds established over centuries may threaten the survival of grasslands and reedbeds. The growth and die-back of reeds will tend to clog up wetland channels and with faster filling-in of the wetland.

— **Introduction of exotic species** can result from deliberate introductions such as the Nile Perch in Lake Victoria, from accidental escapes such as the water hyacinth and fish species such as Chinese Grass Carp from aquaculture ponds, or from major engineering projects such as interbasin transfer of water. The introduction of an exotic species which has fewer biological controls on its population can disturb the ecological balance resulting in loss of indigenous species.

There are four ways in which these changes may arise:

— **Natural changes**, resulting from the normal progression and development of wetlands (e.g. from lake to swamp to marsh to dryland), from climatic events such as drought or flood, geological changes such as earthquakes, landslides etc. and overall climate change.

— **Intentional changes of land-use**, in which the wetland is drained, infilled or otherwise reclaimed, e.g. intensive cropping, forestry, urbanisation and reservoir creation.

— **Side-effects of non-wetland activities**, e.g. hydrological changes from water abstraction, especially lowering of the water table, pollution from agriculture, industry or urban areas. Often these result from a lack of awareness of the value of wetlands, and hence no legal protection.

— **Over-exploitation and non-sustainable use of the natural wetland resources**, from lack of alternatives, greed and short-term interests, e.g. forests clearance, over-fishing, peat extraction.

D. Principal impacts and mitigation measures of development activities

Table 2.1 shows some of the principal impacts of various development activities which may fall into any of the above categories. Not all of these impacts will necessarily occur, but they should be assessed and appropriate mitigation measures taken. However, if there is an impact, it may have knock-on effects with loss of the wetland benefits and socio-economic consequences for the wetland dependent populations.

Under mitigation measures, "No net loss" provisions are frequently mentioned. These are measures to create, restore or improve a similar nearby area, if a wetland is lost due to development. Although this might be a costly option which is applicable to certain forms of wetland, it might involve, for example, replanting of mangroves in an adjacent bare area to replace those cut down, or some creative management measures to ensure that adjacent wetland areas remaining are protected more effectively.

Table 2.1. Principal impacts and mitigation measures of development activities

PROJECT TYPE	PRINCIPAL WETLAND IMPACTS	POSSIBLE MITIGATION MEASURES
NATURAL RESOURCE DEVELOPMENT		
AGRICULTURE Intensive crops	* Wetland drainage & conversion * Acidification of soils * Loss of flood control capacity	* "No net loss" provisions
AGRICULTURE Irrigation	* Water diversion from wetlands * Groundwater changes — drying of upstream wetlands and waterlogging downstream * Soil & water salinity & alkalinity changes * Loss of downstream water supply * Increase in water borne disease * Increased soil erosion & siltation	* Increased efficiency of irrigation * Improved drainage of irrigation water, * Improve traditional cultivation making use of wetland, * Freshwater releases on floodplains
AGRICULTURE Drainage	* Groundwater changes * Wetland drying — size & species changes * Oxidation of acid sulphate soils * Increased salinity of drainage water and receiving waters	* "No net loss" provisions
Use of fertilizer & agricultural chemicals	* Eutrophication of water bodies — algal blooms, fish kills etc. * Pollution by pesticides — fish & wildlife kills, bioaccumulation	* More efficient use of fertilisers * Integrated pest management
FORESTRY Upland forests	* Soil erosion increase * Sediment in downstream rivers & wetlands increased * Flood risk increased * Surface saturation increased	* Water shed management * Re-afforestation * Sediment check dams * Riparian strip plantation
FORESTRY Wetland forests	* Loss of ecosystem components — productivity decreased * Loss of storm & erosion protection * Clear-cutting may cause soil changes — oxidation & acidification * Increased sediment disturbance * Increased fire hazard	* Sustainable cropping of wetland timber * Replanting or enhanced natural regeneration * Selective felling
Forest industry	* Water pollution, especially from paper & pulpmills, and toxic wood preservatives	* Waste water treatment * Control of preservative use

