UNDERSTANDING OUR WETLANDS:

A RESOURCE BOOK FOR UNIVERSITIES AND TERTIARY INSTITUTIONS

Wetlands and Biodiversity Component
Nile Transboundary Environmental Action Project
Nile Basin Initiative

August 2009

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Foreword

The Nile Basin Initiative (NBI) is a partnership between riparian countries of the Nile; namely Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. The NBI's shared vision is to "achieve sustainable socioeconomic development through the equitable utilization of, and benefit from the common Nile Basin water resources". To translate this shared vision into action, there are two complimentary programs: the Shared Vision Program (SVP) which creates a basin wide enabling environment for sustainable development; and the Subsidiary Action Programs (SAPs) engaged in concrete activities for long term sustainable development, economic growth and regional integration of the Nile Basin countries.

The Nile Transboundary Environmental Action Project (NTEAP), one of the projects under the Nile Basin Initiative's (NBI) Shared Vision Program, was mandated to provide a strategic environmental framework for the management of the trans boundary waters and environmental challenges in the Nile River Basin. One of the ways NTEAP met this objective was to develop wetlands education, training and awareness materials for use at five stakeholder levels as follows:

a) Understanding our Wetlands – A Resource Book for Primary Schools;
b) Understanding our Wetlands – A Resource Book for Secondary Schools;
c) Understanding our Wetlands – A Resource Book for Tertiary Institutions;
d) Wetlands Awareness resource book for Communities;
e) Wetlands Awareness resource book for Policy Makers.

This Resource Book for Tertiary Education students, has been produced through a consultative and interactive process with the Regional Working Group Members of the Nile Basin Wetlands and Biodiversity Component and the Environmental Education and Awareness Component. The book has been designed to guide instructors and learners to confidently address wetlands education issues as part of the effort to address the challenges of wetlands degradation and promote their wise use.

This book is for enhancing professionalism for wetlands and biodiversity management for students doing their tertiary education. It is user friendly, designed to address the pertinent issues affecting wetlands management in the Nile basin countries. The learning student should be able to be motivated to carry out research, awareness, production of outreach materials such as brochures, handouts, charts, radio and TV programmes, cartoons, role plays, drama and songs.

We hope that this Resource book shall be useful to instructors and practitioners wishing their students to learn about wetlands and their importance as an efforts towards their sustainable conservation.

Gedion Asfaw
Regional Project Manager
Nile Transboundary Environmental Action Project

How to Use this Book

Many scholars in the Nile Basin countries study wetlands as part of environmental education or awareness programs usually with no prescribed stand-alone course outlines that would enable instructors or learners to articulate issues that are pertinent to the management of Wetlands. This book has been designed to guide instruction in wetlands management, as a taught course unit and to exposes learners to the various challenges of wetlands management.

The resource book is generic with aim of motivating learners to appreciate that wetlands management is about sustaining their functions and values. The learners at the end of the course should be able to balance up options in favour of proposed conversions that can only be done if the alternatives supersede current uses. Emphasis at this level of education shall be on emphasizing wetland values, with appreciation of their connectivity in the hydrological regimes hence requiring linkage in their management regionally and internationally. The building blocks of this resource book assume that the learners have been exposed to the resource books for Understanding Wetlands that have been designed for Primary and Secondary schools in which information on wetlands values and functions can also be obtained.

At tertiary levels of education, learners should be in position to prepare a management plan for a particular wetlands, which is a main guideline that brings all stakeholders in the managing of a shared resource. They should also be able to design a simple restoration program for a wetland that was degraded, together with linking functions of a local wetlands to globally acceptable management principles and poverty reduction techniques. They should also be in position to deal with policy and institutional issues that bring together various key players in the management of wetlands.

In this resource book, the instructor is a facilitator, who guides an interactive process. Wetlands near the institution would be appropriate to provide additional learning that encourages stakeholders involvement in managing wetlands. Activities, questions and exercises can be selected in such a way that they can be monitored over a period of time, which allows to build an information base for management of a particular wetland so that it can be regularly monitored.

ACKNOWLEDGEMENT

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Special thanks go to Working Group members, Mr Messele Fisseha from Ethiopia, Dr Khalid Riak from Sudan, Mr Jean Marie Bukuru from Burundi, Mr Crispin Sedeke from DR Congo, Mr Fred Omego from Kenya, Paul Mafabi from Uganda and Wetlands Trainer Dalmus Oyugi from Kenya. Thanks also go to Ms Grace Bithum Pacutho for the art work. All those who provided photographs and case studies excerpts that have been reproduced in this book are acknowledged. Ms Beatrice Adimola and Ms Lucy Iyango are thanked for reviewing the final version of this print.

