THE PUBLISHERS

The publishers of this document: AWB, IWRB and WA, are committed to working together to promote the sustainable use and conservation of wetlands worldwide. The three organisations have signed memoranda with one another to collaborate to form a global network for wetland conservation in conjunction with other organisations. AWB and IWRB have also more formally linked and now represent each other in respective regions. This cooperation is a bold move to halt the continuing destruction of wetlands worldwide. By joining forces and sharing resources, the catalytic role of each party should be enhanced. More detailed descriptions of the organisations are given below and on the inside back cover of this publication.

Asian Wetland Bureau (AWB)

AWB is an international non-profit organization established in 1983 and committed to promoting the protection and sustainable use of wetlands and their resources in the Asia/Pacific region.

AWB achieves this mission by facilitating and supporting the work of local organisations throughout the region. It does this by maintaining a regional overview of the wetland situation; assisting in development of regional and national wetland action plans; information dissemination; providing support to local organisations to manage wetlands on a sustainable basis and providing linkage with international organisations, conventions and expertise outside the region.

AWB is governed by a Council and works very closely with other partner organisations. AWB currently has its headquarters in Malaysia and other offices in Indonesia, India and United Kingdom. Most of these offices operate through formal agreements with counterpart organisations. AWB has more than 50 staff with a wide range of expertise complemented by consultants, advisors and counterparts. AWB currently supports a wide range of activities in more than 20 countries in the Asia-Pacific Region.

For more details please contact the Asian Wetland Bureau, Institute of Advanced Studies, University of Malaya, Lembah Pantai, 59100 Kuala Lumpur, Malaysia, Telephone No: (+60-3) 7572176/7566624, Fax No: (+60-3) 7571225.

International Waterfowl and Wetlands Research Bureau (IWRB)

IWRB was established in 1954 and is the only global independent organisation concerned primarily with the conservation of wetlands and their biodiversity. IWRB achieves this goal by stimulating and coordinating international technical cooperation. This includes coordinating international projects (inventory and monitoring programmes, recovery plans for endangered species, etc.), running training courses, and disseminating information through conferences, workshops and publications. IWRB played a key role in the creation of the Ramsar Convention and provides a high level of technical support to this and other conservation conventions. IWRB maintains computerised databases containing information on all listed Ramsar sites, and the results of the International Waterfowl Census.

(Continued on inside back cover)

WETLAND BENEFITS

The Potential for Wetlands to Support and Maintain Development

(Adapted from an original text by Howe, C.P., Claridge, G.F., Hughes, R. & Zuwendra, (1991): ***Manual of Guidelines for Scoping EIA in Tropical Wetlands***. PHPA/AWB Sumatra Wetland Project Report No.5. Asian Wetland Bureau-Indonesia and Directorate General for Forest Protection and Nature Conservation, Department of Forestry, Bogor.)

Compiled and edited by
Jon Davies and Gordon Claridge

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International Waterfowl and Wetlands Research Bureau

Wetlands for the Americas

May 1993

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Cover Photos:
Top left: Fishermen on Ganrapota Lake, West Bengal, India. (Jon Davies)
Top right: A glacial lake in the Pyrenees, France. (Jon Davies)
Bottom left: A boardwalk through the Everglades, Florida, USA. (Duncan Parish)
Bottom right: Pen culture of tilapia in Lake Sebu, Mindanao, Philippines. (Jon Davies)

PREFACE

In 1991, the AWB Indonesia Programme produced the "Manual of Guidelines for Scoping EIA in Tropical Wetlands" (Howe et al. 1991). This manual was produced as part of the PHPA/AWB Sumatra Wetland Project as an output which would aid in the development of guidelines and design criteria for sustainable wetland resource use.

The authors of that document were very much aware that much had to be done in order to raise the level of awareness among planners, managers and decision makers as to the many different benefits which are provided by intact wetlands. Accordingly, they included in the manual a section which explained the many benefits provided by wetlands. Since there is no self-contained document which details the values of wetlands which could act as basic resource material, this section of the manual was subsequently extracted to be used for several workshops which AWB conducted. Due to the very favourable response to the document, it was decided that it be expanded to include more information, especially specific examples of wetland benefits, whilst still retaining the simplicity and clarity of the original text. Additionally, examples given in the text have been drawn not only from Asia, but also from Africa, Europe and the Americas.

After its production in English, the document will be translated into numerous languages to ensure that the message that "wetlands are not wastelands" gets across to as many people in different countries as possible.

We recognise that this text can still be improved upon. We would encourage those with comments and suggestions as to how to revise or use the document to contact AWB, IWRB or WA.

Jon Davies and Gordon Claridge,
May 1993

ACKNOWLEDGEMENTS

The many people who contributed to the development of the original manual have been acknowledged there. Thanks go to the other authors of the original text: Chris Howe, Ross Hughes and Zuwendra. The Dutch Government provided funds in 1990 and 1991 for the development of the original manual through a grant to the AWB Indonesia Programme in conjunction with the Directorate-General for Forest Protection and Nature Conservation of Indonesia. Numerous people commented on drafts of the present document and gave material to include. Thanks go to: Dr. Gonzalo Castro, Dr. Patrick Denny, Brett Lane, Mike Moser, Faizal Parish, Crawford Prentice, Selvanathan and Drs. Marcel Silvius. Development and production of this revised publication has been partly supported by grants to AWB from World Wide Fund for Nature International/Overseas Development Administration of the UK (WWF-I/ODA) and the John D. and Catherine T. MacArthur Foundation; and from contributions from IWRB and WA.

FOREWORD

I am very happy to write the foreword for this publication because it signifies a new approach to the promotion of wetland values and secondly demonstrates the values of partnership.

Firstly, we hope that this publication will be used as an important public awareness tool to promote the wide range of benefits from wetlands and to assist in their wise use. Although there are a number of large technical publications available on wetland benefits from different parts of the world, we wanted to produce a publication to explain wetland benefits in a simple manner to people who are not necessarily technical experts. The simple style and the many illustrations should make it readily understandable and easy to translate and use in other contexts or languages. While it was developed initially in the Asian tropics, we have tried to make it more widely applicable.

Secondly, this project is a result of partnership and we hope that it will encourage future partnerships. The initial concept of simply illustrating wetland benefits was developed in the collaborative programme between AWB and the Directorate-General of Forest Protection and Nature Conservation (PHPA) in Indonesia and used for training in that country. This current document has been adapted from the Indonesian work by staff at the AWB Headquarters and is being published with two of AWB's most important partner organizations: the International Waterfowl and Wetlands Research Bureau (IWRB) and Wetlands for the Americas (WA). This first edition will be launched at the Fifth Meeting of the Contracting Parties to the Ramsar Convention in Japan, an important forum for partnerships.
In late 1992, IWRB, AWB and WA agreed to link together more closely to promote the creation of a global network for wetland conservation. This document is the first formal tripartite publication of the network. We hope that each party within the network will promote it in their respective region and work with further partners at the national or subregional level to adopt or translate the document for local use. The document is also suitable to be adapted to a variety of different formats to appeal to specific target audiences; for example, it has been adapted as a slide display and could be adapted for a comic style format.

Only through the free sharing of such resources can wetland conservation organizations hope to achieve their goals with their currently meagre resources. We hope that this publication will be a good example of partnership and will stimulate others to follow suit.

Faizal Parish
Executive Director,
Asian Wetland Bureau

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GLOSSARY

ATTRIBUTE: An aspect of a wetland (or any other ecosystem) which does not necessarily provide a function or support a use, but is valued by a group within society (Claridge 1991).

ENVIRONMENTAL IMPACT ASSESSMENT: A process which involves the systematic evaluation of all the significant effects an action is likely to have upon the environment before the decision to take the action is made. The process should also suggest mitigating measures if the proposed action is likely to have an adverse impact on the environment.

FUNCTION: An aspect of a wetland (or any other ecosystem) that potentially or actually supports or protects human activities or human property without being used directly, or supports or protects natural systems or natural processes. Functions are also known as "indirect-use values" by economists (Claridge 1991).

SCOPING: The identification of potentially significant impacts using environmental and/or project information for an Environmental Impact Assessment (EIA) Study .

USE: The direct utilisation of some aspect of a wetland (or other ecosystem). Uses are known as "direct-use values" by economists (Claridge 1991).

WETLAND BENEFITS: Commonly known in the literature as functions, uses, values and attributes, features, goods or services, they are defined as any of these terms which may have a value to people, wildlife, natural systems or natural processes (Claridge 1991).

Claridge, G.F. (1991). *An Overview of Wetland Values: A Necessary Preliminary to Wise Use.* PHPA/AWB Sumatra Wetland Project Report No.7, AWB, Bogor.

WHAT ARE WETLANDS?

How do you define a wetland?

The term 'wetland' means different things to different people - indeed, there are about fifty definitions of wetlands in current usage (Dugan 1990). The definitions can be divided into two main groups - those which are broad and those which are narrow.

The Ramsar Convention definition is a broad one. There are certain advantages to using it which are described below. The Ramsar definition is internationally accepted and is used throughout this publication. Wetlands are:

> **"Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static, flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres."**

THE RAMSAR CONVENTION

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat, often known as the Ramsar Convention from its place of adoption in Iran in 1971, is an intergovernmental agreement which provides the framework for international cooperation for the conservation of wetlands.

By 1993, more than 75 countries had become parties to the Convention. One of the obligations under the treaty is to designate wetlands of international importance for inclusion in a list of so-called Ramsar sites. Already, more than 600 wetland sites have been added to the Ramsar list, covering more than 30 million hectares of wetland habitat. In addition, parties are obliged to wisely manage the wetlands in their territories.

This definition encompasses reef flats and seagrass beds in coastal areas, through mudflats, mangroves, estuaries, rivers, freshwater marshes, swamp forests and lakes, as well as saline marshes and lakes.

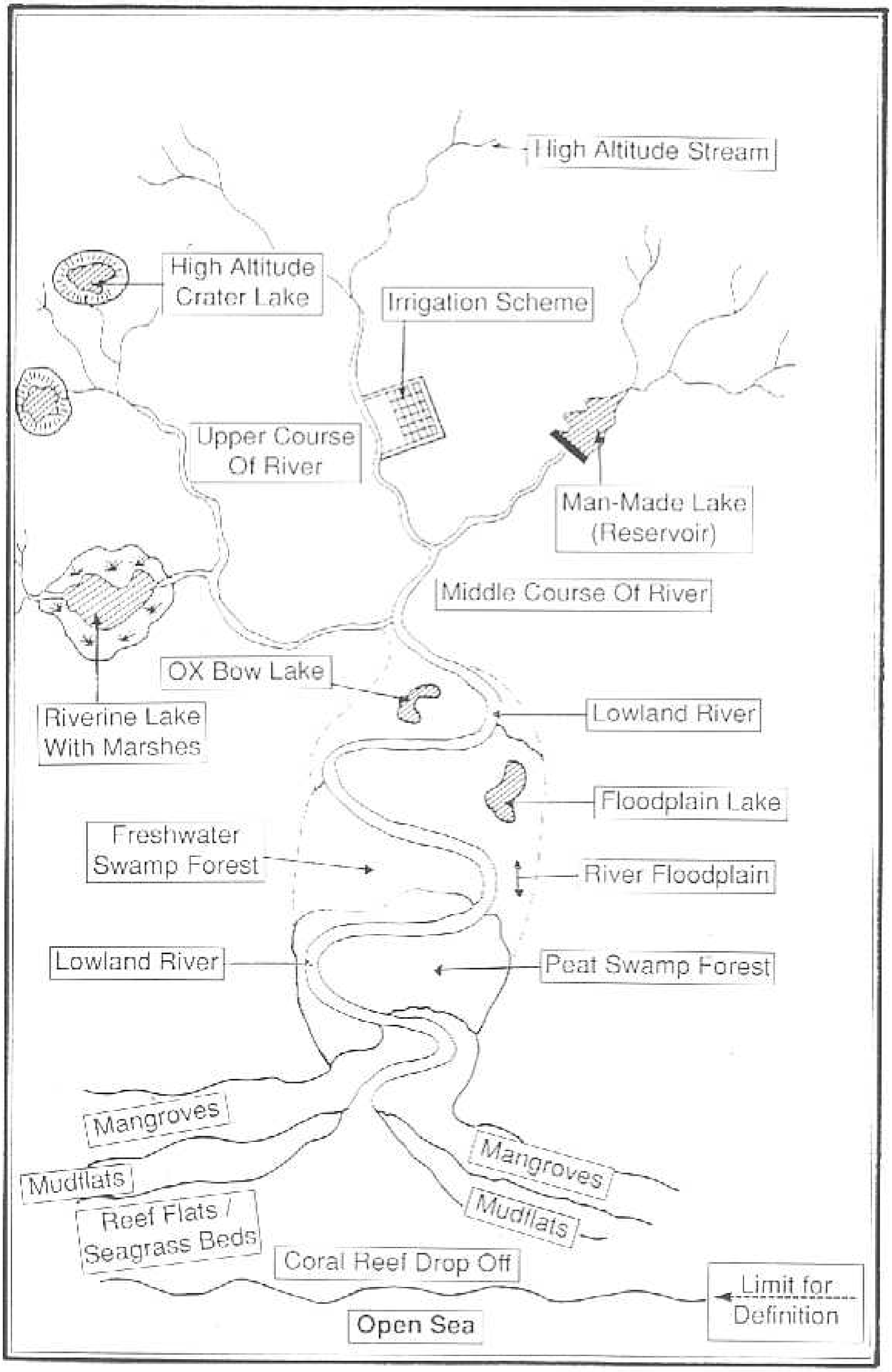
The narrow definitions generally look at wetlands as ecotones* ; areas which are transitonal between terrestrial and aquatic environments and where the waterlogging of the soil causes the development of a characteristic vegetation.(e.g. IBP in Worthington, 1976; Cowardin *et al.*, 1979; Denny, 1985). There is a practical problem with this definition in that it may mean that only a part or parts of a water body are included within the definition. Most of them regard areas with emergent vegetation as distinct from open water, which would not be included in the definition. Hence, in the case of lakes, littoral areas having emergent vegetation would be regarded as "wetland" whereas the main body of open water would not. Since both the littoral zone and the open water are very closely linked to each other, in terms of management it may create problems to separate them in this way.

There are obvious advantages for conservation and management in accepting a broad definition of a wetland such as the Ramsar definition. This is because the basic unit of land use planning should be at the catchment level; i.e. whole river basins. This acknowledges the fact that anything which disturbs the upper part of the catchment will have an effect lower down since the whole catchment is linked by water flow from top to bottom. Thus, the development of a broad science, working with the broad definition of a wetland which takes these hydrological linkages into account, is ideally placed to ensure the sound management of all water resources in that catchment. It must not be forgotten that this sound management must also include the terrestrial components.

Thus, wetland science, which integrates the study of all water bodies (lakes, marshes, rivers, man-made wetlands) in the catchment, and emphasises the linkages between the wetlands and the lands that surround them, is a science which can effectively devise wise management strategies at the catchment level.

* An ecotone is defined as a transition zone between two or more diverse communities - in this case the transition zone between terrestrial and aquatic communities.

Figure One: Types of wetlands included in the Ramsar Definition.



How do you classify wetlands?

As with definitions, there is a wide range of classifications for wetlands; e.g. Cowardin et al. (1979); Larson *et al.* (1989); Scott (1989); Dugan (1990). It is recommended that the Ramsar classification of wetlands should be adopted together with the Ramsar definition.

CLASSIFICATION OF WETLAND HABITATS ACCORDING TO DUGAN (1990). (ADAPTED FROM THAT APPROVED BY THE RAMSAR CONVENTION):

1. SALT WATER

1.1 MARINE

1. Subtidal

i) permanent unvegetated shallow waters less than 6m deep at low tide, including sea bays and straits.
ii) subtidal aquatic vegetation, including sea grasses and tropical marine meadows.
iii) coral reefs

2. Intertidal

i) rocky marine shores, including cliffs and rocky shores.
ii) shores of mobile stones and shingle.
iii) intertidal unvegetated mud, sand or salt flats.
iv) intertidal vegetated sediments, including mangroves, on sheltered coasts.