Table 2.1(continued). Principal impacts and mitigation measures of development activities

PROJECT TYPE	PRINCIPAL WETLAND IMPACTS	POSSIBLE MITIGATION MEASURES
FISHERIES	* Increased production/improved facilities may cause over-fishing.	* Fishery controls * Selective fishing gears
Capture fishery	* Inappropriate fishing techniques and gear may decrease juvenile stocks. * Fish harbours & processing may cause water pollution	* Industry managed quotas * Provision of waste reception facilities
Aquaculture	* Natural wetlands destroyed * Mangroves cut down * Loss of natural fish spawning areas & seed * Natural fish populations reduced * Exotics compete with indigenous species * Use of chemicals and antibiotics * Water pollution from feed and fish excreta	* Care with site selection * Planning controls * Control on introduced species
LIVESTOCK	* Over-consumption of water -- ground water depletion * Water pollution from intensive livestock operations and dairy farms * Overgrazing of catchment area, leading to erosion and increased sediment in waterways	* Match animal numbers to water resources carrying capacity * Waste water treatment
INFRASTRUCTURE, UTILITIES & PUBLIC WORKS		
HYDROPOWER	* Flooding of upstream wetland and dryland areas, loss of some wetland functions * Changes in water quality & seasonal flow of water downstream -- rivers and floodplains dry up * Flood control * Rise in water table downstream, with increase in soil and wetland salinity * Transport of nutrients and sediments altered; sediments trapped behind dams reduce delta maintenance * Reductions in downstream and delta fish catches, possible increase in reservoir fishery * Eutrophication of reservoir, water weed problems * Dam acts as a barrier to migratory fish * Possible increase in water borne diseases	* Proper allowance for downstream wetland water needs * Seasonal releases for floodplain maintenance * Facilities for sediment release * Facilities for fish movement over dams

Table 2.1(continued). Principal impacts and mitigation measures of development activities

PROJECT TYPE	PRINCIPAL WETLAND IMPACTS	POSSIBLE MITIGATION MEASURES
THERMAL & NUCLEAR POWER	*Cooling pond construction *Heated water effluents -- microclimate change *Chemicals for biological growth control *Oil pollution *Nuclear waste disposal	* Adequate cooling and mixing of heated effluents. * Minimal use of chemicals * Oil spill measures
POWER LINES	*Partial wetland clearance *Increased access for hunting & poaching *Electromagnetic interference with migratory and nesting birds, especially waterfowl.	* Planning to avoid wetland areas
AIRPORTS	*Infilling of wetland and marine areas *Water, ground and air pollution *Noise disturbance of wetland bird species *Air strikes of wetland birds	*Water, ground and air pollution control measures * "No net loss" provisions
ROADS AND RAIL	* Infilling of wetland areas * Run-off from construction sites * Effects upon groundwater flow * Impeded circulation of surface water flow, especially in tidal wetlands * Noise disturbance of adjacent wetlands * Polluted rain water run-off * Increased access to wetland areas	* "No net loss" provisions * Ensure free movement of ground and surface water from one side to other * Culverts * Road design & routing to avoid wetlands
PORTS & HARBOURS	* Infilling of wetland areas * Dredging of access channels, disposal of dredgings, disturbance of toxic muds e.g. in an already polluted area. * Destruction of mangroves * Oil and industrial waste pollution * Changes to hydraulic regime and consequent bank erosion * Disturbance to fish and wildlife	* "No net loss" provisions * Management of surrounding wetland areas, including mangroves * Safe disposal of dredgings * Provision of waste reception and treatment facilities for ships * Oil pollution control equipment & training
Coastal protection	* Infilling of wetland areas * Construction disturbance * Increased access to wetland areas * Water movement changes resulting in changes in sedimentation patterns and benthic communities, especially corals	* "No net loss" provisions * Wetland sensitive design

Table 2.1(continued). Principal impacts and mitigation measures of development activities