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MODULE 1: INTRODUCTION TO WETLANDS

1.1 Introduction

Wetlands are important natural resources, whose appreciation of values and functions are increasingly being understood by many people. The general trend all over the world and in particular, the Nile basin region, is to reverse wetlands degradation by enhancing the understanding of their uses and functions, so that they are wisely used rather than being referred to as wastelands. It is therefore important for everyone to understand and appreciate the wealth and value of these useful resources because they contribute to functioning ecosystem integrity. This module will introduce you to the wetlands definition and characteristics, formation, types and their importance.

Learning Objectives

By the end of this module, learners should be able to:

- Define, explain the term wetland and their characteristics
- Describe how wetlands are formed.
- List the different types of wetlands
- Name wetlands in their respective countries.
- Explain the various uses of wetlands and their importance.

The overall aim is to enable the learner to use the knowledge obtained to promote the conservation of wetlands by acting as agents of change to wetlands conversion.

1.2 Definition of Wetlands

Wetlands are habitats whose definition depends on three main characteristics that include the soils, adapted fauna and flora, and presence of water. The existence of the four at a single location determines the description to give a particular wetland, which implies that the description of wetlands vary depending on the component constituents. The boundaries will fluctuate depending on the seasons. Generally, in the Nile Basin region, wetlands may be defined as:

> *"Those areas that are logged with surface or ground water at a frequency and duration sufficient to support a prevalence of adapted plants and animals" Seasonal wetlands are water logged for a limited period or several times in a year, while permanent wetlands are logged throughout the year.*

In other terms, wetlands are areas of land that are wet, flooded either permanently or seasonally and where land retains water for long enough to allow the development of characteristic soils, plants and animals. This description is derived from the Ramsar Convention[1], which gives the international definition of wetlands as

"areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters".

The Ramsar Convention, which is the international convention dealing with the wise use of wetlands provides that; "wetlands include riparian and coastal zones adjacent to islands or bodies including marine ecosystems less than six meters at low tide". Therefore, shallow freshwater resources such as rivers and lakes, and coastal and shallow marine ecosystems, including coral reefs, artificial water bodies and underground water resources are also included in the definition of wetlands.

1 Convention on Conservation of Wetlands, also see www.ramsar.org

Wetlands - including (inter alia) rivers, lakes, marshes, estuaries, lagoons, mangroves, sea grass beds, and peatlands - are among the most precious natural resources on earth. These highly varied ecosystems are natural areas where water accumulates for all or at least part of the year. Driven by the hydrological cycle, water is continuously being recycled through the land, sea and atmosphere in a process, which ensures the maintenance of ecological functions. Wetlands are an integral part of the hydrological cycle, playing a key role in the provision and maintenance of water quality and quantity as the basis of all life on earth. They are often interconnected with other wetlands and frequently constitute rich and diverse transition zones among themselves between aquatic ecosystems and terrestrial ecosystems such as forests and grasslands. Wetland ecosystems, by definition, depend on water to maintain their ecological functions, and in the process, they have characteristic soils and organisms.

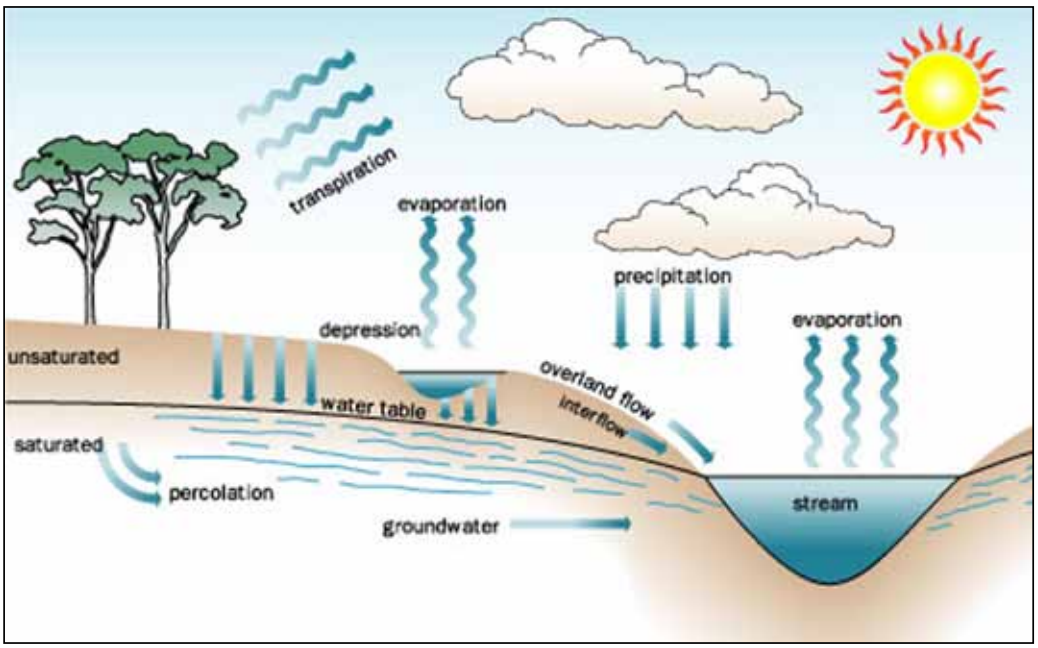

Figure 1. The hydrological cycle.