1.2 ESTUARINE

1. Subtidal

i) estuarine waters: permanent waters of estuaries and estuarine systems of deltas.

2. Intertidal

i) intertidal mud, sand or salt flats, with limited vegetation.
ii) intertidal marshes, including salt meadows, tidal brackish and freshwater marshes.
iii) intertidal forested wetlands, including mangroves, nypa and tidal freshwater swamp forest.

1.3 LAGOONAL

i) brackish to salty lagoons with one or more relatively narrow connections to the sea.

1.4 SALINE (INTERNAL DRAINAGE)

i) permanent and seasonal saline or alkaline lakes, flats and marshes.

2. FRESHWATER

2.1 RIVERINE

1. Perennial

i) permanent rivers and streams, including waterfalls.
ii) inland deltas

2. Temporary

i) seasonal and irregularly flowing rivers and streams.
ii) riverine floodplains, including river flats, flooded river basins and seasonally flooded grassland.

2.2 LACUSTRINE

1. Permanent

i) permanent freshwater lakes (> 8ha), including shores subject to seasonal or irregular inundation.
ii) permanent freshwater ponds (< 8ha).

2. Seasonal

i) seasonal freshwater lakes (> 8ha) including floodplain lakes.

2.3 PALUSTRINE (MARSHES/SWAMPS)

1. Emergent

i) permanent freshwater marshes and swamps on inorganic soils with emergent vegetation whose bases lie below the water table for at least most of the growing season.
ii) permanent peat-forming freshwater swamps, including tropical upland valley swamps dominated by *Papyrus* and *Typha*.
iii) seasonal freshwater marshes on inorganic soil, including sloughs, potholes, seasonally flooded meadows and sedge marshes.
iv) peatlands, including acidophilous, ombrogenous, or soligenous mires covered by moss, herbs or dwarf shrub vegetation, and fens of all types.
v) alpine and polar wetlands, including seasonally flooded meadows moistened by temporary waters from snowmelt.
vi) freshwater springs and oases with surrounding vegetation.
vii) volcanic fumaroles continually moistened by emerging and condensing water vapour.

2. Forested

i) shrub swamps, including shrub-dominated freshwater marsh on inorganic soils.
ii) freshwater swamp forest, including seasonally flooded forest on inorganic soils.
iii) forested peatlands, including peat swamp forest.

3. MAN-MADE WETLANDS

3.1 AQUACULTURE/MARICULTURE

i) aquaculture ponds, including fish ponds and shrimp ponds.

3.2 AGRICULTURE

i) ponds, including farm ponds, stock ponds and small tanks.

ii) irrigated land and irrigation canals, including rice fields, canals and ditches.

iii) seasonally flooded arable land.

3.3 SALT EXPLOITATION

i) salt pans and evaporation ponds.

3.4 URBAN/INDUSTRIAL

i) excavations, including gravel pits, borrow pits and mining pools.

ii) wastewater treatment areas, including sewage farms, settling ponds and oxidation basins.

3.5 WATER STORAGE AREAS

i) reservoirs holding water for irrigation and/or human consumption with a pattern of gradual, seasonal drawdown of water level.

ii) hydro-dams with regular fluctuations in water level on a weekly or monthly basis.

This classification can be modified specifically for each country in which it will be used; for example, local names could be used for specific types of wetlands to render the classification more familiar to the user. Similarly, unique types of wetlands which occur only in the country in question could be added.

WETLAND BENEFITS

Why are Wetlands Important?

What Functions do They Perform?

Wetlands are generally highly productive ecosystems, providing many important benefits. These benefits, sometimes described as 'goods and services', may be wetland functions (e.g. groundwater recharge, flood control), uses of the wetland or its products (e.g. site for wood collection or research site) or attributes of the wetland (e.g. aesthetic component of the landscape, religious significance).

Many of the benefits provided by wetlands are essential to communities, and to industrial and agricultural activities. Loss of wetlands will remove these benefits. This is not to put a case for 'development vs conservation', but simply to state that **maintenance of wetlands as functioning ecosystems will often ensure that important contributions to development are maintained.**

The remainder of this document describes the range of benefits provided by wetlands.

Wetlands are extremely productive systems and often approach, or even exceed, the productivity of intensive agricultural systems. Figures for African wetlands support this. The annual primary production of *Papyrus* is estimated at 100 tonnes per hectare, whilst values for *Typha* range from 30-70 tonnes per hectare. Surface floating plants may produce 40 tonnes per hectare. Submerged plants, too, are very productive. Those of the genus *Potamogeton* are reported to produce 40 tonnes per hectare. Just for comparison, sugar cane can produce 63 tonnes per hectare and maize 60 tonnes per hectare. To achieve these levels of production, though, they require a high amount of inputs in the form of water, fertiliser and pesticides.

Source: Denny, P. (1991) ***Africa***. In: Finlayson, M. & Moser, M.(eds.) ***Wetlands***.

TYPES OF WETLAND BENEFITS

WATER SUPPLY

* **Direct extraction of water by people**
  Wetlands are very frequently used as a source of water for domestic, industrial and agricultural use. Streams, rivers, ponds and lakes all contain water which can be extracted. Other wetlands, eg. peat swamp forests, can often become sources of water by use of shallow wells.

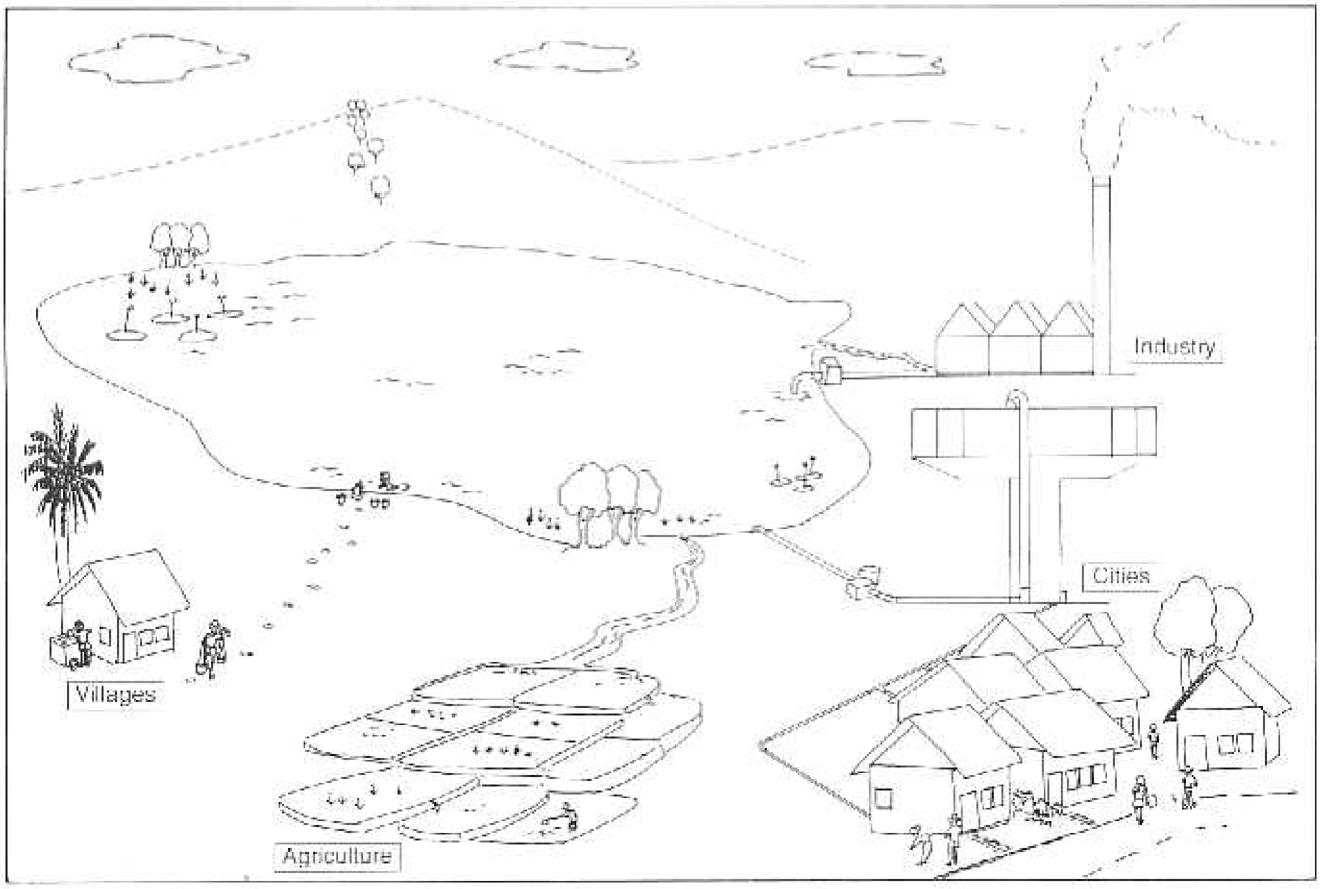


Figure Two: Water Supply - direct extraction

*** Water supply to an aquifer (groundwater recharge)**

This occurs when water moves from the body of the wetland area into the underlying aquifer system(s). However, it must be borne in mind that not all wetlands are recharge areas for groundwater; some may be discharge areas where groundwater flows into the wetland.

Water which moves from the wetland to an aquifer can then remain as part of the shallow groundwater system, which may supply water to surrounding areas and sustain the water table, or it may eventually move into the deep groundwater system, providing a long-term water resource.

This is of value to communities and industries which rely on medium/deep wells as a source of water. In some cases, one wetland area may recharge an aquifer which supplies a more complex system of natural habitat, agriculture, settlement areas or industry.

> An intensive eel aquaculture scheme has been set up in the South East Pahang Peat Swamp Forest on the east coast of peninsular Malaysia. Huge quantities of groundwater have been pumped up for the ponds which has resulted in the drying up of wells used by the local communities for their domestic needs.
>
> Source: New Sunday Times, May 2 1993

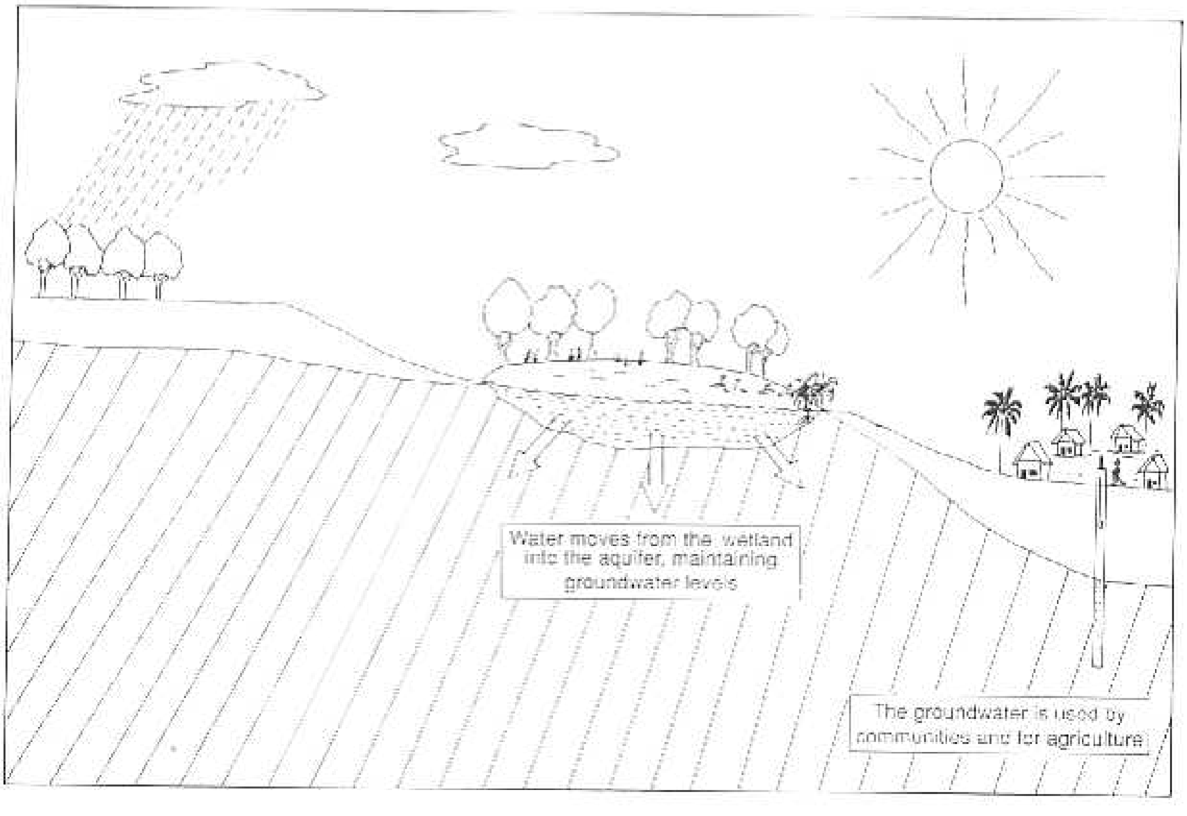


Figure 3a: Water Supply to an aquifer (groundwater recharge)
WITH WETLAND

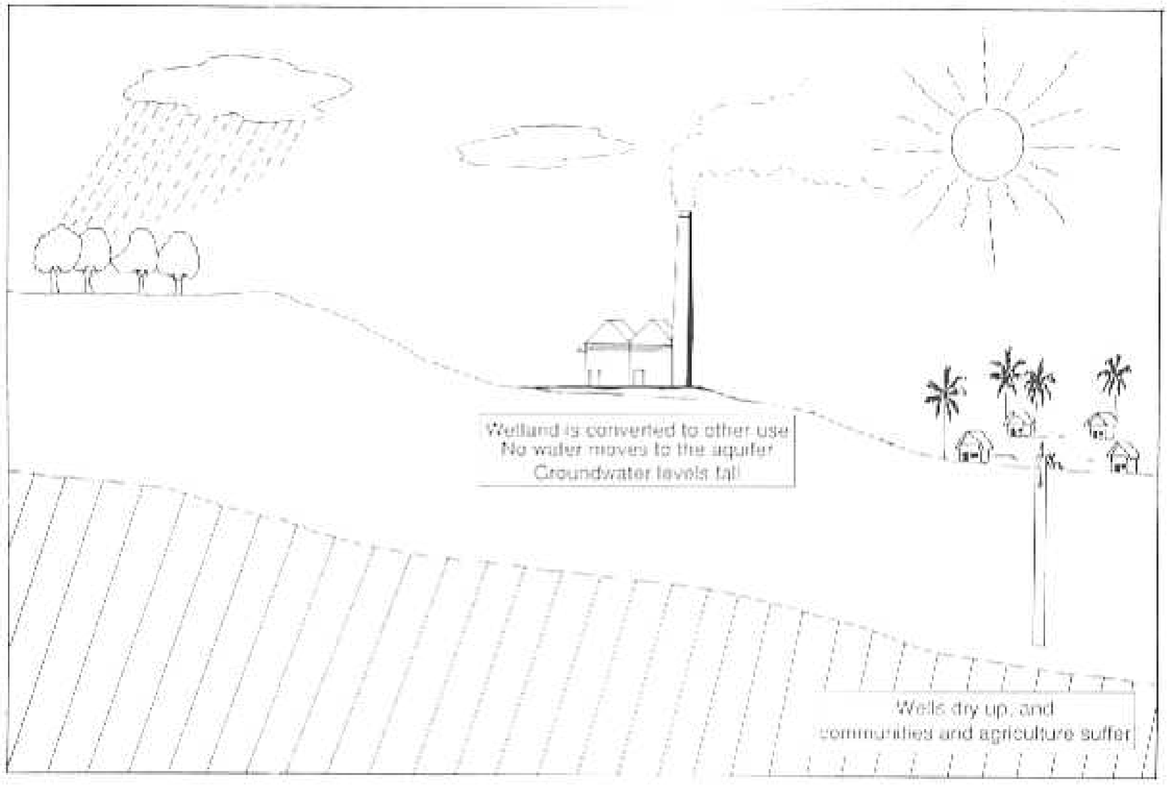


Figure 3b: Water Supply to an Aquifer (groundwater recharge)
WITHOUT WETLAND

* **Water supply to another wetland (lower in catchment)**

  This occurs where the supply of water to a second wetland is maintained by a wetland higher in the catchment.