PROJECT TYPE	PRINCIPAL WETLAND IMPACTS	POSSIBLE MITIGATION MEASURES
FLOOD CONTROL	* Construction impacts * Reduction of natural fertility from spread of nutrients and sediment in floodwaters * Increased impacts of catastrophic flooding * Reduction of floodplain benefits	* Use of wetlands for flood storage * Early warning systems for major floods breaching embankments * Controlled release of floodwaters to floodplain
SETTLEMENTS, URBAN DEVELOPMENT, PUBLIC HEALTH		
URBAN DEVELOPMENT/ HOUSING	* Infilling and drainage of wetland areas * Waste disposal * Water pollution of surface and ground waters * Construction site run-off with sediments * Increased surface run-off, erosion & flood risk * Reduced recharge of ground waters	* "No net loss" provisions * Water pollution control equipment * Safe solid waste disposal * Use of wetlands for waste water treatment * Construct groundwater recharge wells
WATER SUPPLY Reservoirs	* Increased abstraction of surface and ground waters * Reduced water tables and groundwater recharge, drying up of wetlands * Reduced possibilities of water abstraction downstream * Salinity intrusion in coastal areas * Pipeline construction damage * See above under Hydropower	* Adequate allowance for downstream wetland water needs
SEWERAGE & SANITATION	* Water pollution if treatment capacity is insufficient or during breakdowns * Infilling of wetlands for treatment sites * Construction damage * Eutrophication of receiving waters * Fish kills	* Use of artificial wetlands for waste water treatment * Adequate treatment capacity * Proper control & maintenance
SOLID & HAZARDOUS WASTE DISPOSAL	* Organic and toxic leachate into ground and surface waters * Use of wetlands for landfill site * Fish kills * Waste dumps attract wetland birds, rats, especially those containing household wastes	* Choice of sites and design to avoid wetland areas, or areas with strong leachate risks
PUBLIC HEALTH	* Drainage or infilling of wetlands for vector control * Use of pesticides for vector control * Fish and wildlife kills	* "No net loss" provisions * Adequate sewage treatment * Controlled use of pesticides

Table 2.1(continued). Principal impacts and mitigation measures of development activities

PROJECT TYPE	PRINCIPAL WETLAND IMPACTS	POSSIBLE MITIGATION MEASURES
INDUSTRY AND MINING		
INDUSTRIAL DEVELOPMENT	* Drainage and infilling of wetlands for industrial sites * Increased water supply needs, increasing abstraction from surface and ground waters * Water pollution, oil, organic and toxic wastes in surface and ground waters * Solid waste dumping in water courses * Fish kills, Eutrophication	* "No net loss" provisions * Adequate allowance for downstream wetland water needs * Water pollution control measures * Safe solid waste disposal
OIL EXPLORATION AND PRODUCTION	* Oil and other pollution of wetlands * Access roads, construction (see Roads) * Increased access to wetlands * Construction damage to wetlands, base camps for labourers * Hunting and poaching pressure * Changes in surface hydrology & aquatic habitat	* Oil pollution control measures * Controls on hunting by construction workers
OIL PIPELINES	* Construction damage to wetlands crossed * Accidental oil spillage	* "No net loss" provisions * Oil pollution control measures
SAND & GRAVEL	* Deepening of wetland areas * Disruption of wetland sites * Changes to wetland hydrology * Construction of access roads * Increased sediments and leachates in water courses and wetlands * Increased erosion	* "No net loss" provisions * Reconstitution of wetland afterwards
PEAT EXTRACTION	* Peat compaction, oxidation & erosion * Subsidence * Peatland habitat destruction * Destruction of hydrological role * Reduced capacity for acting as a carbon sink -- links with climate change issues * Release of toxic metals * Peat fires	* Planning controls

Table 2.1(continued). Principal impacts and mitigation measures of development activities