Wetlands are entities of the hydrological cycle whose water is replenished by runoffs from rivers, aquifers and lakes. Their complexity depends on what they receive from their catchment, for example, the nutrient and sediment loads that move from catchment would easily find their way into water bodies downstream, but the wetlands absorb most of them and turn them into a dependable habitat for other organisms. The water quality is modified and its quantity distributed in time and space. The dynamics of what goes on in wetlands is a mystery that needs a good understanding to guarantee a continued renewal of energy in ecosystems. In the process of their functioning, wetlands reduce the impact of potential hazards since many harmful agents such as pesticides, fertilizers or other chemicals can easily be transported to other areas where they might have adverse impact on the organisms and the environment. For this reason, wetlands are called filters or water purifiers, because they remove what would prevent the use of water downstream. They therefore provide a buffer between the catchments and water bodies.

Essential information on wetlands

- Wetlands occur in every country - from the tundra to the tropics. The World Conservation Monitoring Centre suggest an estimate of about 5.7 million square kilometers - roughly 6% of the Earth's land surface to be wetlands. The greatest proportion made up of bogs (30%), fens (26%), swamps (20%) and floodplains (15%), with lakes accounting for just 2% of the total.
- They exist as swamps, flood plains, seasonally flooded grasslands, edges and shallow waters of rivers and lakes, estuaries and coasted mashes, mangroves, creator lakes and peat bogs.

- They have characteristic flora and fauna with specified features for adapting to variability in hydrology, chemical composition, environmental physical characteristics like temperature, soil nature, sediment composition, etc.
- They are fragile habitats, therefore easily degraded in terms of ecological functioning, social and economic services and products provision.
- Wetland types can be grouped as; lacustrine (wetlands associated with lakes), riverine (wetlands along rivers and streams), palustrine (marshes, swamps and bogs), marine (coastal wetlands, including rocky shores and coral reefs), estuarine (including deltas, tidal marshes and mangroves), and artificial water bodies (fish ponds, reservoirs and artificial lakes).

Activity 1.1
Visit the Website www.ramsar.org and study the ramsar web page

a) What is the convention of wetlands about?
b) Why was it necessary to have a Convention on Wetlands Management?
c) How many types of wetlands do you find in your country and of these how many are Ramsar sites?
d) How many countries in the world have ratified the Ramsar Convention?
e) What threats and challenges are facing wetlands management in your country?

1.3 Formation of Wetlands

Wetlands are formed when water from a catchment collects in a depression or basin, along the valley, flood plain and is retained long enough for characteristic plants and animals to adapt. There is little or no observable movement of water because of the low gradient. The vegetation gradually establishes itself and the slow movement of water facilitates sedimentation of suspended silt and eroded soils. This promotes more vegetation growth and further reduction in speed of water flow leading to the removal of suspended solids and excess nutrients that the water comes with from the catchment and a gradual expansion sideways and across the valley resulting into wetland. The sediment in the water grades itself as the water moves downstream, into the sand, clay and silt and depending on the time water logs, characteristic vegetation will zone itself to form a variety of habitats in the wetlands for different water adapted animals.

Activity 1.2
In a groups, examine the role of each of the following in the process of wetland formation;
- Faulting and folding
- Down warping
- River meandering system
- Earth movements and slow-flow theory
- Human activities

1.4 Classification of Wetlands

Wetlands differ due to variation in soils, landscape, climate, organisms (plant and animals) and human disturbance. Different categories of wetlands perform different functions Coastal wetlands (mangroves, estuaries, salt marshes, sea grass beds, coral reefs and mudflats) are vital spawning and nursery areas for large numbers of fish. Inland wetlands - rivers and lakes are habitat to organisms (plants and

animals) which provide food and income for millions of people, but also serve as an essential lifeline for communications: goods have been traded along all major rivers for centuries.

Photograph 1: Human activities in a Wetland can affect its natural performance.

Due to these variations, the Ramsar Convention on wetlands of International Importance classifies wetlands as follows:

- Riverine wetlands: These are wetlands along rivers and streams.
- Lacustrine wetlands: These are wetlands associated with lakes, which include water edge wetlands and above shoreline wetlands.
- Palustrine wetlands (dominated by persistent emergent plants like marshes, swamps and bogs)
- Marine wetlands (Coastal wetlands, including rocky shores and coral reefs)
- Estuarine wetlands (including deltas, tidal marshes and mangroves)

Wetlands may also be classified based on their hydrological status, that is

- *Permanent wetlands*; these are permanently flooded with water.
- *Seasonal wetlands*; these are wetlands that are mainly flooded during the rainy season.