  This is important where the water from the second wetland is used by communities, agriculture or industries, or when it maintains important ecological assemblages. It includes the case where water is pumped or otherwise artificially moved from one wetland to another.

FLOW REGULATION
(primarily flood control)

Wetlands can act as storage for excess amounts of water (which may occur during times of heavy rainfall or high flows in rivers). The water can come from rain, run-off, rivers, or from underground sources.

> The Pantanal, one of the largest wetlands in the world, slows the flow of water in the La Plata Basin of Bolivia, Paraguay, Brazil and Uruguay, thus avoiding catastrophic flooding downstream. The loss of this "sponge" function would produce significant damage to extensive agricultural areas in Argentina.
>
> Source: Bucher, E.H., Bonetto, A., Boyle, T., Canevari, P., Castro, G., Huszar, P. & Stone, T. (In Press) *An Initial Environmental Examination for the Hidrovia Waterway in the Paraguay-Parana River Basin.* Wetlands for the Americas, Manomet, MA and Buenos Aires, Argentina, 100pp.

Two processes occur which result in flow regulation and flood control:

* flood water can be stored, either in the soils (eg. peat can be up to ninety percent porous) or retained as surface water in lakes, marshes, etc. This reduces the volume of immediate downstream flood water. Some of this water may be discharged from the storage site over days, weeks or months, and some is removed from the flow regime through evapo-transpiration and percolation to groundwater.

> In the USA, drainage of the Charles River wetlands in Massachusetts was halted when a study revealed that the cost of flood damage would increase by a minimum of US$3 million per year if forty percent of the wetlands were drained
>
> Source: Maltby, E. (1986). ***Waterlogged Wealth. Why Waste the World's Wet Places?*** International Institute for Environment and Development, London.

* wetland vegetation slows down the flow of the flood water, so that not all of it arrives downstream at the same time.

The effect of both processes is that downstream flood heights are reduced and stream and river flows are maintained for a longer period each year than would be the case without the wetland.

Figure Four: Flow Regulation, primarily flood control

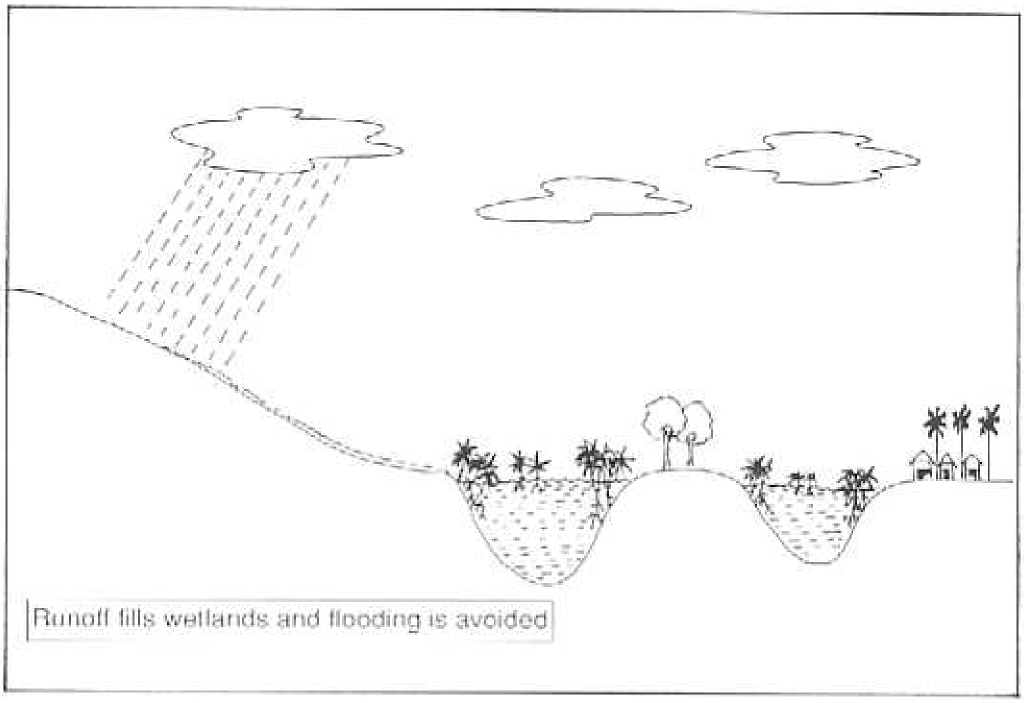


Figure 4a: Wetlands store floodwater

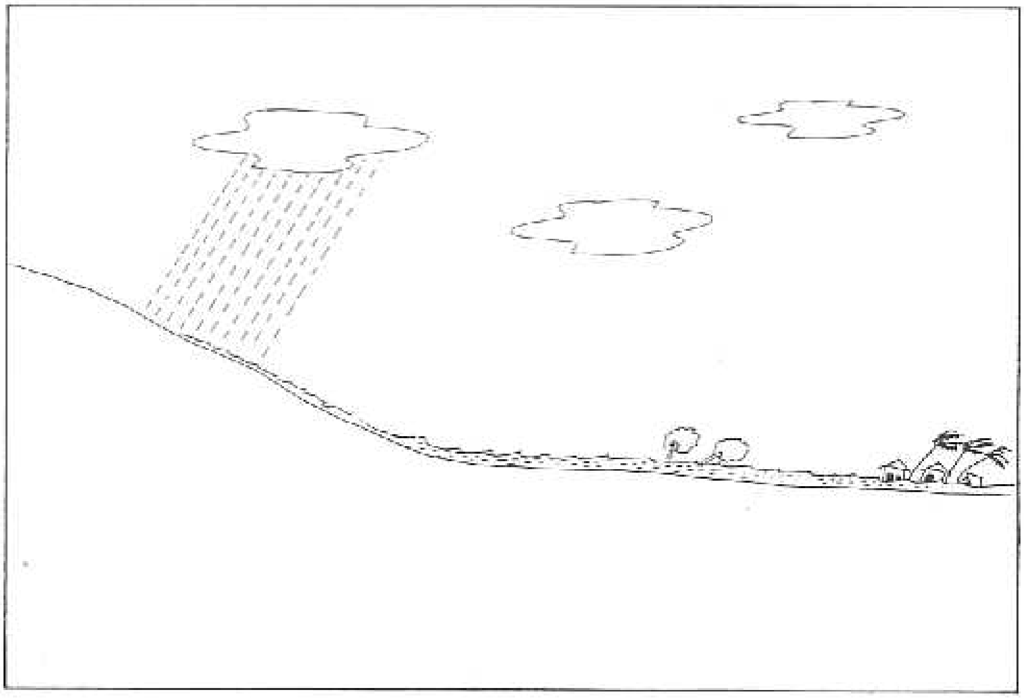


Figure 4b: Without wetland flooding occurs

Figure Five: Flow Regulation, primarliy flood control

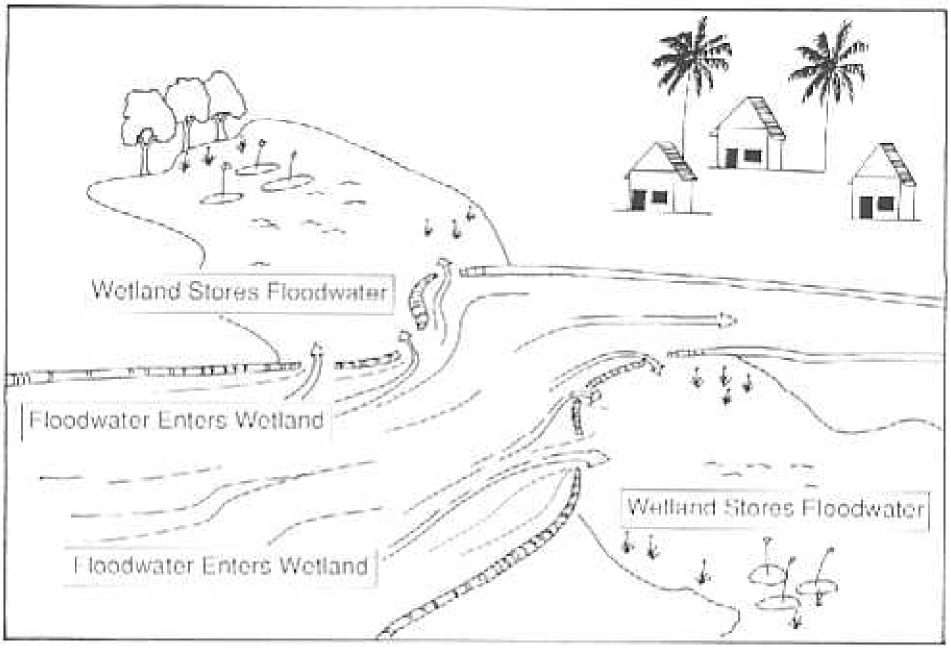


Figure 5a: Wetlands store floodwater

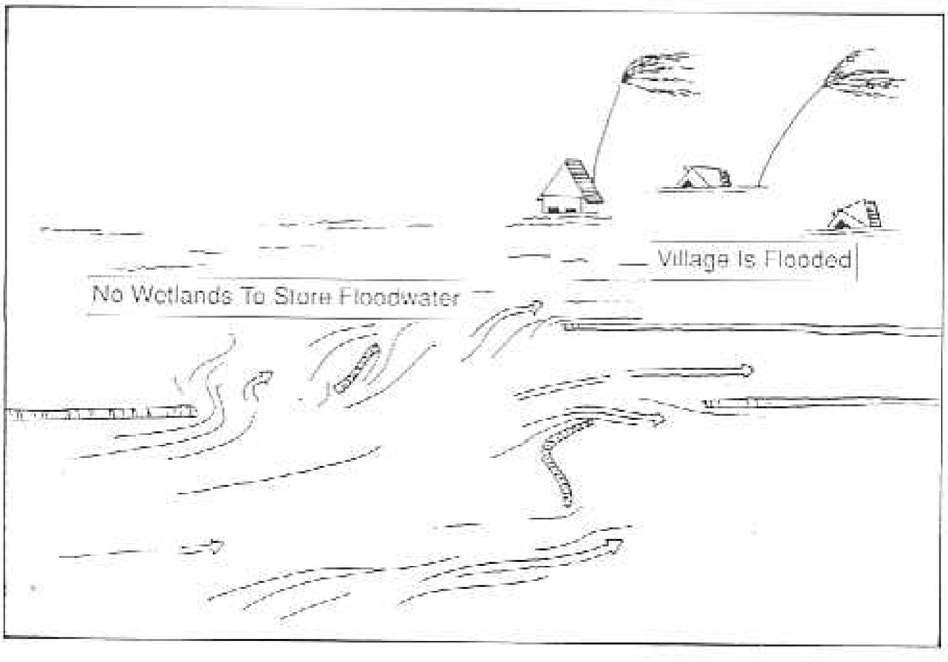


Figure 5b: Without wetlands, there is nowhere to store floodwater - villages are flooded

PREVENTION OF SALINE WATER INTRUSION

* **Ground water**

In low lying coastal areas where the underlying substrate is permeable, a wedge of freshwater frequently overlies deeper saline water. The existence of this freshwater wedge is frequently maintained by coastal freshwater wetlands.

Removal or reduction of the freshwater wedge allows the deeper saline water to move upwards towards the land surface, where it can affect water supplies to ecological communities and to people.

It is very important to retain the freshwater wedge in low-lying coastal areas, as it ensures a supply of drinking, washing and irrigation water to local communities and agriculture, and prevents salinisation of the soil.