PROJECT TYPE	PRINCIPAL WETLAND IMPACTS	POSSIBLE MITIGATION MEASURES
MINING	* Pollution of surface and ground waters from mine tailings and toxic materials used in processing and heavy metals ores * Increased erosion & sediment loads in water courses * Acidification of ground & surface waters * Water drawdown in mines may cause lowering of water table, saline intrusion, drying of wetlands * Access roads, service facilities damage to adjacent wetlands * Mine waste dumps into or affecting wetlands	* Water pollution control measures * "No net loss" provisions * Control of leachates* from solid wastes from mines
TOURISM DEVELOPMENT		
HOTELS	* Construction damage adjacent to or on wetlands * Infilling of wetlands * Pollution from uncontrolled sewage discharge * Eutrophication of enclosed wetlands	* " No net loss" provisions * Water pollution control measures * Wetland managed as visitor attraction
MARINAS	* Conversion of wetlands, deepening and construction activities * Removal of mangroves * Oil and sewage pollution	* " No net loss" provisions * Water pollution control facilities * Waste reception facilities * Wetland managed as visitor attraction
ECO-TOURISM	* Disturbance of wildlife organisms & habitat * Poaching to provide visitor souvenirs * Increase in exploitation pressures	* Control on visitor numbers & timing * Local & Visitor awareness campaign * Local involvement in management & benefits

III. Overcoming the Underlying Reasons for Wetland Loss

Usually the direct threats to wetlands are caused by some underlying issues affecting society and its governance. If these issues are not addressed, then wetland loss will continue, despite all the direct interventions to conserve them. Wetland-sensitive assistance programmes should aim to address all or some of these issues.

A. Social issues

The fundamental social issue threatening wetlands is the increase in population, especially when coupled with unequal patterns of access to land and water resources and inappropriate land-use policies. The more people there are, the greater the demand for land for housing, agriculture and industrial development. Whilst this pressure is not wetlands specific, wetlands are often infilled or drained to provide the land, because the wetland is perceived to have little use and there is little competition for it. The issue of population growth and wetlands can not be addressed directly, but specific urban development, relocation and transmigration policies and projects should be aware of the uses and threats to wetlands.

The general lack of awareness of wetlands is a major problem — wetlands are often considered as wastelands. This attitude runs through the whole of society from top decision makers, the general public, and communities living near wetlands. It is caused by both limited wetland information being available and by poor communication. To overcome the issue, the information base on the particular wetlands in a country needs to be improved through research and inventory, and specific wetland awareness campaigns targeted appropriately — to wetland users (both local and distant), different levels and sectors of government and the general public.

The users of wetlands may be aware of loss or damage to the wetland, but may be powerless to do anything about it. This may result from landownership issues, for example, if the wetland owner is different from the traditional users and is damaging the wetland through neglect or development activities; or if the wetland is considered as common property (even if it is actually government owned) wetland products are seen as "free goods", and are not managed sustainably. If a wetland is converted or diverted to exclusive use, the traditional communities dependent upon the wetland products and services are disenfranchised. The ways to overcome these issues, apart from radical changes in landownership, relate to consultation, compensation and conflict resolution between wetland owners and wetland users. They may often be combined with an awareness campaign.

In the past, traditional wetland users have not always been considered capable of managing wetland resources. Governments have usually assumed sole responsibility for natural resource management, only to find that conventional ways of controlling wetland resource use, such as permits and enforcement, have not worked effectively. Recent experiences in involving wetland users in joint-management* agreements offer a much greater potential for success, because the actual users are also involved in and committed to management decisions. The possible steps in the development of joint-management agreements are shown in Box 2.2.

Traditional users, however, may not be able to stop over-exploiting wetland resources, because they have no viable alternatives, such as substitute employment for fishermen who are damaging fish stocks through overfishing, or herdsmen who are keeping too many animals on the wetland, or nearby communities who are

abstracting groundwater supplies for drinking or irrigation. To overcome these social issues, an analysis of the situation and a search for appropriate alternatives should be linked to sustainable management of the wetland. Many wetland projects now have a strong component for development of alternative income generation opportunities.