Factors that influence the type of wetland in a specific location include;

- Presence of water; permanent or seasonal
- Source of water e.g. rainfall, surface run-off, ground water etc
- Water depth
- Shape of the water basin
- Degree of slope of the basin
- Geological factors e.g. soil or rock type
- Altitude
- Anthropogenic activities

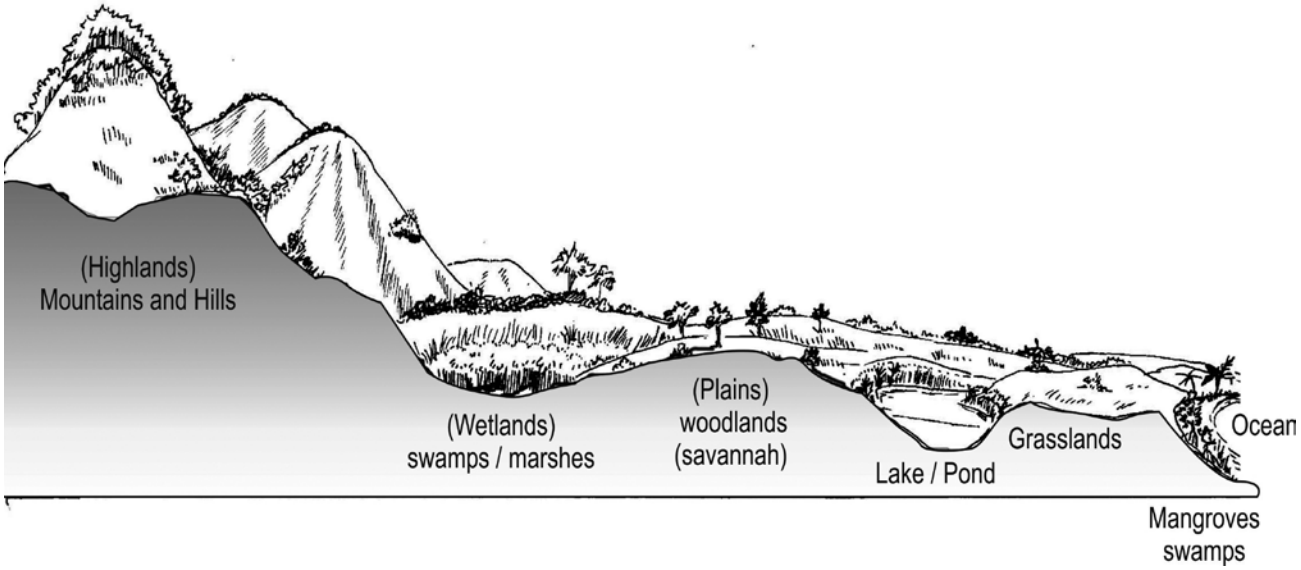

Figure 2: The Land scape influences the type of wetlands

Activity 1.3
In Groups
Study figure 2. Using suitable examples, discuss how the factors listed above influence wetland types. Use internet information about wetlands to enrich the discussion on the definitions for the types of wetlands

Fact sheet: Distinguishing features of wetlands

- Presence of water, either at the surface or within the root zone, for most or at least some part of the year.
- Water in permanent wetlands is shallow (less than 6 metres deep at low tide); this distinguishes wetlands from lakes or large deep rivers.
- Wetlands have unique soil conditions that differ from the adjacent dry land soils. Wetland soils are frequently waterlogged either permanently or seasonally.
- Wetland plants and animals are specifically adapted to wetland soil and water conditions.
- Characteristic wetland plants and animals are usually naturally absent in the dry lands
- In many wetlands, there is a large accumulation of organic matter

1.5 Importance of Wetlands

Wetlands are among the most precious natural resources on earth, whose benefits have been underlooked. The benefits may directly and indirectly support livelihoods. Included among the indirect benefits of wetlands are their:

- Roles as natural reservoirs for storage of water: Wetlands capacity to retain water makes them perform the function for water storage and distribute it in space and time hence maintenance of water sources including recharging of rivers, lakes and groundwater
- Capacity to absorb huge volumes of water, wetlands control floods by acting as shock absorbers by reducing the speed of water hence protecting the organisms and other infra-structure from the

damage they would be exposed to due to large volumes of water.

- As habitats of considerable levels of biological diversity, wetlands are homes to countless forms of plants and animals. Without wetlands, many species of both plants and animals, some with optional uses would become extinct.
- Role in acting as sediment traps by filtering sediment and other solids hence reduce the impurities from the water as it continues to flow along its hydrological path, in the process they contribute to maintenance of water quality by cleaning and reducing pollution from catchment. The water can hence be reused as it moves along its hydrological path
- Wetlands also serve as an effective shoreline barrier against wave action, thus acting as a buffer to protect organisms from wave action.
- Role in microclimate and climate regulation which is very crucial in modulating the micro climate of an area.