Figure Six: Prevention of saline water intrusion - groundwater

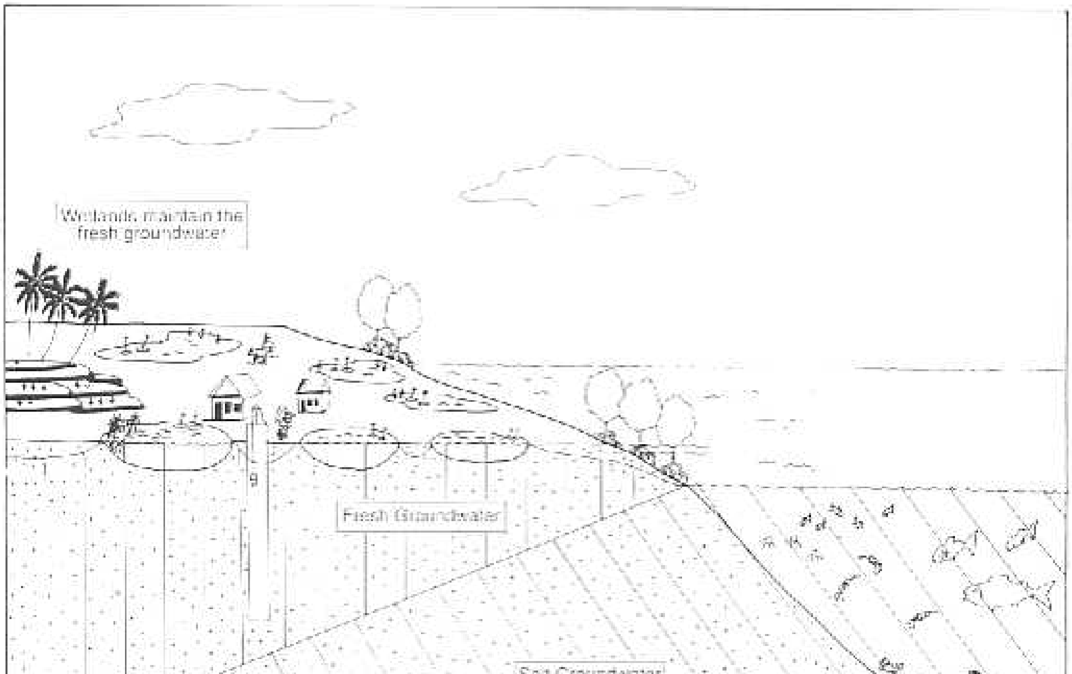


Figure 6a: Prevention of saline water intrusion with wetlands

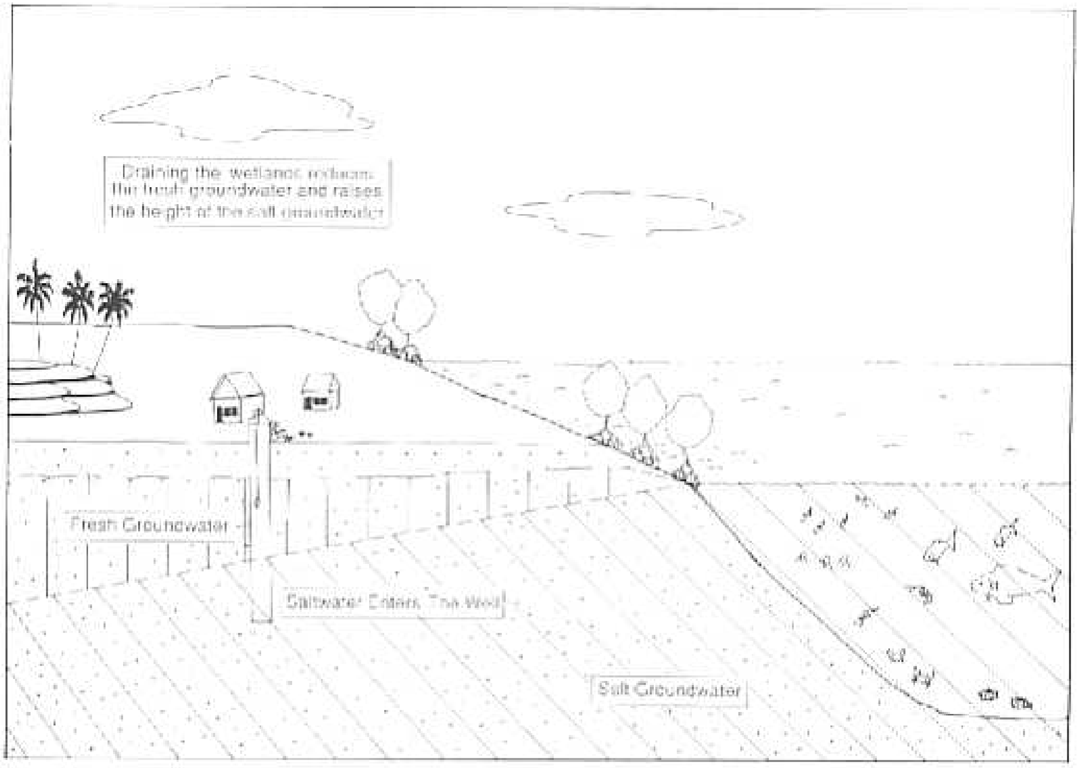


Figure 6b: If the wetlands are cleared, there is saline water intrusion

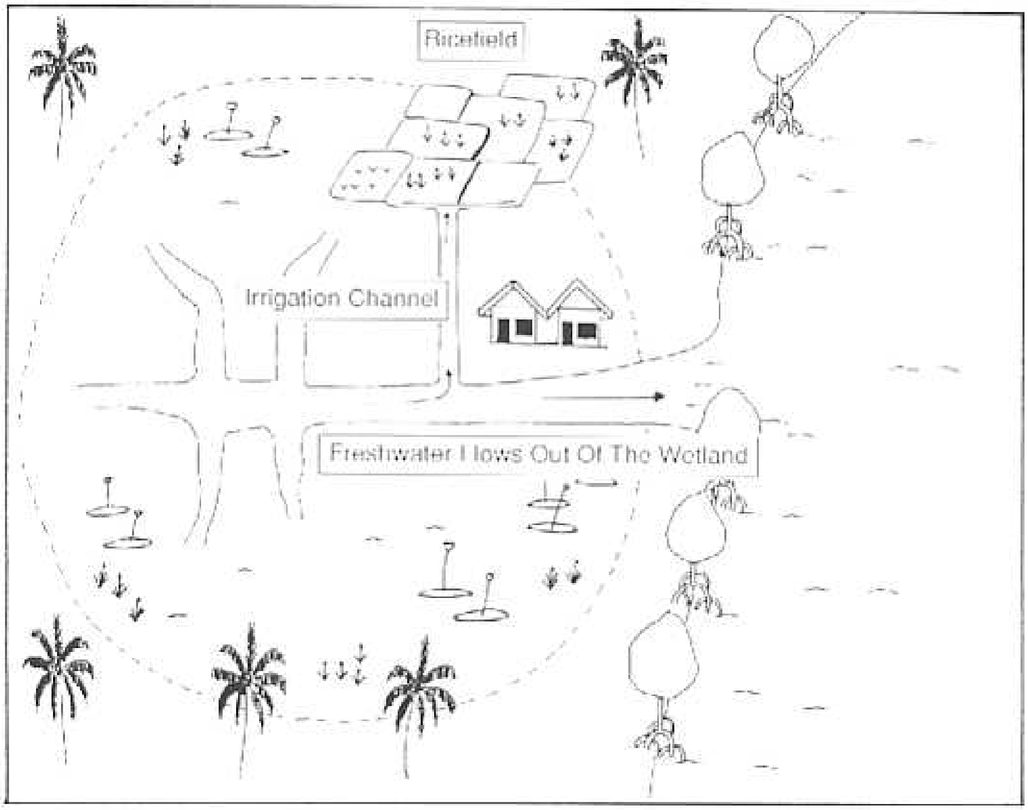
* **Surface water**

The outward flow of freshwater from a watercourse, such as a river or a stream, usually limits the entry of seawater into that watercourse. However, with reduced freshwater flow (due to over-extraction or drainage of surrounding wetlands), seawater is able to intrude further upstream so depriving people, agriculture, industry and ecological communities of the freshwater that they need.

> Local people in Samarinda (East Kalimantan) report that seawater formerly intruded upstream in the Mahakam River as far as the town only in the very few years with a dry season of ten or eleven months. However in 1991 saline water moved well upstream of Samarinda after only six months of the dry season. This had significant impacts on agriculture, industry and the health of the community. It is believed locally that this saltwater intrusion was caused by decreased outflow from the lakes and rivers of the Mahakam system as a result of extensive forestry clearfelling in the catchment.
>
> Source: Regional Development Planning Agency, East Kalimantan, pers. comm.

In some cases, the characteristics of river channels and coastal vegetation help to prevent the flow of tidal waters into a river. Straightening, deepening or clearing the vegetation of the channel may result in greater penetration of saline water into the river, especially at peak tides.

Figure Seven: Prevention of saline water intrusion - surface water



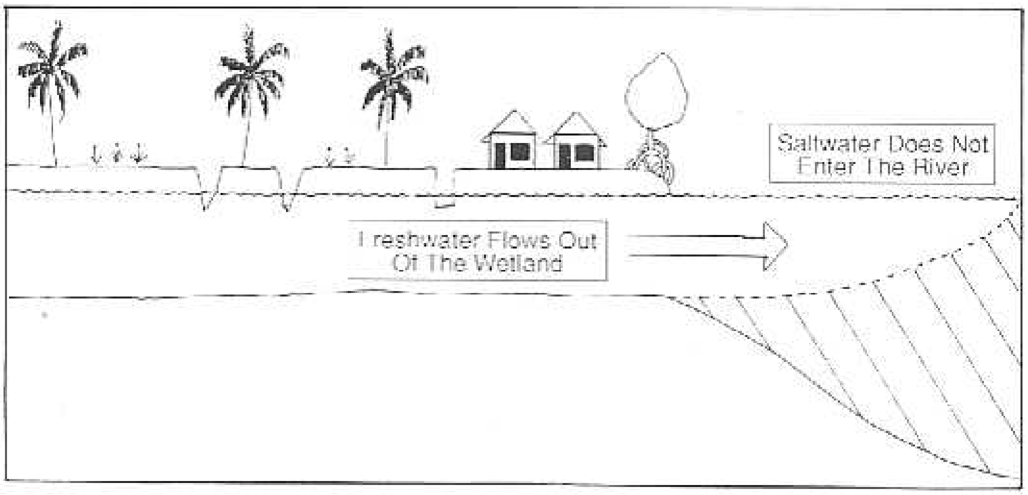


Figure 7a: With wetlands, saline water intrusion is prevented

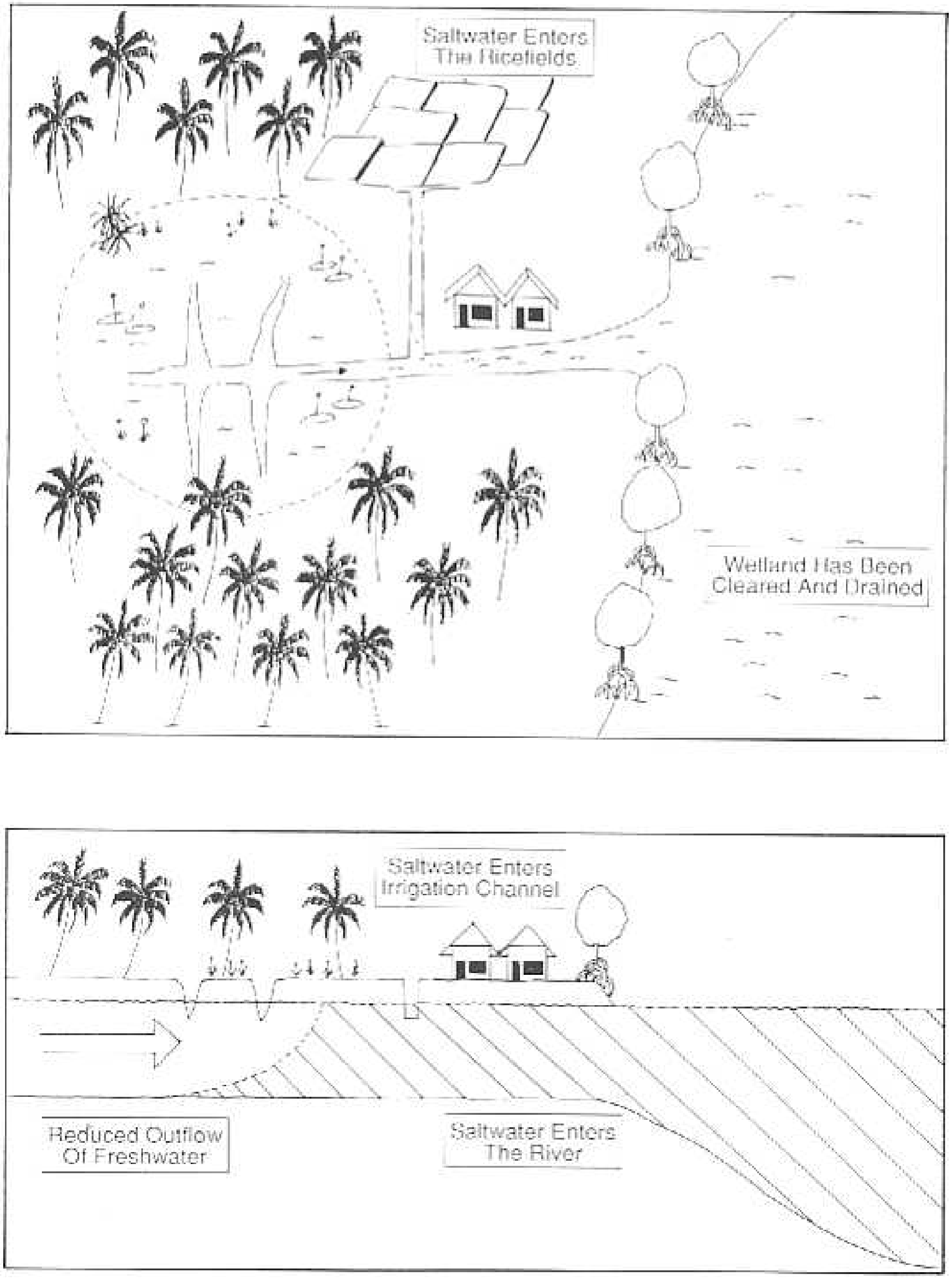


Figure 7b: If the wetands are drained, saline water intrusion occurs

PROTECTION FROM NATURAL FORCES

* Shoreline protection and erosion control

The physical characteristics of wetland vegetation prevent or reduce erosion of coastlines, estuaries and riverbanks.

The three main processes that occur are:

* the binding and stabilisation of substrate by plant roots and deposited vegetative matter;
* dissipation of wave and current energy; and
* trapping of sediments.

> Where the bankside vegetation has been destroyed along the rivers of eastern England, the cost of maintaining artificial reinforcement to prevent erosion averages US$425 per metre of bank.
>
> Source: Turner, K. (1989). ***Market and Intervention Failures in the Management of Wetlands: Case Study of the United Kingdom.*** Mimeographed report, OECD, Paris.

* Windbreak

Wetland vegetation can shield structures, crops or natural vegetation from damage by strong wind or salt-laden wind.

> Some 15 million people live in the extensive delta system that makes up most of Bangladesh, most of which has been cleared of its natural vegetation. In June 1985, over 40,000 people were drowned by storm surges. Recognising the importance of mangroves in damping down these storm surges, the government of Bangladesh has embarked on an ambitious mangrove reforestation scheme. As of 1985, 25,000 ha had been planted.
>
> Source: Maltby, E. (1986) *Waterlogged wealth. Why waste the world's wet places?* International Institute for Environment and Development, London.

Figure Eight: Protection from natural forces - shoreline protection and flood control

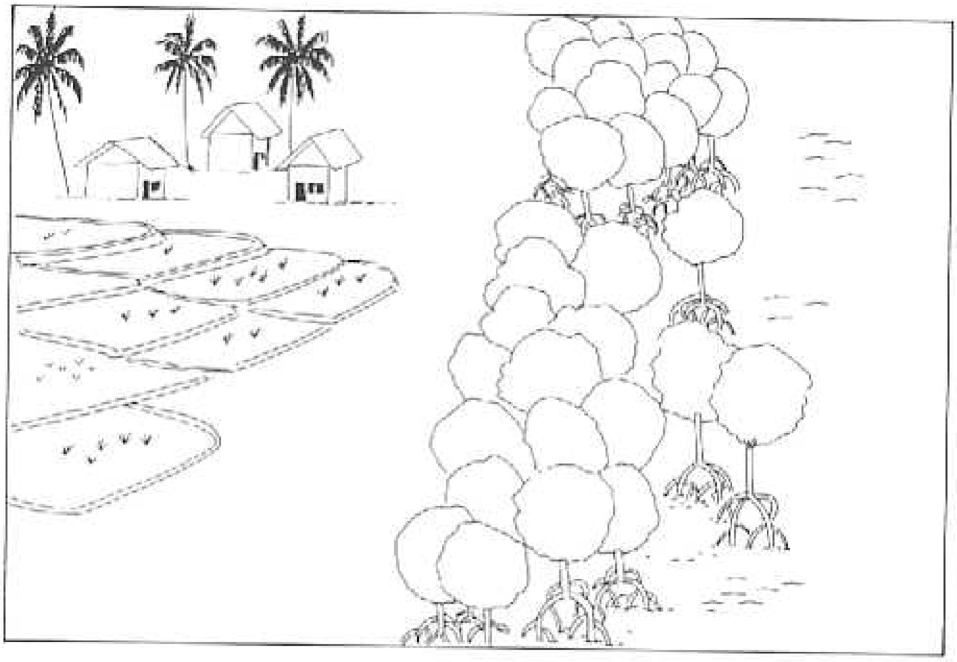


Figure 8a: With wetlands such as mangroves, the shoreline is protected

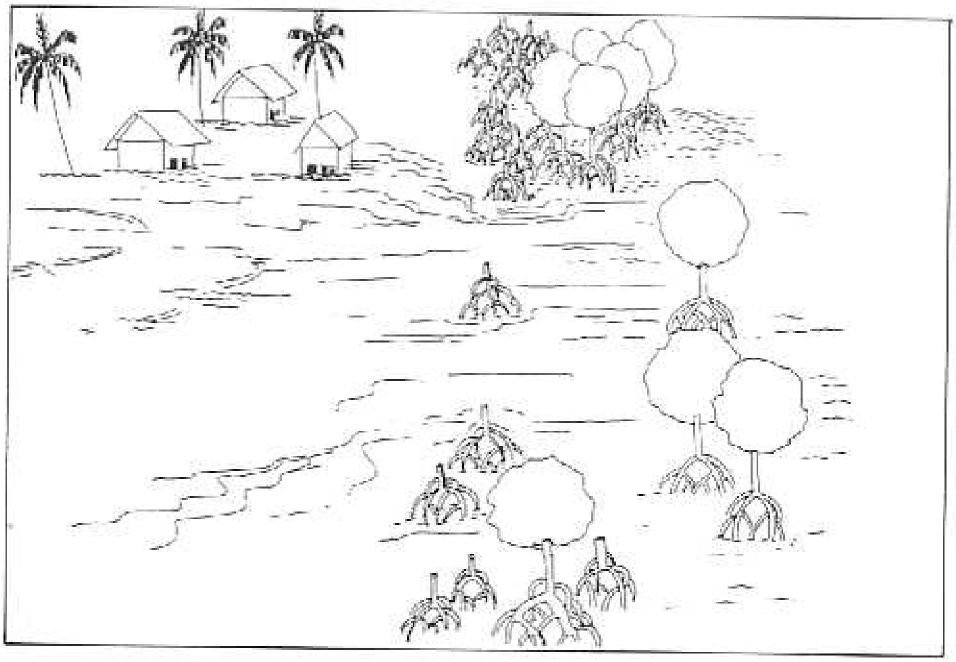


Figure 8b: If the mangroves are cut down, flooding and erosion of the coast can occur