Box 2.2 Possible steps in developing joint-management agreements

* Various stakeholders in the wetland identify themselves and agree to take part in the process of developing a joint-management agreement.
* Unorganised stakeholders (especially those who are socially vulnerable and disenfranchised) are assisted to organise and agree on their own basic objectives, rules and forms of representation.
* Stakeholders clarify their wishes and capabilities around the wetland and exchange such information with each other.
* Stakeholders identify the management goals and priorities in the area.
* Stakeholders identify and discuss existing management arrangements in the area (formal or informal, explicit or implicit).
* Stakeholders develop and discuss management options to respond to the identified goals and priorities.
* Stakeholders identify and manage the possible conflicts rising among themselves.
* Stakeholders negotiate an agreement around a specific management option that establishes relevant rights and responsibilities for each of them.
* Stakeholders identify appropriate requirements, procedures and regulations to maintain the agreement viable and effective.
* Stakeholders fulfill requirements, implement procedures and enforce regulations.
* Stakeholders monitor the process and review the agreement as necessary.

B. Economic issues

When the wetland owner is different from the wetland users, there will be a divergence of private and social benefits, since the owner may have no interest in maintaining a wetland where the benefits go to others. The response will be indifference or drainage for perceived more productive use, unless the owner wishes to maintain the wetland for other benefits (hunting, for example).

Negotiations for change of ownership or compensation for wetland benefits can be explored in order to overcome such issues.

Vested interests may arise over use of the resources, both natural and mineral. Because wetlands are multi-functional, powerful interests in one particular function may jeopardise other wetland benefits. For example, the interests in prawn aquaculture in mangrove areas threaten the adjacent capture fisheries relying upon the mangroves as fish breeding grounds. Careful planning controls, sensitive to the needs of all the wetland users, is the only way to counteract over-exploitation by vested interests.

Often such over-exploitation is allowed because this is seen as the only economic use of the wetland. The other wetland benefits are not adequately valued, especially those which do not have a direct market value. This makes it difficult for planners in deciding the best use of a wetland; it may also be an issue in assessing compensation for the loss of benefits, or for owners when a wetland is set aside for conservation. Achieving recognition for non-market values of wetlands may be an important part of an awareness campaign.

The use of wetlands as a sink or treatment for water pollution is an example of such a non-market value. Water bodies have always been used by communities and industrialists to receive their solid and liquid wastes. If this goes beyond the carrying capacity of the water body, the other wetland benefits will be impaired, such as fisheries and water supply. Water pollution has always been regarded as an externality by economists, with the result that industries wishing to improve their profitability have been able to do so at the expense of the environment. The application of the Polluter Pays Principle and the enforcement of appropriate discharge standards are ways to overcome these economic imbalances.

A similar economic imbalance may arise from the setting of low prices for water and electricity (for water pumping). As a result water usage e.g. for irrigation or industry, is not efficient and water is wasted. This can lead to over-abstraction of water, depletion of the water table and drying of wetlands. Where water supply is an issue, the pricing policies or incentives to save water should be considered carefully.

C. Legal issues

Many wetlands have been lost because they have not been adequately protected under the law — the legislation controlling activities which might damage wetlands is either absent or haphazard. Two types of legislation may be needed — the protection of wetlands as landscape units, and the control of activities such as drainage, excavation, pollution and overuse. Often the legislation may be sectoral, for example controls on fisheries, forestry or national parks, and there may be many loopholes, duplications and conflicts. Usually wetland legislation is restricted to the protection of water quantity and quality and not to other benefits. There may also be specific legislation to protect particular wetlands, e.g. wetlands as part of the national park and protected area system in a country, but there is rarely legislation to protect wetlands outside of these areas.

To overcome legislative gaps and anomalies requires an initial review of the laws and regulations which affect wetlands and their uses. Revisions to legislation should be comprehensive with regulation of all impacting activities. Protective standards, mitigation, monitoring and enforcement arrangements should be established. In addition the laws should ensure adequate planning for the long-term use of water and land, and they should require comprehensive impact assessment of major agricultural, residential, commercial or industrial projects.