Wetlands directly provide immediate needs for people including food, water, shelter, fish, medicine, thatching materials, crafts, building material, and dry season grazing etc many of them free of charge to the populations living near wetlands (Discuss a list of direct benefits).

In many parts of Africa and elsewhere in the world there is increased pressure on wetlands and their resources due to social and economic dynamic aspects such as increased poverty, industrialization, overpopulation, climate change, human habitats development and urbanization. The Stockholm Conference (1972) which recommended natural resources use and Ramsar convention provided guidelines and principles for wise-use and proper management of wetlands. Several countries ratified the Ramsar convention to show commitment to promoting sustainable management of wetlands and conserve its uses, attributes, services and ecological functions. (For details about wetland values and functions, refer to Module 2)

Photograph 2. An example of Shoreline of Lake Wetland covered with papyrus.

Activity 1.4

- Visit to a nearby Wetland
- Observe the catchment of the wetlands
- Record the activities that are taking place in the wetland
- What are the major threats facing the wetlands
- Determine the number of wetlands that have been altered or encroached in your local area. This can be done by talking to area farmers, your parents, grand parents, businesspersons and other people who have been living in the area for a relatively long period. Or comparing past Geographical Information systems (GIS) with the present.
- Prepare a proposal to a concerned government department and land owners persuading them to conserve wetlands, by bringing to their knowledge the various values and uses of wetlands.
- Discuss why you think there should be more Ramsar sites in the Nile Basin region?
- Discuss the Wise use concept for conservation of wetlands

Ramsar Sites

It is important at this stage in this module to introduce the idea of the "Ramsar Sites". The Convention on Wetlands of International Importance was adopted at Ramsar, a City on the Iranian Shores of the Caspian Sea, in 1971. The convention provides the framework for national and international cooperation for the conservation and wise use of wetlands and their resources. The broad aim of the convention is to halt the worldwide loss of wetlands and to conserve them through wise use and management, which requires cooperation at all levels including national, regional and international communities. The convention member countries identify and list Wetland of International Importance called Ramsar Sites. The following is a list of the Ramsar Sites found in the Nile Basin Countries as of the year 2008.

Table 1. The Ramsar sites of Nile Basin.

COUNTRY	WETLAND	DESIGNATION DATE
UGANDA	L .George	4/March/1988
	L. Nabugabo wetland system	11/Feb/2004
	L. Bisina wetland system	15/Sept/2006
	L. Mburo-Nakivali wetland system	15/Sept/2006
	L. Nakuwa wetland system	„
	L. Opeta wetland system	„
	Lutembe bay wetland system	„
	Mabamba bay wetland system	„
	Nabajjuzi wetland system	„
	Murchison falls-Alberta Delta wetland	„
	Sango-bay-Musambwa island-Kagera wetland system	„
	Rwenzori Mountains	2009
BURUNDI	Delta de la Rusizi de la Reserve Natuelle de la Rusizi et la paritie nord de laa zone littorale du lac Tanzanyika	05/06/2002
D.R. CONGO	Parc.national des virunga	18/Jan/1996
RWANDA	Rugezi-Bulera-Ruhondo	1/Dec/2005
SUDAN	Sudd	5/June/2006
	Dinder	07/May/2005

Source: www.ramsar.org

1.6 Module Summary

In this Module, you studied:

- Definitions of wetlands
- The formation of wetlands
- The importance of wetlands
- Types and some examples of wetlands
- Threats to Wetlands

1.7 Further reading

Gawler, M. (1993). **WWF Wetland Conservation Activities in Africa**. IUCN Wetlands Programme Newsletter 8: 8-9.

Gawler, M. (2002). **Strategies for Wise Use of Wetlands:** Best Practices in Participatory Management. *Proceedings of a Workshop held at the 2nd International Conference on Wetlands and Development*. Wetlands International / IUCN / WWF Publication No. 56, Wageningen, The Netherlands. 116pp

Duffy, Trent. (1994). **The Vanishing Wetlands.** New York: Franklin Watts.

IUCN and Wetlands Division (2005) **"From Conversion to Conservation"** edited by Elroy B. *et al* (2005), A publication of fifteen years of Managing Wetlands for People and the Environment in Uganda, An IUCN publication.

MODULE 2: WETLAND VALUES AND FUNCTIONS

2.1 Introduction

Wetlands are unique and vital ecological resources that provide many benefits at little cost to humanity. They contribute to the national economies by providing goods, services and attributes, which may be direct or indirect. Wetlands are important regardless of their location and type. Their values include commercial values, recreational values, wildlife habitats, water quality management, and flood control. In recent years, the multiple roles of wetland ecosystems and their value to humanity have been increasingly understood and documented. This has led to the need to restore lost or degraded wetlands and to involve world leaders in institutionalizing the management of wetlands to cope with the need to sustain livelihoods and reverse the accelerating water crisis, effects of climate change and the challenges of the increasing world's population.