Figure Nine: Protection from natural forces - windbreak

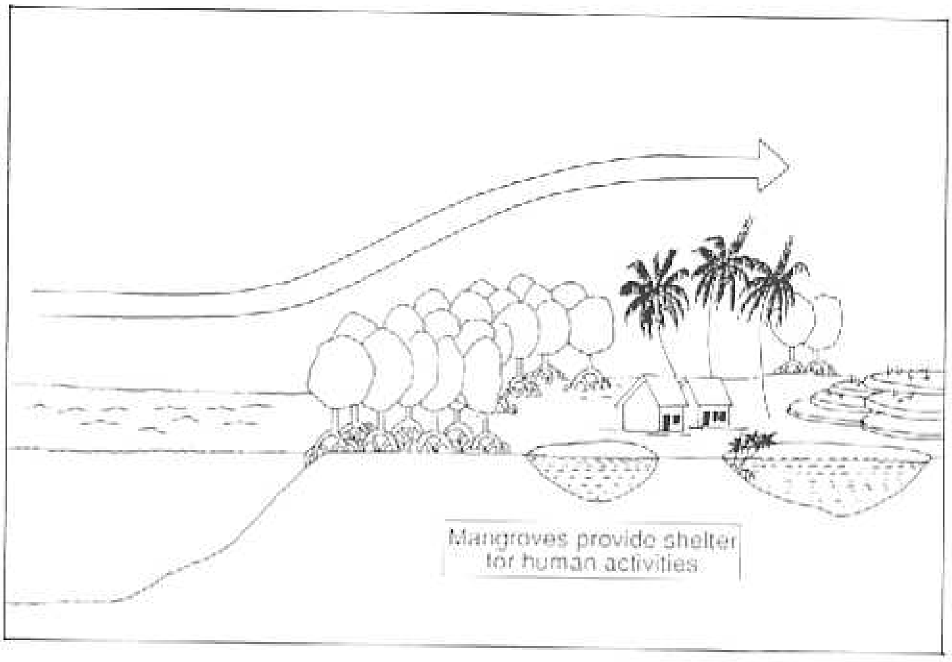


Figure 9a: Mangrove areas provide shelter from the wind

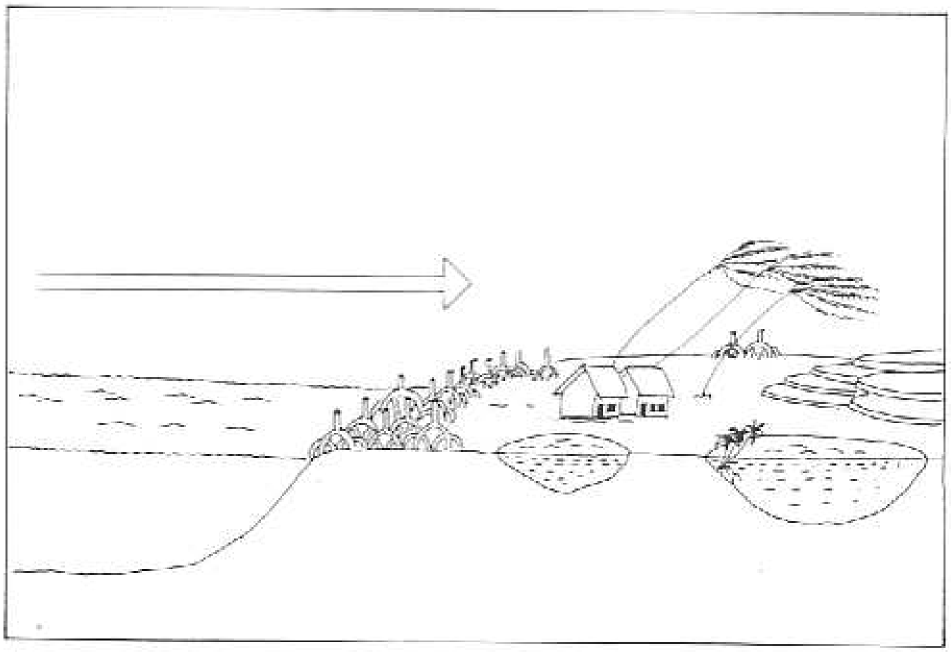


Figure 9b: Cutting of mangroves leads to exposure to storms

SEDIMENT RETENTION

The physical properties of some wetlands (eg. vegetation, size, water depth) tend to slow down the flow of water. This is especially true of swamps, marshes and floodplains. This facilitates the deposition, and therefore the removal, of sediment. This deposition is closely linked to the beneficial removal of toxicants and nutrients since these substances are often bound to sediment particles.

Since the drainage of the *Papyrus* swamps in the Hula Valley, which leads into Lake Kinneret, Israel, the loss of the filtering capacity of the swamp has resulted in a delta of sediment in the lake and increased turbidity of the lake which has in turn decreased the water quality.

Source: Dugan, P (Ed.)(1990) ***Wetland Conservation; A Review of Current Issues and Required Action.*** IUCN

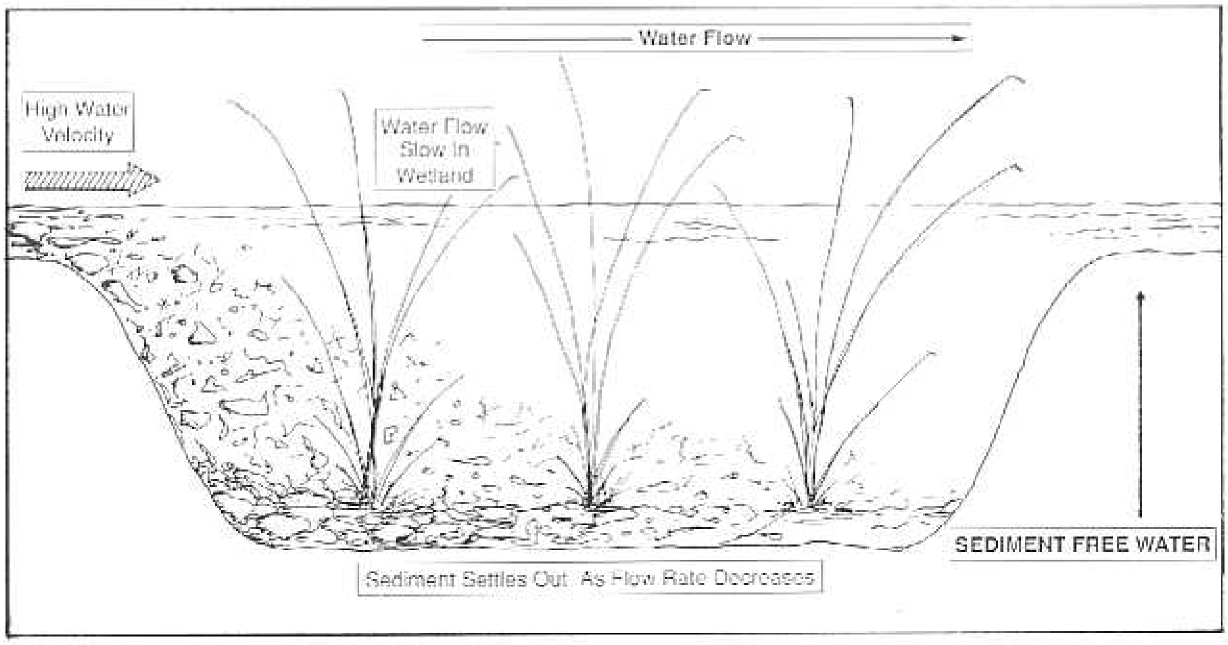


Figure Ten: Sediment removal/retention

If there is drastically increased sedimentation due to increased soil erosion in the catchment of the wetland, the excess deposition may have adverse effects on the receiving wetland. Their capacity to further absorb sediments will be considerably reduced in additon to causing water quality problems in lakes and reservoirs. An important point to bear in mind is that wetlands do not have an inexhaustible capacity to absorb potentially harmful substances such as sediments, nutrients and harmful substances such as toxicants. Rather than relying on wetlands alone to buffer excess sediments, nutrients and toxicants, it is far better to ensure
that land practices within the catchment keep the input of such substances into wetlands to a minimum.

Sediment removal by wetlands may:

* benefit communities and developments downstream by maintaining water quality, by preventing shallowing of waterways which would lead to flooding and loss of water transport function; and

* benefit agriculture in those wetlands by renewing nutrients and soil.

Soil erosion and the subsequent deposition of the eroded soil in waterways and water bodies is one of the most serious environmental problems facing the developing world today. Not only does the loss of valuable top soil result in reduced yields or even complete loss of land for agriculture, but the siltation of water bodies causes many adverse effects as well. The economic losses as a consequence of increased erosion can be crippling.

Soil erosion is a natural process but has been drastically accelerated by man's activities. Clear felling of steep slopes is particularly harmful - studies have shown that the sheet erosion from a logged area on slopes is 240 times greater than that from undisturbed forest (Hodgson & Dickson 1988). Similarly, the amount of soil eroded from an agricultural plot on Mount Makiling in the Philippines was estimated to be a staggering 200 tonnes per hectare per year, whilst the erosion from forests was only in the region of 2-8 tonnes per hectare per year (Ramirez 1988).

Sources: Hodgson, G. & Dickson, J.A. (1988) ***Logging versus fisheries and tourism in Palawan.*** Occasional Papers of the East-West Environmental and Policy Institute. Paper No.7.

Ramirez, D.M. (1988) *Soil conservation strategies: some cases in Philippine upland farms.* Paper presented at the technical workshop on Philippine biological diversity, UP Campus, Diliman, Quezon City, Philippines. March 1-2 1988

NUTRIENT RETENTION

The physical properties of some wetlands tend to slow down the flow of water facilitating the deposition of sediments. Nutrients are often associated with sediments and can therefore be deposited at the same time. Nutrients may be from a wide variety of sources, but are commonly run-off of fertilizer from agricultural areas, human wastes and industrial discharges.

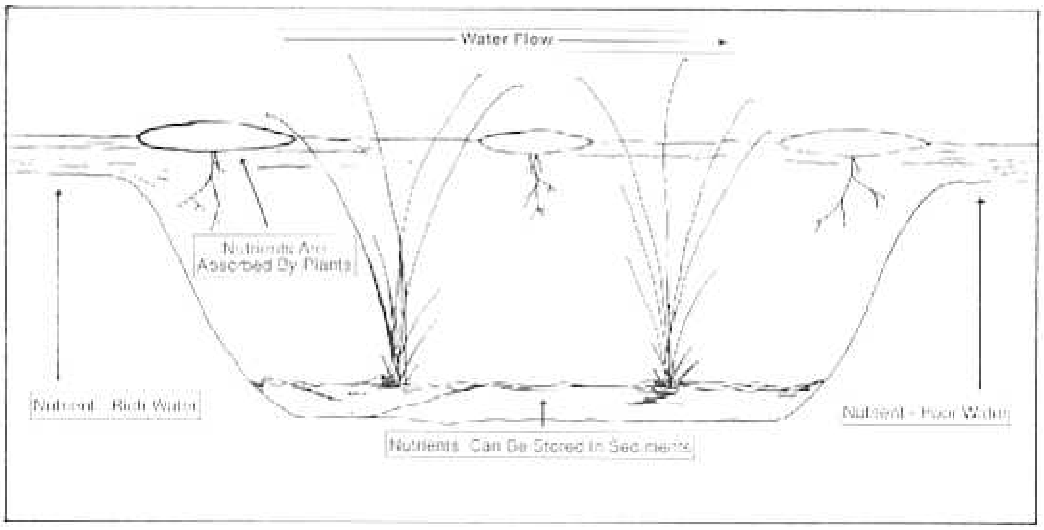


Figure Eleven: Nutrient removal/retention

When the sediment is deposited, the nutrients may be stored with it, taken up by wetland vegetation or transformed by chemical and biological processes. Uptake by wetland vegetation does not ensure the nutrient's removal from the water since the nutrients can be released again through decay of the plant. However, harvesting biomass from the wetland such as grasses and sedges for thatch and fishes for food means that nutrients are taken out of the system in a useable form. Inorganic phosphorus and nitrogen are the most significant nutrients which are removed, stored or transformed by chemical processes in wetlands. Nitrates can

> Due to the efficiency of swamps and marshes in removing nutrients from water passing through them, many natural wetlands are used to treat waste water. In the Florida, USA, cypress swamps it was found that 98 percent of all nitrogen and 97 percent of all phosphorous was removed from waste water passed through them before this water entered the groundwater
>
> So efficient is this process that wetlands are artificially created in many parts of the world to purify water. These natural systems have been found to be cheaper to set up, operate and maintain than conventional artificial systems.
>
> Source: Maltby, E. (1986). *Waterlogged Wealth. Why Waste the World's Wet Places?*. International Institute for Environment and Development, London.

be removed by the process of denitrification in which bacteria found in oxygen-poor wetland soils convert nitrates and nitrites into molecular nitrogen which diffuses into the atmosphere. Phosphates can be bound to inorganic ions in mineral soils of wetlands. If these soils become saturated with phosphates, however, they may actually export phosphorus. Moreover, under reducing conditions (where there is a lack of oxygen), nutrients such as phosphates may actually be released into the overlying water and be exported out of the wetland.
Many wetlands are more efficient at transforming and removing nutrients than terrestrial habitats.

The process of nutrient removal may benefit communities and developments downstream by maintaining water quality. Excess nutrients in lakes may lead to eutrophication. In this process, excess nutrients stimulate so much plant growth (macroscopic and microscopic) that it becomes a nuisance. For example, there could be blocking of waterways and covering of lakes by floating plants such as the water hyacinth (*Eichhornia crassipes*). Excessive growth of microscopic algae (phytoplankton) in lakes and reservoirs will cause a decrease in water quality, lowering dissolved oxygen levels such that fish kills result. Other effects may include excessive growth of blue-green algae which may produce toxins and an increase in the filtration costs of water treatment for domestic supplies.

The city of Calcutta, India, has no sewage treatment plant. All of the domestic effluent from the city is fed into a complex of modified wetlands to the east of the city. The effluent is used to culture fishes with a yield of 2.4 tonnes per hectare per year and to irrigate rice, with an annual production of around 2 metric tonnes per hectare. Moreover, vegetables are grown on the solid garbage dumped in the same area which are also irrigated by the effluent. Large amounts of nutrients are removed in the form of food from this effluent.
The wetlands of east Calcutta remain an example to the world on how to treat large amounts of domestic effluent at low cost while at the same time gaining food from them.
Sadly, the wetlands are now threatened by the expansion of Calcutta which has very serious implications for the future treatment of effluent from the city.

Source. Ghosh, D. & Sen, S. (1987) *Ecological history of Calcutta's wetland conversion*. EnvironmentalConservation 14 (3) 219-226

TOXICANT REMOVAL

Many toxicants entering aquatic ecosystems are bound to the surface of fine sediments or within the molecular lattice of clay particles. The slower flow rates in many wetlands facilitate dropping of sediment loads, and the storage and transformation of sediment-bound toxicants. In some cases, certain plant species actively take up toxicants; e.g. water hyacinth (*Eichhornia crassipes*).

This process may benefit communities and development downstream by maintaining or even enhancing water quality. Since many toxicants enter aquatic systems bound to sediments, the process of removal is similar to that of sediment trapping.