The other major legal problem is enforcement of the legislation, regulations and standards. The inability to bring offenders to court, the small penalties imposed and the abilities of offenders to get around the system, all contribute to the failure of the legal system to protect wetlands. Once a wetland is destroyed, it is very difficult and costly to re-establish it — the penalties do not reflect this. One of the reasons for lack of enforcement may be the limited resources (both people and equipment to "police" the wetlands) of the sectors involved and the lack of commitment of the authorities towards wetland protection. This is a good reason for ensuring the involvement of wetland users in joint management* schemes, since these people have a much greater incentive to protect the resources they aim to use sustainably; hence there will be less need for "policing".

D. Policy issues

The low level of wetlands awareness has resulted in the lack of wetland policies relating to the conservation and sustainable use of wetlands outside protected areas. Sectoral policy decisions are likely to have been taken without any integrated assessment and without considering the interests of many wetland users. Often different sectoral policies conflict over the use of water and wetlands. The absence of a dedicated wetland policy reinforces this tendency to neglect wetland issues by the other sectors.

Experience has shown in the past that, in most developed countries, agricultural policy has often encouraged the draining of wetlands, as a means to increasing production — by offering tax incentives or grants to farmers. Price incentives on particular crops encourage production on marginal agricultural land (such as drained wetland). The maintenance of artificially low crop prices may encourage increased production and overuse of wetlands in order to achieve a viable income. Both pricing policies may cause wetlands to be drained.

Likewise, forest policy may encourage the planting of trees on wetlands as a means of making a more commercially productive use of the land; grants and tax breaks may be used for this. In some instances, fisheries policy, in order to capitalise on lucrative export markets for prawns, has resulted in widespread cutting down of mangroves for intensive aquaculture.

The failure to recognise wetlands in sectoral policies has knock-on effects upon planning at all levels. As a result wetlands are forgotten in land-use planning and even water-use planning decisions. Water allocation plans share out water resources between domestic supply, agriculture and industry without considering the quantity of water required to maintain the wetlands. Often this results from a

lack of systematic land-use planning and a failure to consult the local wetland users. The ways to overcome this include the preparation of specific wetland policies and increased awareness and training on wetland needs and management options for government officials at appropriate levels and sectors. Various policy instruments for the management of wetlands are shown in Table 2.2.

E. Institutional issues

The lack of wetland awareness, policies and legislation has led to wetland institutions being short of financial and human resources. If these were considered important then the institutions would be set up to implement them. As it is, institutions which have responsibility for wetlands research, monitoring, management and control generally suffer from a lack of trained staff to deal with wetland issues, and limited resources to carry out their work. With the importance now being attached to wetland conservation and sustainable use, the need for training, equipment and funds should increase, if the institutions are to become effective.

Often these institutions have been organised along sectoral lines; wetland issues cut across these sectors and create difficulties of where the actual responsibility lies. As a result some issues may fall between two institutions and be neglected. In other situations there may be duplicated or conflicting responsibilities. In developing wetland action plans, clear responsibility must be set out for the different activities, and for a co-ordinating function of the institutions involved.

Another issue which affects the capacity of institutions to conserve and manage wetlands, is the lack of information about specific wetlands — how they function and are threatened, and methodologies for their management. This requires investment in research, in modelling of different environmental scenarios, e.g. different rates of water abstraction, and in applying management methodologies. One of the most urgent areas of methodology development is in joint management between government institutions, non-government organisation (NGOs) and communities. This is still a field where experience and confidence needs to be gained — government institutions need to learn that communities have a critical role to play in wetland management, and NGOs and communities have to learn to work with government officials in this way.

Table 2.2 Wetland management policy instrument options
(from Turner R.K., Policy Failures in Managing Wetlands. OECD 1992.)