Wetlands are diverse, whether they are ponds, marshes, coral reefs, peatlands, lakes or mangroves. They all share one fundamental feature: the complex interaction of their basic components; soil, water, animals and plants - that fulfil many functions and provide many products that have sustained humans over the centuries. Of course, not every wetland performs all these functions - but most wetlands perform many of them.

Learning objectives:
By the end of this module, learners should be able to;

- Outline major wetland values and functions
- Demonstrate how wetlands can contribute to the livelihoods of the people.
- Justify proper management of wetlands due to their different values and functions

2.2 Wetland Values

Wetlands goods, services and attributes have value. The value may be direct or indirect (ecosystem services and functions, option or non-use value). The value is direct when products are obtained from goods extracted from wetlands or by consuming the goods directly. The value is indirect when we enjoy benefits from wetlands functions and ecosystem services, but further indirect values are vested optional future uses and intrinsic non use values as elaborated below.

- **Direct value**: these are extractable resources of the wetland, which can be used directly and often processed and traded as wetlands products.
- **Indirect values**: these are non-extractable services, which cannot be removed from the wetland directly, but do produce benefits to users. Other benefits are
    - **Option values**: this is a value obtained from a wetland by retaining a claim on future use.
    - **Heritage value:** this is a value placed on the ability to pass the wetland on to future generations, and let them have the choice to use it the way they want
    - **Existence value**: this is a value derived from knowing that the wetland is there.

2.2.1 Direct Values

Direct values are obtained from extracted goods, which can be consumed directly or modified into products. Some of the goods when processed can contribute to various benefits that can directly be consumed as explained below

Water Storage and Supply

Wetlands act as reservoirs for the watershed or catchment, hence they release the water they store from precipitation, surface water, and ground water for various other uses depending on the quality. The water will therefore always be there to replenish springs, rivers, ground water and lakes. Without this wetland function there would be no steady flow of water and is the main reason for the existence of rivers or lakes. Drainage of wetlands lowers the water table and reduces capacity for recharging water for ground water storage. If a recharge wetland is drained, the water resources into which ground water discharges will receive less inflow, potentially changing the hydrology of a watershed. The capacity for springs to contain water is associated with the function of wetlands to store and supply water.

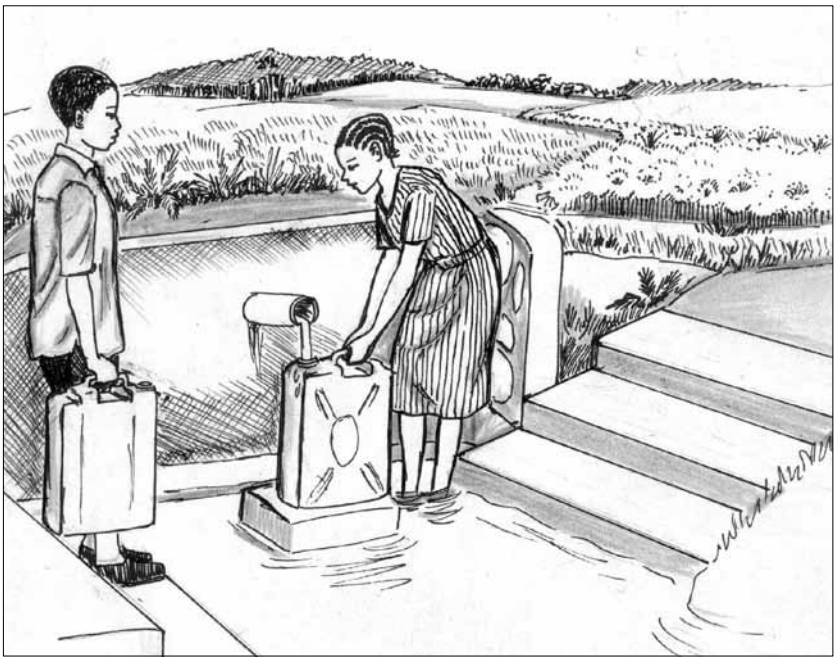

Figure 3: Source of water from a protected wetland.

Commercial and Recreational Values

Wetlands provide opportunities for many popular recreational activities such as boating, hiking, hunting, fishing, and bird watching. Many people all over the world hunt, fish, bird watch, or photograph wildlife. These activities, which rely on wetlands, add millions of dollars to the economies through non-consumptive utilization, in addition to the direct economic value from the variety of commercial products they provide, such as food, fiber, lumber, and provision of energy resources.