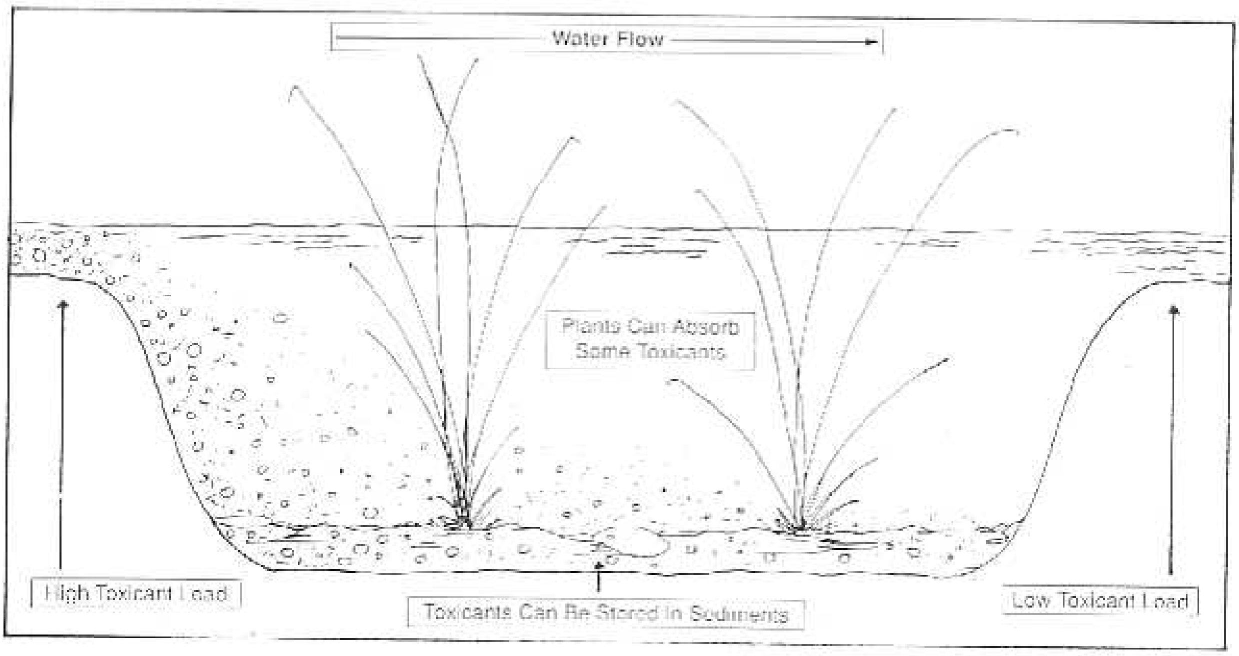


Figure Twelve: Toxicant removal/retention

Toxic substances may come from a variety of sources, but are commonly from run-off of pesticides from agricultural areas, industrial discharges and mining activities.

It must be emphasised again that wetlands do not have a boundless capacity for absorbing toxicants. Indeed, they may "leak" toxicants in cases where the substance is taken up by plants instead of being adsorbed onto sediments. In this case, there is the likelihood that the harmful substance may re-enter the food chain if a herbivore eats the contaminated plants. Ensuring that toxic substances enter the environment in the least possible concentrations in the first place is the best course of action.

Many aquatic plants found in wetlands, including emergent, floating and submerged types, can concentrate heavy metals in their tissues up to 100,000 times the concentration in the surrounding water. Many of them also contain substances which bind heavy metals and thus are involved in metal detoxification. *Eichhornia crassipes*, *Typha* and *Phragmites* have all been successfully used to treat effluents; e.g. from mining areas, which contain high concentrations of heavy metals such as cadmium, mercury, nickel, copper, zinc and vanadium.

Source: Lakshman, G. (1987) *Ecotechnological opportunities for aquatic plants - a survey of utilization options*. IN: Reddy, K.R. & Smith, W.H. (Eds.) *Aquatic plants for water treatment and resource recovery*. Magnolia Publishing Inc., Florida, USA.

SOURCE OF NATURAL PRODUCTS (ON-SITE)

This is a broad category encompassing all animal, plant and mineral products which may be harvested directly from wetland areas. It is distinct from SOURCE OF NATURAL PRODUCTS (OFF SITE) because in order to obtain on-site wetland benefits people have to go to the wetland.

Examples of on-site products commonly taken from wetland areas include peat, timber, fruit, meat (e.g. fish, deer, birds), cane, reeds for thatch and matting, resins and medicinal products.

In addition to supplying products which provide the main source of livelihood for local populations, wetlands frequently also supply natural products which constitute an income supplement during times when other sources of income are not available. Such products can make the difference between survival or failure for rural populations.

In the lower Mekong Basin 236,000 million tons, out of a total fisheries catch of 500,000 million tons, is derived from the wetlands associated with the river. In 1981, the wetlands contributed US$90 million to the economy as well as supplying 50-70 percent of the protein needs of the Mekong delta's 20 million people.

Source: Pantulu, V.V. (1981). ***Effects of Water Resource Development on Wetlands in the Mekong Basin.*** Environment Unit, Mekong Secretariat, Bangkok.

Transmigrants and other settlers in the wetlands of the East Sumatran Lowlands sometimes supplement their income by cutting the trunks of the nibung palm (*Oncosperma tigillarium*) which are used in constructions where resistance to water is required. In South Sumatra alone this had an estimated value of Rp400 million (US$200,000) in 1988.

Source: Danielsen, F. & W. Verheugt (1990). ***Integrating Conservation and Land-use Planning in the Coastal Region of South Sumatra.*** PHPA/AWB Indonesia, Bogor.

Natural wetlands are among the most productive ecosystems, with some surpassing even the most intensive agricultural systems. Thus, the benefits which can be gained from harvesting wetland products are often significantly higher, per unit land area, than are available from many other habitats, including those resulting from the draining of wetland areas.

In a literature review cited by Birkeland (1985), seagrass beds and coral reefs ranked higher in gross primary productivity per square metre per year than other ecosystems, including sugar cane fields in Java, and the nutrient-enriched waters of the Peru current.

Source: Birkeland, C. (1985). Ecological interactions between mangroves, seagrass beds and coral reefs. In: SPC/SPEC/ESCAP/UNEP ***Ecological Interactions Between Tropical Coastal Ecosystems.*** UNEP Regional Seas Reports and Studies No.73. UNEP, Nairobi.

SOURCE OF NATURAL PRODUCTS (OFF-SITE)

This category specifically covers those products which are produced by the wetland and then either migrate or are transported by natural processes to another site.

They may be used directly by people at this second site, act as a food source for other organisms or perform some other function eg. coastal accretion in the case of transported sand and sediment.

There is a great variety of products in this category, including organic and inorganic material and dissolved nutrients transported downstream (which then support local fisheries), migratory fish, shrimp, marine mammals and birds.

The products may be important on a local, regional, national or international scale.

Genera of commercial importance in Southeast Asia which depend on seagrass beds at some stage in their life history include: *Penaeus*, *Lutjanus*, *Lethrinus* and *Siganus*. These populations are not necessarily harvested in the seagrass habitat. Often they are caught after moving to other areas, so that this represents an export of natural products from the seagrass wetland.

The economic value of the fishery associated with a seagrass ecosystem in Tarut Bay, Saudi Arabia, has been estimated at US$8 million.

Source: Chou, L.M. (1991). ***Marine Environmental Issues in Southeast Asia: State and Development***. Paper presented at the Regional Seminar on Ecology and Conservation of Southeast Asian Marine and Freshwater Environments Including Wetlands, 4-6 November, 1991. Kuala Lumpur.

The fishing industry in and around the Matang Mangrove Forest Reserve in Perak State on the west coast of the Malay Peninsula provides direct employment for 2,500 people and indirect employment for a further 7,500. In 1979 the value of the shrimp and cockle industries in the area was estimated to be at least US$30 million.

Source: Ong, J.E. (1982). Mangroves and aquaculture. ***Ambio*** 11(5):252-257.

Because of the very high productivity of some wetland types the loss of wetlands in one location can have very significant economic impacts in another area.

It has been shown in Sumatra that the average coastal fishpond produces 287 kg/ha/year of fish, but the loss of one hectare of mangrove leads to a loss of approximately 480 kg/yr of offshore shrimp and fish.

Source: MacKinnon, J. and MacKinnon K. (1986). ***Review of the Protected Areas System in the Indo-Malayan Realm***. IUCN, Gland.

ENERGY PRODUCTION
(hydro-electric power, firewood, peat)

Wetlands can provide energy by various means, the most common being hydroelectricity, firewood and peat. In East Africa, papyrus is cut, dried and pressed into brickettes. Some estuaries have the potential to generate tidal power.
Exploitation of wetlands for energy production, though, has had some very adverse impacts on some wetlands.

> Peat, called *champa* in the Quechua language of Peru, is abundantly found in the Puna wetlands of Andean South America. It is regularly used as a houehold fuel, especially for cooking.
> Source: Pulgar-Vidal, J. (1946) ***Historia y Geografía del Peru.*** Tomo 1: ***Las Ocho Regiones Naturales del Peru.*** Universidad Nacional Mayor de San Marcos, Lima, Peru. 256pp.

For example, peat, just like coal, is a non-renewable resource and peat mining has the capacity to destroy peat wetlands and their many values. Similarly, some consequences of damming river valleys to create dams for hydroelectric power have been negative. In some cases, the economic losses incurred exceeded the forecast benefits from the development. These losses include prevention of upstream fish migration to spawning areas, loss of seasonal flooding of floodplains downstream (leading to prevention of replenishment of nutrients and sediments downstream and prevention of lateral fish migrations in the floodplain), increased coastal erosion and changes in the salinity regime in downstream coastal areas.

> In Rwanda, peat mining for peat-fired power stations is causing destruction of highland peatlands and has caused associated problems such as increased run-off from the highlands.
> Source: Denny, P. pers. comm.

Ideally, fuel should be produced from wetlands on a sustainable basis. At the same time it must be ensured that the other functions and values of the wetland remain intact.

> Benefits in the form of flood control, irrigation and hydropower have been realised from the Aswan High Dam in Africa. However, many of the adverse effects were unforeseen. Some of these most serious effects are just being felt, 30 years after the closure of the dam. The loss of sediment deposited in the coastal areas of the Nile delta in Egypt has meant that billions of dollars now have to be spent to artificially protect the coast from erosion.

WATER TRANSPORT

In many wetland areas, water transport is the most efficient, as well as the most environmentally sound method of travelling. In other areas, water transport is often easier than other methods. In some cases, it is the only practical means of transport.

> Canals within the mangrove system of the Pacific coast of Nicaragua are the only means of communications between settlements. Transport is cheap and convenient and thus of great importance for the local communities.
>
> Source: Dugan, P.(Ed.) (1990) *Wetland conservation: a Review of Current Issues and Required Action*. IUCN.

Water transport is important not only for passengers, but also for supply of goods to local markets and for moving bulk cargo, agricultural and wetland products over longer distances.

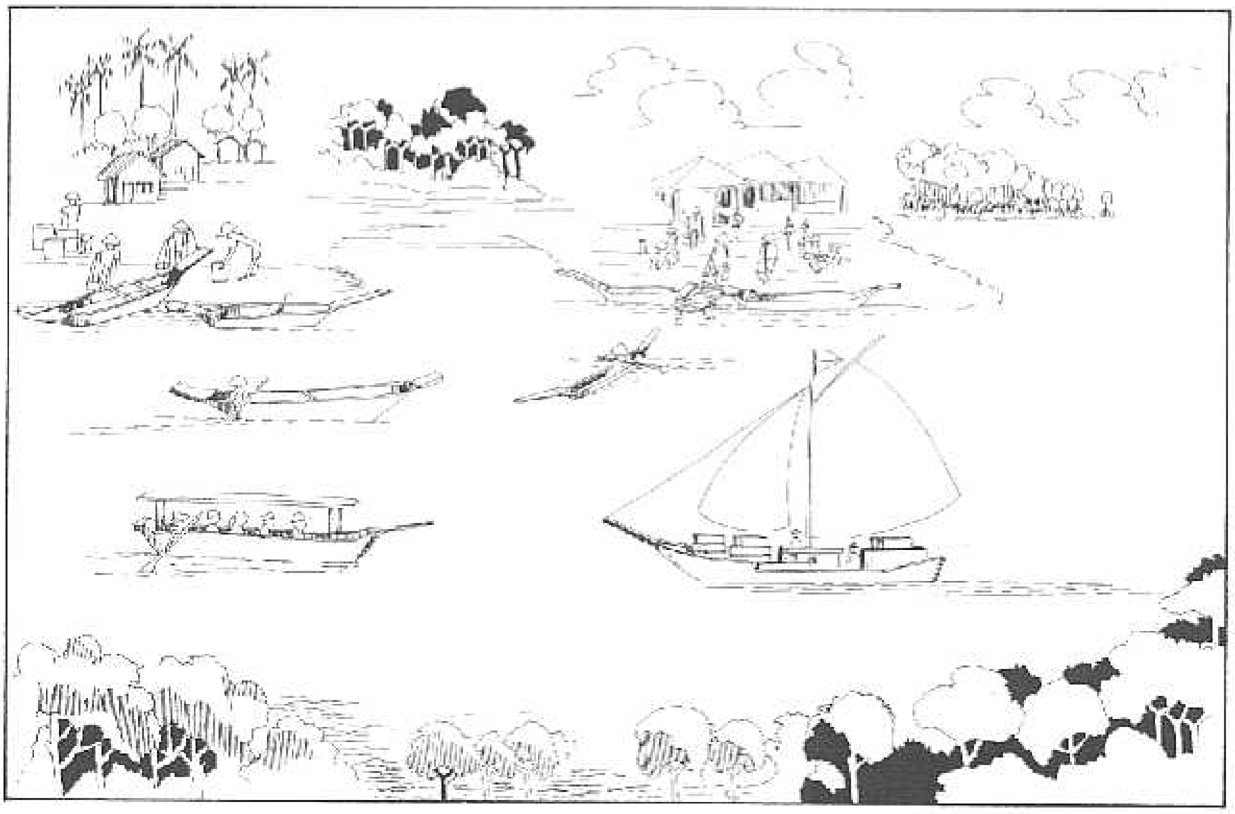


Figure Thirteen: Water transport

GENE BANK

* **Commercial exploitation**

The use of genes from wild species to improve commercial species is well established. Many wetland areas contain wild species which have the potential to contribute genetic material for the improvement of commercial species.

In Nepal, some of the remaining swamps hold three species of wild rice from which commercial varieties were bred. These swamps are now under threat of conversion, thus access to the original genetic material would be lost.

Source: G.L. Shrestha; pers. comm.

Genes from wild species have characteristics which can assist in improving factors such as taste and growth rates and in reducing susceptibility to disease.

* **Maintenance of wildlife populations**

The maintenance of wildlife populations requires an adequate pool of genetic material. In cases where populations have fallen to very low levels (eg. fewer than 500 individuals), it is important to try to maintain genetic variation.

Occasionally, genetic variation can be maintained with ex-situ resources, but in most cases, the best option is to conserve adequate areas of habitat with in-situ wild populations. This is clearly the only option available in areas where the species composition is as yet unknown.

Some wetlands have concentrations of inordinate amounts of the genetic composition of whole species. Migratory shorebirds in particular show large concentrations at a few wetlands along their migratory routes. The coasts of Tierra del Fuego in Argentina and Chile, for example, harbour 70% of all Red Knots (*Calidris canutus*), 46% of all White-rumped Sandpipers (*Calidris fuscicollis*) and 69% of all Hudsonian Godwits (*Limosa haemastica*) in the western hemisphere.

Sources: Morrison, R.I.G. & Ross, R.K. (1989) ***Atlas of Nearctic shorebirds on the coast of South America.*** Canadian Wildlife Service Special Publication. Two Volumes, 325pp. Canadian Wildlife Service, Headquarters, Ottawa.

Anon. (1992) ***Site Profiles, Western Hemisphere Shorebird Reserve Network.*** Wetlands for the Americas, Manomet, MA. USA and Buenos Aires, Argentina. 75pp.