POLICY	INSTRUMENT	COMMENT
1. Regulation		
Planning designations	Prohibitions Zoning and designation (subject to licence/permit) Permissions	Regulations of wetland uses and activity impact mitigation, with or without compensation. National, or local permits with uniform conditions.
Pollution abatement	Specific controls over land use (subject to licence permit)	Zoning and designation of wetlands by permitted use or activity; nature reserves, national/regional parks, global bio-spherical reserves (Ramsar Convention); varying degrees of site protection in practice. Increased stringency in pollution control policy; ambient environmental.
Function protection	Regulations to protect wetland functions	
2. Acquisition and management		
Purchase	Public body Charitable body with public grant aid (convenants)	Includes perpetual restrictions/easements and covenants.
Leasehold	Via convenant, with management	By owner, by accredited agent.
Management agreement	With landowner	
Joint management agreement	With communities and NGOS	

Table 2.2(continued). Wetland management policy instrument options

POLICY	INSTRUMENT	COMMENT
3. Incentives and charges		
Protection	Environmentally sensitive areas: management agreements	
Subsidies for conservation	Compensation for wetlands, wildlife and crop damage; Conservation practices	
Tax incentives for conservation management	On land On inputs and other costs	Income, capital gains, and estate tax exemptions for protected wetlands; deductions or credits on wetland donations or sales for conservation; property tax relief for protected wetlands.
Weland loss mitigation charges		Wetland development fees and related public trust fund for conservation; mitigation land banks (unadulterated or restored wetlands).
User charges	Entrance fees Licences	Wetland hunting, fishing license fees; non-consumption use licenses; recreation entrance fees.
Development activity subsidies	Agriculture Road construction Recreational Housing, forestry, etc.	Removal or reduction in scope/extent e.g. of agricultural subsidies -- including drainage and irrigation cost-sharing, loans, crop flood insurance, commodity price supports; tax deductions for development costs.

Notes

1. For the purposes of this guideline, the tropics and sub-tropics are taken to include those areas between latitudes 30° North and South.
2. OECD Development Assistance Committee *Guidelines No. 8 for Aid Agencies on Global and Regional Aspects of the Development and Protection of the Marine and Coastal Environment*, 1996, OECD, Paris.
3. Proceedings of Fifth Meeting of the Conference of the Contracting Parties of Ramsar, Kushiro, Japan. 9-16 June 1993. Rec. C.5.5.
4. In 1988, the Treasury of the United States issued a set of "voting standards" which should be used for review of projects that may have adverse impacts on wetlands to USAID and its directors of IBRD. These standards recommend that alternative sites and projects be considered in appraisal reports. In particular, two general guidelines should be applied: " i) projects should preserve the hydrological regime of the ecosystem and ii) they should ensure the preservation of the ecological, species and genetic resources within the region".
5. OECD Council Recommendation on Environmental Assessment of Development Assistance Projects and Programmes [C(85)104 of 20 June 1985], and OECD Council Recommendation concerning an Environmental Checklist for Possible Use by High-Level Decision Makers in Bilateral and Multilateral Development Assistance Institutions [C(89)2(Final) of 22 February 1989].

Annex 1
GLOSSARY OF WETLAND TERMS

Acid-sulphate soils contain high concentrations of sulphur. Under conditions of waterlogging and deoxygenation this will be converted to hydrogen sulphide. When the wetland is drained this is oxidised to sulphate liberating hydrogen ions causing the soils to become highly acidic, rendering them useless for agricultural production.

Algal blooms are dense growths of planktonic algae, which often cause the water to take on the colour of the algae (green, brown, blue-green or red). Algal blooms can occur under both natural conditions and as a result of nutrient enrichment from human activities

Alkalinisation is the process of increasing alkalinity of soils as a result of evaporation of water from high water tables, leaving high concentrations of alkaline salts in the soil.

Bioaccumulation is the process of concentrating certain elements and chemicals (e.g. heavy metals and pesticides) in living organisms through the food chain.