2.2.2 Indirect Values

These are value for wetlands functions and ecosystem services which should be taken seriously by ecosystem managers and planners

Wetlands as Wildlife Habitats

Wetlands are important as habitat to wildlife, a value that has put them among the most productive natural ecosystems on the earth. They habit plants and animals many of which can not live in other ecosystems. Some of the plants specific to wetlands are *Papyrus spp, Phragmites* spp, water lilies, and *Pistia* spp. Many of the wetland plants provide food, shelter, and nesting areas for animals. Wetlands are major breeding grounds for various resident and migratory birds. They are migratory stopovers for many species of wading birds, shorebirds, and songbirds. Many species of invertebrates, amphibians, reptiles,

and mammals depend on wetlands for survival. Wetlands are extremely important refuges for this plentiful variety of wildlife hence support a diversity of life much of it not studied and well understood in Africa.

Wetlands Improve and Modify Water Quality

Wetlands help to improve and modifies the quality of water hence enabling it to be re-used for similar purposes it was discharged. Run-offs with eroded soils or municipal wastewater and sewage can be filtered by the wetlands thus removing the dirt, suspended and dissolved nutrients. One way is recharging the ground water since the water in the wetlands percolates into the ground, and can later comes out clean in springs and rivers. This implies also that contaminated water will not immediately flow into streams, rivers, lakes, or the gulf or ocean. The other way is by the run off water spreading throughout adapted plants in the wetlands. The vegetation slows the water long enough for sediments and nutrients in the water to settle or be used respectively. As the water moves slowly in the wetlands, the plants absorbs what have been modified as nutrients that come with water to build their biomass, and this supports various organisms in the wetlands. The ability of wetlands to remove nutrients and suspended materials out of the water leads to filtering of the water leading to discharge of a clear effluent from the wetlands that can be re-used. Generally, wetlands maintain water quality through the following processes.

- **Nutrient Removal**

Scientists have estimated that wetlands may remove between 70% and 90% of entering nitrogen. Riparian forests can reduce nitrogen concentrations in runoff and floodwater by up to 90% and phosphate concentrations by 50%. The estimated mean retention of phosphorus by wetlands is 45%. Wetlands with high soil concentrations of aluminum may remove up to 80% of total phosphorus. *Constructed wetlands* are used in wastewater treatment to improve water quality before discharge into natural water systems. Wetlands can be extremely useful in agricultural and industrial watersheds because they retain huge amount of nutrients hence preventing deterioration of water quality in recipient water bodies.

- **Removal of Biological Oxygen Demand from Surface Water**

Biological Oxygen Demand (BOD) is a measure of the oxygen required for the decomposition of organic matter and oxidation of inorganic matter. BOD increases through inputs of organic matter such as sewage effluent, surface runoff, and natural biotic processes. Wetlands remove BOD from surface water through decomposition of organic matter or oxidation of inorganic compounds.

- **Removal of Suspended Solids and Associated Pollutants from Surface Water**

Suspended solids (such as sediment and organic matter) enter wetlands in runoff, as particulate litter fall, or with inflow from associated water bodies. Sediment deposition in wetlands depends upon water velocity, flooding regimes, vegetated area of the wetland, and water retention time. Typically, wetland vegetation traps 80-90% of sediment from runoff. Less than 65% of the sediment eroded from uplands exits watersheds that contain wetlands. Other pollutants that affect water quality such as nutrients, organic materials and metals are often adsorbed onto suspended solids. Deposition of suspended solids to which such substances are adsorbed, removes the pollutants from the water.

- **Removal of Metals**

Wetlands play an important role in removing metals from other water resources, runoff, and ground water. Wetlands remove 20% - 100% of metals in the water, depending on the specific metal and the individual wetland. Forested wetlands play a critical role in removing metals downstream of urbanized areas.

- **Removal of Pathogens**

Feacal coliform, bacteria and protozoans, enter wetlands through sewage, urban storm water, leaking septic tanks, and agricultural runoff. Wetlands environments are known to reduce the effects of pathogenic organisms usually because of anoxic conditions caused by increased oxygen demand due to presence of trapped organic matter.

Control of flooding

Wetlands protect adjacent and downstream properties from potential flood damage. When water levels are high due to storms and flooding, the heavy, spongy vegetation spreads the water as its slows its speed. The combined action of storing and slowing can lower flood heights and reduce the water's erosive power. The presence of only 15% of a watershed in wetlands can reduce flooding peaks by as much as 60%. The flood control by wetlands increases with :

- Wetland area or size
- Location of the wetland (along a river, lake, or stream)

Wetlands within urban areas are particularly valuable for flood protection. The impervious surface in urban areas greatly increases the rate and volume of runoff, thereby increasing the risk of flood damage.

The drainage of wetlands, the diversion of rivers from their original floodplains, and unplanned development in the floodplains are responsible for the economic damage to businesses, homes, crops, and property that occur because of floods

Vegetated wetlands help to hold together banks of lakes, rivers, and the beach rim that are often prone to serious erosion problems. Soil erosion increases when wetlands are converted and the vegetation removed or damaged.

Coastal wetlands serve an extremely important storm surge protection function when tropical storms or hurricanes come ashore. Research has shown that for every mile of vegetative wetlands, storm surge height can be reduced by one foot. Coastal wetlands such as brackish marshes, bottomland forest, and barrier islands absorb enormous amounts of wave energy and hold large quantities of water that would otherwise allow storms to do much more damage inland.