SIGNIFICANCE FOR CONSERVATION

* Significant habitat for the life cycle of important plants and animal species

This category includes habitats that directly support the life cycles of important plant and animal species.

> Although wetlands occupy less than 5% of the land area of the continental United States, 43 % of all federally listed threatened and endangered species utilize wetlands at some point in their life cycle. This demonstrates their importance in harbouring endemics and species of limited distribution.
>
> Source: Feierabend, J.S. (1992) *Endangered Species, Endangered Wetlands: Life on the Edge.* National Wildlife Federation, Washington D.C.,USA. 49pp.

For some species, especially plants, a particular wetland or wetland type provides every element required to complete their life cycles. Other species may depend on wetland areas for a part of a more complex life cycle, including many aquatic animals such as fish and prawns which depend on wetland areas for spawning and juvenile development.

There are many species of migratory birds which depend on wetlands for part of their life cycle (eg. for resting or feeding while on migration), and in these cases the value of the wetlands on which they depend needs to be assessed on an international scale.

* Presence of rare species, habitats, communities, ecosystems, landscapes, processes or wetland types

This category covers seven important classes of environmental features: species, habitats, communities, ecosystems, landscapes, processes and wetland types. Rarity is often valued by people and governments. Once one of these features become rare, the chance of it being "lost" forever becomes greater.

Zapata Swamp in Cuba is the largest wetland in the Caribbean at 340,000 ha., comprising brackish and saline lagoons and marshes, magroves, intertidal mud-flats and sawgrass swamps. The swamp supports a wide variety of wildlife, but it is especially important for the high number of endangered and endemic species that occur there. It is the only known locality for the Zapata rail (*Cyanolimnas cerverai*), the Zapata wren (*Ferminia cerverai*) and the nominate race of the Zapata sparrow (*Torreonis inexpectata*). It is the most important breeding area for the endangered Cuban race of the sandhill crane (*Grus canadensis nesiotes*). The West Indian manatee still occurs in very small numbers, but the very rare dwarf hutia (*Capromys nanus*), a small rodent known only from the swamp, is now thought to be extinct. Reptiles include an endemic subspecies of the lizard *Anolis luteogularis* and a small population of the endangered Cuban crocodile. Some 300,000 ha. of the swamp are protected in the Zapata National Park, an important centre for outdoor recreation and nature tourism.

Source: Scott, D.A. (1991) *Latin America and the Caribbean*. IN: Finlayson,M. & Moser, M (Eds.) *Wetlands*. IWRB.

Figure Fourteen: Significance for conservation - habitat for the life-cycles of important animal and plant species

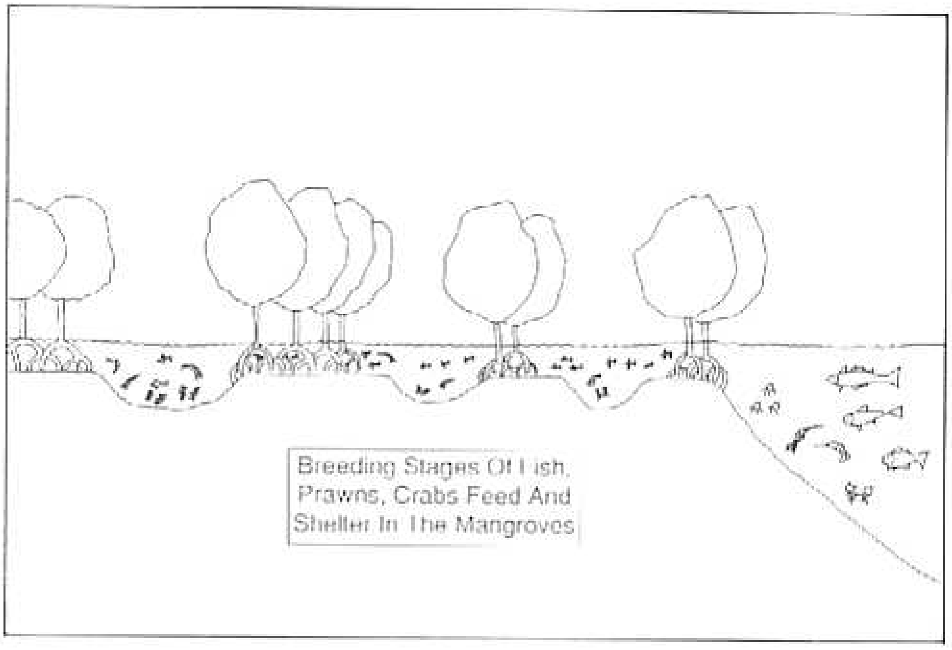


Figure 14a: High tide

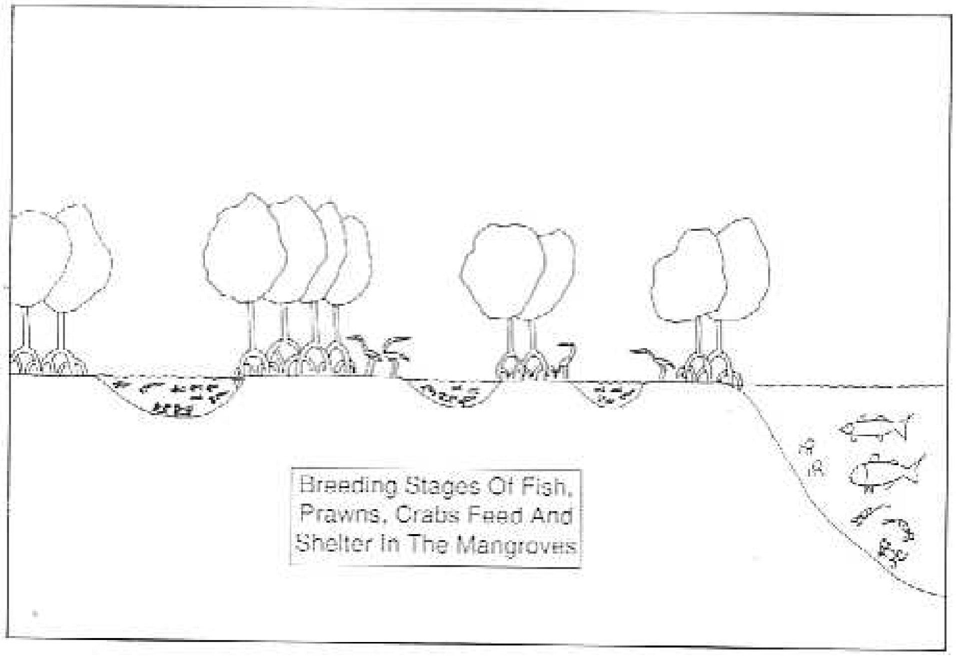


Figure 14b: Low tide

RECREATION AND TOURISM

This category includes areas that are being used for recreation and tourism, or which have the potential to be used for these purposes. The indicators of areas that can provide this benefit include:

* contain species, habitats, communities, ecosystems, landscapes, natural processes, or wetland types which are endangered, rare or threatened;
* extensive in area and largely undisturbed;
* contain a high diversity of habitats; and
* significant altitude changes across the site.

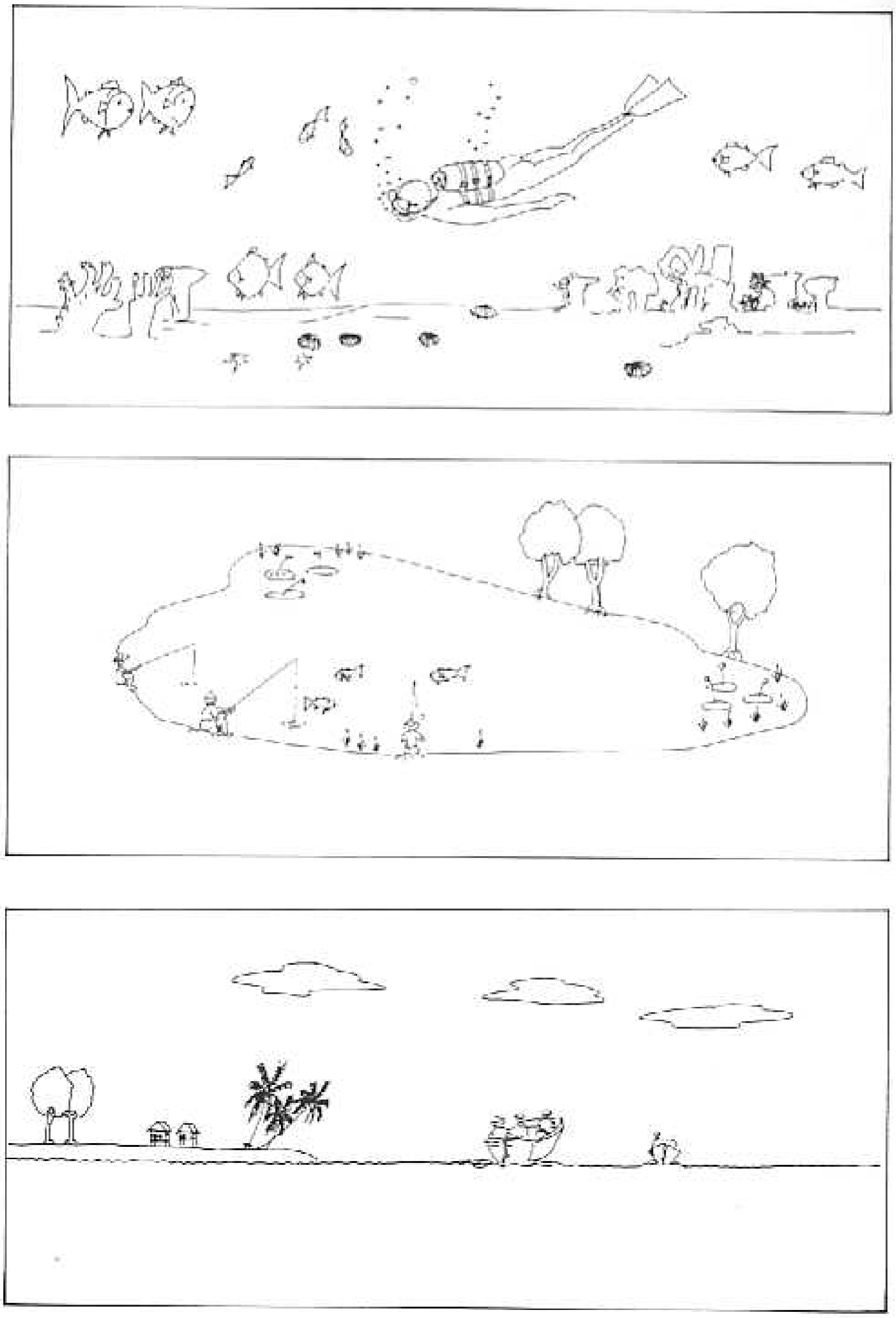
> Tourism of all sorts earned developing countries US$55 billion in 1988[2]. The following figures for wetland reserves are indicative of the considerable potential of wetlands for generating income from tourism and recreation:
>
> * tourists in the Morrocoy National Park in Venezuela spent an estimated US$7 million per year in the mid-1980s;
> * the cash income from tourism in the Caironi Swamp in Trinidad is of the order of US$2 million per year;
> * Kenya's Ambroseli National Park, which has significant wetland attractions, had an estimated annual income of US$1.3 million in 1979[1];
> * Caribbean marine wetlands earn close to US$1 billion a year just from scuba diving tourism[2].
>
> Source: [1]various authors cited in Dugan, P.J. (ed). (1990). *Wetland Conservation: A Review of Current Issues and Required Action*. IUCN, Gland.
> [2]Lindberg, K. (1991). *Policies for Maximising Nature Tourism's Ecological and Economic Benefits*. World Resources Institute, Washington D.C.

Sites more suitable for recreation and tourism are those where adequate infrastructure is present or where there is the potential for developing adequate infrastructure. However, care must be taken to ensure that any infrastructural development does not reduce the values of the area for tourism. Ease of access, close views of wildlife and spectacular scenery are other factors important for tourism.

Recreation and tourism may contribute significantly to local, regional and national economies.

The importance of an area for tourism is enhanced by high values for some other benefits such as SIGNIFICANCE FOR CONSERVATION AND SOCIO-CULTURAL SIGNIFICANCE.

Figure Fifteen: Recreation/Tourism: Wetlands support many different types of recreation



SOCIO-CULTURAL SIGNIFICANCE

* **Significant component of the landscape/aesthetic significance**

Landscape is the total of all components of the view, either from a particular location or throughout a region. Wetlands are often key components of landscape, providing diversity and a focal point for views.

The aesthetic significance of a landscape or of a component of landscape is dependent on harmony of lines, textures and land uses. A large factory set in the midst of open natural areas is not harmonious and is likely to significantly lower landscape values.

Landscape offers value to many different groups. It may be important to local communities as part of their perceived quality of living, or to regional planners and entrepreneurs when they attempt to attract business or tourists to their region. It is therefore important to include landscape considerations in planning decisions when developing wetland sites, especially in coastal areas where a large proportion of the landscape may consist of wetlands.

Landscape and its associated aesthetic values are difficult to recreate once destroyed, and this is especially true where wetlands are concerned. Therefore it is important to consider the potential needs of future communities and for development when planning to alter wetland landscapes.

* **Association with religious and spiritual beliefs and activities**

Many communities use distinct sites for religious and spiritual activities, or value a site for some religious or spiritual occurrence that they believe took place there. This attitude to a site may be so completely integrated into the way of life of a community that it is not immediately apparent to outside observers.

In addition, local inhabitants may have a strong spiritual attachment to a site because their family or community has used the site for many generations, or because it is associated with aspects of their culture.

It is important to remember that in many cases it is impossible to compensate the loss of a site which has this value because such sites are, by definition, unique.

> The culture of the Maranao people of the Lanao provinces of Mindanao in the Philippines in inextricably linked to Lake Lanao. This involvement ranges from the unique fishing methods that they have developed to exploit the fish species in the Lake through to its religious/mythical significance. This cultural significance is the one of the reasons for on-going hostility towards development plans for the lake.
> Source: Jim Davies, pers. comm.

* **Wilderness (ecotourism)**

A wilderness is a large area with little or no human disturbance. Many wetland areas are wilderness areas, undisturbed by human activity.

Wilderness can have considerable economic significance based on wilderness activity tourism; e.g. white-water rafting and trekking.

Wilderness areas also provide pristine catchments for water supplies, and allow natural processes to take place without interference from humans. Also important is the value many people give to knowing that wilderness areas exist, even though they may never visit it.

Many countries have recognised the need to preserve areas of wilderness, and have included areas of wilderness as part of a national land use strategy.

* **Presence of distinctive human activities (specialised fishing methods etc.)**

Many wetlands are unique environments where human activities have evolved to make best use of the resources available. These activities include specialised fishing methods, methods of collecting fruits, resins and other forest products, and methods of using otherwise unproductive soils.

In many cases, these activities demonstrate sustainable use of valuable resources. The activities may not necessarily be long-established: methods of use evolve with time, and if allowed to continue to develop may prove to be even more valuable in the future.

> Coastal wetlands in Peru have been managed for fibre extraction (from *Typha*) for at least 1,500 years. These fibres are used in making fishing vessels. Fishermen in the Huanchaco Extractive Reserve of northern Peru still rely on this source of material for their fishing vessels. In this way, the Huanchaco Extractive Reserve affords protection to a cultural tradition that can be traced back thousands of years.
>
> Source: Wetlands for the Americas (1993) *The Haunchaco Extractive Reserve: Integrating Environmental protection and Sustainable Development in Peru.* Unpublished Project profile, 14pp.

* Historically important site

In some cases wetlands have been the site of historically significant events. These might include sites of battles, proclamations, first settlements and human migrations. Wetlands might also be the site of historically significant research, either because the result of the research itself was important, or because of the importance of the researcher.