Biochemical Oxygen Demand (BOD) is a measure of the quantity of dissolved oxygen (expressed in parts per million) used in the decomposition of organic matter by biochemical action over a given time period (usually 3 or 5 days).

Carbon sequestration refers to the process of taking carbon out of circulation in the carbon cycle by the long-term storage as woody biomass, peat or coal. Burning these releases the carbon back into the atmosphere, thereby increasing green house gases.

Emergent refers to plants such as reeds, grasses and sedges which are rooted in wet areas, but whose leaves and flowering parts grow up out of the water.

Eutrophication is the process of enrichment of waters by the addition of nutrients e.g. from natural sources and especially from sewage, agricultural run-off and industrial wastes. It is often characterised by profuse growths of algae.

Floodplains are the low-lying areas into which river waters spread during the flood seasons. These are often very extensive on either side of the river, and can be both inland or estuarine. During the dry seasons, floodplains are very fertile and can support agriculture and grassland for pasture.

Functions are the capacity of natural processes and components to provide goods and services that directly or indirectly contribute to human welfare.

Joint-management is the term given to arrangements for management of natural resources agreed between users, owners and government.

Leachate is the liquid which drains from soil. If the soil contains garbage or industrial waste products or mine tailings the leachate can be heavily contaminated with organic and toxic compounds which will cause pollution if they are discharged into a water course.

Meltwaters are the waters which are derived from melting snow usually in mountainous areas. Meltwaters have both diurnal and seasonal fluctuations.

Oxbow lake is a small curved lake lying on the floodplain of a river, being the remnant of a former meander of the river.

Polderisation is the process of reclaiming areas of land from the sea or lakes using a system of dykes and drainage channels.

Saline intrusion is the movement of saline ground water inland from the sea, often caused by the reduction of freshwaters flowing downriver, or by excessive abstraction of groundwater in coastal areas.

Salinisation is the process of increasing salt concentration of soils, often caused by evaporation of groundwater at the surface leaving behind dissolved salts in the topsoil.

Salt marsh is an area of marshy ground that is intermittently inundated with salt water, or that retains pools of salt or brackish water.

Stakeholders are those people, groups or communities which have an interest in or an on effect on a wetland resource, and which should be consulted in any development plans.

Annex 2

CONTACT ADDRESSES OF SPECIALISED WETLAND AGENCIES

The Ramsar Bureau can answer requests for information on wetlands and redirect them to its official partners or to the most appropriate research and rural development institution. The Ramsar official partners are: the World Conservation Union (IUCN) (with its world-wide network of members); the World Conservation Monitoring Centre (WCMC); the World Wide Fund for Nature (WWF) and Wetlands International (recently formed from the integration of the International Waterfowl and Wetlands Research Bureau, the Asian Wetlands Bureau and Wetlands for the Americas). Their addresses are as follows:

The Ramsar Convention Bureau
Rue Mauverney 28
CH-1196 Gland
Switzerland
Tel: ++41 22 999 0170
Fax: ++41 22 999 0169

IUCN - The World Conservation Union
Rue Mauverney 28
CH-1196 Gland
Switzerland
Tel: ++41 22 999 0001
Fax: ++41 22 999 0002

WWF - World Wide Fund for Nature
Avenue du Mont-Blanc
Ch-1196 Gland
Switzerland
Tel: ++41 22 364 9111
Fax: ++41 22 364 4238

The World Conservation Monitoring Centre
219C Huntingdon Road
Cambridge CB3 0DL
United Kingdom
Tel: ++44 1223 277314
Fax: ++44 1223 277136

Wetlands International
Slimbridge
Gloucester GL2 7BX
United Kingdom
Tel: ++44 1453 890 624
Fax: ++44 1453 890 697

Annex 3

SELECTED DOCUMENTATION

The following titles have been mentioned in the text or provide further reading on the subject of wetlands and their management for sustainable use, or on the impacts of development assistance: The Ramsar Bureau, IUCN, and Wetlands International publications departments can be contacted for assistance to find references to specific issues and sites.

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