> According to tradition, the first flag of Peru was conceived by General Jose de San Martin while observing flamingoes in Paracas, Peru. The first Peruvian flag, in fact, showed the colours of a flamingo in flight. This historic event helped in the creation of the Paracas National Reserve in Peru and adds to its importance as a site of national heritage value.
>
> Source: Wetlands for the Americas (1993) Manomet, USA and Buenos Aires, Argentina. *Peruvian Law 1281-75-AG of September 25, 1975.*

Wetlands have also been the site of research or other activities which are important for either the history of science or for an historically significant national or international event.

Such historical sites constitute an important component of a nation's or humankind's cultural inheritance.

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SIGNIFICANCE FOR RESEARCH AND EDUCATION

* **Site for scientific research**

  Many wetland sites are used as sites for scientific research, including monitoring, experimentation and reference. They are often used to study long-term global environmental trends.

* **Type locality (reference site, long studied)**

  A type locality is a site where a specimen of a certain species was first described, a fossil species found, a type of rock described or a habitat or community first identified.

  Type localities are used by researchers as the reference site whenever the same species, fossil, rock, habitat or community is found elsewhere. The site is therefore unique and irreplaceable. It is important, not only that specimens previously collected or habitats or communities previously described can be collected or described further, but that the habitat or collecting conditions do not change. If the habitats or collecting conditions change, there is a possibility that further collections would not be comparable with the originals.

* **Education site**

  Some wetland sites contain evidence of past and present processes, historical features that may lead to a better understanding of human occupation, or accessible examples of wetland species, communities or habitats.

  If reasonably accessible, these sites may be valuable for educational purposes.

CONTRIBUTION TO THE MAINTENANCE OF EXISTING PROCESSES AND NATURAL SYSTEMS

* Ecological, geomorphological and geological processes and systems

Wetlands frequently contain or contribute to ecological, geomorphological or geological systems or processes.

Ecological processes may be short-term, for example breakdown of vegetable matter, breeding or migration, or they may be long-term, as in succession and evolutionary processes. In wetlands, these processes are often cyclical, occurring over periods of tens, hundreds or thousands of years. This is particularly true of coastal wetlands and their response to sea level fluctuation.

Geomorphological processes lead to the development of landforms such as rivers, floodplains and coastal mudflats. In wetlands these processes include accretion, deposition, erosion, peat formation, river capture and meander formation.

> The maintenance of geomorphological processes is vital for the well-being of vast numbers of people. The process of annual sediment and nutrient deposition on floodplains is one such example. The lush vegetation of African floodplains supports enormous numbers of livestock as well as a profusion of wildlife - the floodplains in the Chad Basin are the home of more than a million people and their cattle. The Sudd floodplains are the lands of the Dinka, Nuer and Shilluk tribes. They are predominantly pastoralists with over half a million cattle and 100,000 goats and sheep.
>
> Source: Denny,P. (1992) *Africa*. IN: Findlayson, M. & Moser, M. (Eds.) *Wetlands*. IWRB.

Geological processes are long-term, usually occurring on time scales of tens of thousands of years and longer. They include uplift, faulting, subsidence and rock formation (usually sedimentary rocks in wetlands).

Natural systems are the result of the interactions of these processes. Many of the benefits of wetlands arise from, and are dependent on, these processes and natural systems. Maintenance of natural systems which include wetlands is often essential to the maintenance of wetland benefits.

*** Global carbon sink**

The process of photosynthesis changes inorganic carbon (from carbon dioxide in the atmosphere) into organic carbon in the form of plant material. In most ecosystems, this material decomposes, and the carbon returns to the atmosphere as carbon dioxide. Wetlands contain large amounts of un-decomposed organic material. Thus wetlands act as a carbon sink rather than as a carbon source. There is great concern over the increases in carbon dioxide in the atmosphere due to burning of fossil fuels since this contributes to global warming. Destruction of wetlands, especially peatlands, will contribute to this effect.

> The loss of peatlands is very serious in terms of the global climate. Peatlands, particularly peat swamp forests, act as a sink for carbon where carbon is fixed by the trees. When the trees die, or when leaves and branches drop off the tree,the organic matter is held within the partly decomposed material that makes up peat. Under complete decomposition, carbon dioxide would be released to the atmosphere, but in this case, the decomposition process is retarded or halted due to factors such as lack of oxygen and low pH, hence, the carbon is kept "locked" in the peat soil. When these forests are disturbed, they act as carbon sources instead of carbon sinks. This means that carbon dioxide is released into the atmosphere. With the large amount of peatlands which is being converted all over the world, this represents a major source of carbon dioxide released to the atmosphere and which contributes towards global warming.
>
> Source: Maltby, E.(1992) *Peatlands - dilemmas of use and conservation*. IN: Maltby,E., Dugan, P.J. & LeFeuvre, J.C. (Eds.) *Conservation and development: the sustainable use of wetland resources*. Proceedings of the Third International Wetlands Conference, Rennes, France, 19-23 September 1988. IUCN.

*** Maintenance of microclimate**

Wetlands can affect the microclimate. Evapo-transpiration from wetlands maintains local humidity and rainfall levels. In forested wetlands, much of the rainfall is evaporated or transpired from the trees back into the atmosphere, and then falls as rain again in the surrounding area. If the wetland is destroyed, the amount of local rainfall will decrease. This has adverse effects on the human activities in the area such as agriculture. For example, morning mists originating from nearby swamps reduces soil water loss.

> In East Africa, when valley swamps were drained, crop yields in the surrounding hills declined due to water stress.
>
> Source: Patrick Denny, pers. comm.

* **Prevention of development of acid sulphate soils**

Many wetlands are in areas which were once marine. In many cases, pyrite-rich marine clays were laid down during the marine phase. When these clays are exposed to the air, for example when a wetland is drained, they oxidise and produce strongly acidic sulphate compounds. These compounds acidify both the soil and the water which pass through it. The high levels of acidity caused by this process result in soil and water conditions which are unsuitable for many agricultural, domestic or other uses. In addition, flushing of highly acidic water from disturbed wetland areas, for example at the onset of the wet season, can lead to significant fish kills.

However, in the natural state these clays are often overlaid by wetlands. This prevents exposure of these pyrite-rich sediments to air, and thus prevents oxidation and the development of acidic conditions. For this reason, development of aquaculture ponds in such areas is not recommended.

Keeping the wetland intact, especially the natural hydrological regime which maintains the waterlogged soil conditions, ensures that acidity does not develop and that the benefits associated with the features of that particular area can continue to be provided by the site. This emphasises that the economic benefits of keeping such wetlands intact are often greater than those arising out of their conversion.

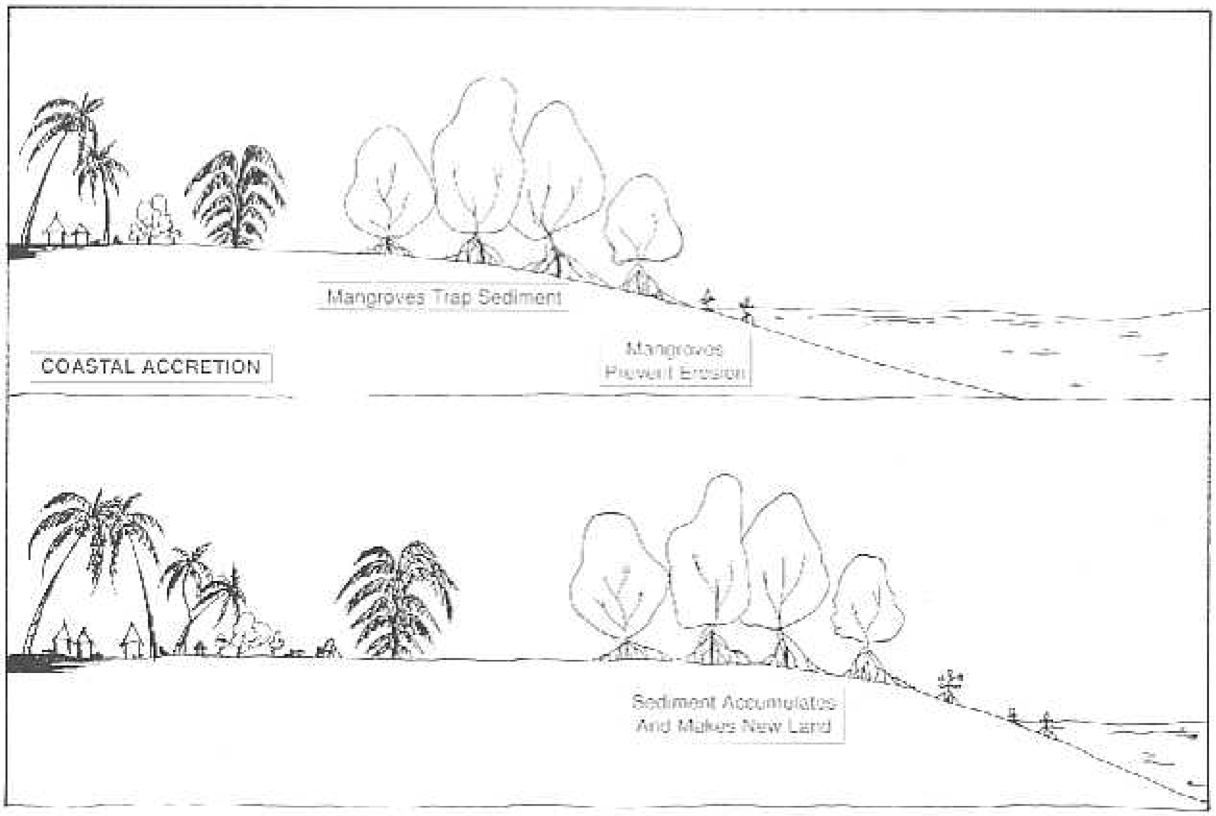

Figure Sixteen: Contribution to maintenance of exisiting processes and natural systems - formation of coastal mudflats

Figure Seventeen: Contribution to the maintenance of existing processes and natural systems - carbon sink

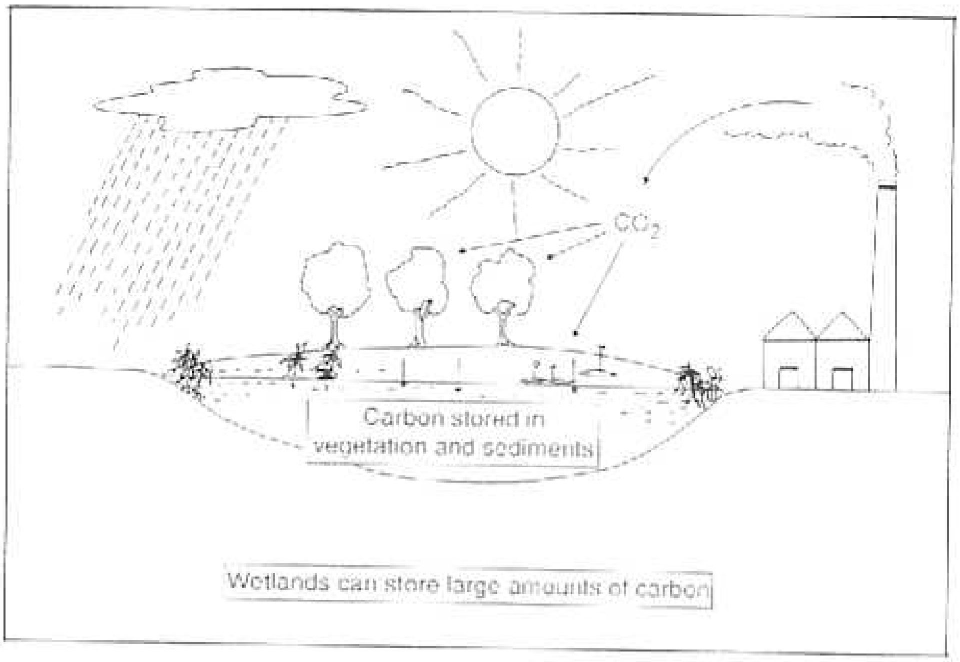

Figure 17a: With wetlands

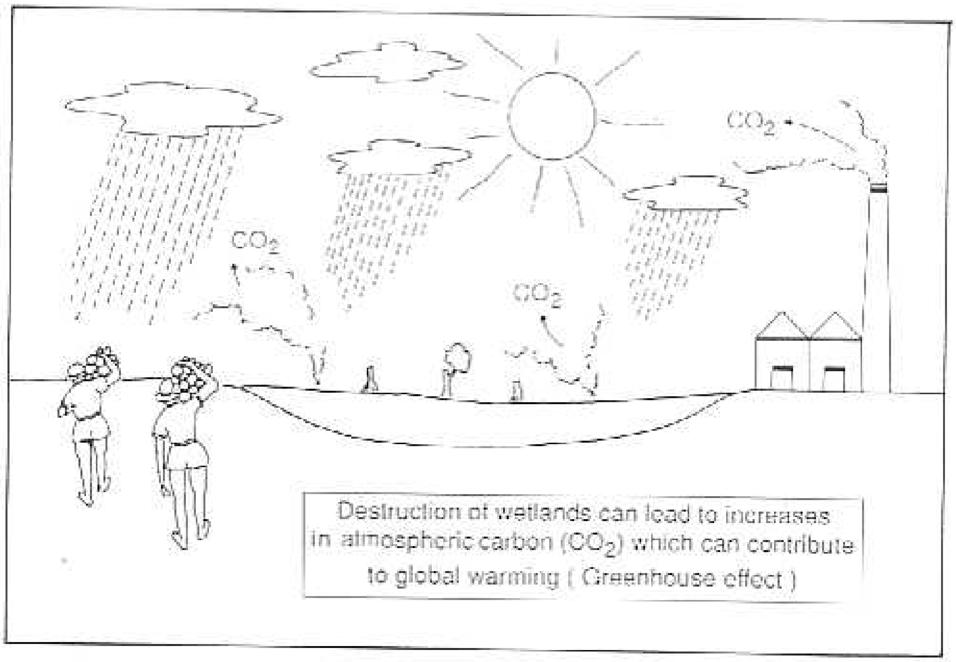

Figure 17b: Without wetlands

FURTHER READING

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Information on Publishers (continued from front cover)

IWRB is governed by an Executive Board comprising National Delegates from over 40 member countries, together with the coordinators of over 20 specialist networks. In addition, IWRB has, either directly or through local partners, on-the-ground networks of specialists actively involved in wetland conservation activities in more than 90 countries. IWRB's headquarters are located in the United Kingdom.

For further information on national membership or on how you can support the activities of IWRB, please write to IWRB, Slimbridge, Gloucester GL2 7BX, UK, Telephone No: (+44-453) 890624, Fax No: (+44-453) 890697.

Wetlands for the Americas (WA)

WA is a non-governmental organisation whose mission is: "To promote the conservation of wetland ecosystems in the Americas". Wetlands for the Americas is directed by a Council of conservation leaders from North and South America. Under their guidance, WA's predecessor organization, the Western Hemisphere Shorebird Reserve Network (WHSRN), was launched in 1985 and today is a major programme of WA, linking 21 sites covering nearly 2 million hectares and supporting over 30 million shorebirds.

The new focus of WA will be on developing strategies that advance the health of wetland ecosystems (particularly in South America), as well as the biodiversity that depends upon them. WA will continue to implement programmes that enhance local capability and conservation whilst maintaining international linkages. Already, implementation of on-the-ground wetland programmes has enhanced local capacity through workshops, small grants and technical support and catalysed the formation of independent conservation programmes in seven countries. At the hemispheric level, close collaboration between governments and non-governmental institutions has led to major conservation strategies at regional and national levels including the development of national action plans. The goals will be carried out primarily through projects that have substantial multiplier effects - such as policy, laws, regulations, conservation strategies, action plans, education and on-site programmes.

For more information please contact: Wetland for the Americas, PO Box 1770, Manomet, MA 02345 USA, Telephone No: (+1-508) 2246521, Fax No: (+1-508) 2249220.