Did you know that?

Maintaining wetlands near developed areas may provide the "least expensive insurance policy" to homeowners and business owners can purchase to protect their property.

Wetlands are valued because of their location on the landscape, the variety of functions they perform and uniqueness of their plant and animal communities. Individual landowners and members of the public also value many wetlands for their open space and aesthetic qualities, as sites for educational research, as locations of important historic or archaeological sites, and as locations for conveying floodwaters.

Generally, wetlands have intrinsic attributes, perform functions, and produce goods and services. Some of these are of primarily local interest, but others have regional, national or international importance. In summary, wetlands represent considerable ecological, social, and economic value. The box below shows wetlands values-derived from attributes, functions, goods and services classified into four categories i.e. direct values, indirect values, option values and non-use values.

Plate 1: Some of the Wetland uses and values

Direct Values	Indirect values	Option Values	Non-Use Values
These are production and consumption goods e.g. Fish Fuel Wood Building poles Sand, gravel, clay Thatch Water Wild foods Medicines Agriculture/cultivation Transport Recreation	These are ecosystem functions and services e.g. Water quality Water flow Water storage Water purification Water recharge Flood control Storm protection Nutrient retention Micro-climate regulation Shore stabilization	This is premium placed on possible future uses and applications of wetlands e.g. Pharmaceutical Agricultural Industrial Leisure Water use	This is an intrinsic significance of a wetland e.g. Cultural Aesthetic value Heritage value Existence value

Activity2.1: Wetland values assessment

- Identify more examples for each categories above based on your knowledge and experience with special reference to wetlands in your country
- With reference to a wetland in your locality, state their products services and functions

Methods:

- Field survey, photography, direct observation, literature review (wetland booklets, internet, journals, newspapers, posters, internet).

Exercise 2.1 Essay and Research questions

a) Based on knowledge of the wetlands goods, services, functions and benefits, explain how wetlands contribute to supporting livelihoods in Africa.

b) Justify the existence of a wetland near your urban center that has been proposed for conversion to other uses.
c) What would be the value of direct and indirect goods and services for that wetland.

2.3 Module Summary

In this Module, you have studied about:

- The major wetland values and functions
- The justification for management and use of wetlands as we continue to benefit from their values
- The multiple roles of wetland ecosystems and their economic value to humanity are increasingly being appreciated and documented.
- The need to restore wetlands that have been degraded
- There uses whose value is for the future.

2.4 Further reading

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MODULE 3: WETLANDS VALUATION

3.1 Introduction

Most planning and development decisions are made on economic grounds, especially the forces at play in the free-market system. While this new paradigm has its own limitations and dangers, it would be unrealistic to ignore it and base our quest for the conservation and wise use of wetlands on completely different sets of values. Hence, wetland goods and services must be given a quantitative value if their conservation is to be taken up over other uses. An economic value can be therefore be estimated based on the uses plus the multiple benefits provided by the direct and indirect values.

The value of wetland functions, such as water quality improvement, can be calculated from the cost of building a treatment plant to perform the same processes. It is may not be easy, however, to value most of the indirect benefits such as biodiversity or the aesthetic beauty of wetlands, as the market for such "products" is much more elusive, hence their economic valuation is much more difficult to achieve with traditional methods but can be estimated. Another limitation is that developing countries face significant challenges in appropriating the global benefits of wetland conservation, such as their biological diversity and have needy populations whose livelihoods are dependant on wetlands goods directly which provides a low economic value to the importance of wetlands. It is therefore important to consider both the direct and indirect value while making the estimates for a particular wetland good. In this case contingent valuations can assist the process.

The trend towards wetland conservation should be that countries must develop and adopted a policy that prevents further wetland loss or degradation, and permit sustainable utilization through promotion of wise use practices. Wetland valuation is one way that promotes informed decision making in utilization of wetland resources. International mechanisms and institutions, such as the Ramsar Convention on Wetlands, the Convention on Biological Diversity, the UN Commission on Sustainable Development, OECD, IUCN-The World Conservation Union, Wetlands International and WWF are promoting research, analysis and dissemination of information on economic valuation of natural systems, including wetlands. They advise that decision-makers should fully consider the social benefits of natural ecosystems as well as those of the development proposals being considered and, that they should make full use of the available techniques for accurately expressing resource benefits in economic terms. The value of a wetland depends on its use, location and ecological functions.

Putting a monetary economic tag on wetlands and the many functions they provide has become increasingly necessary. The Ramsar Convention recognizes that it is "vital that all wetland economic values be identified, measured and reported upon to increase national and international awareness of the needs for and benefits of wetland conservation". Appreciation of the "real" value of wetlands is growing, because of the realization of the costs involved in failure to provide alternative services if wetlands are destroyed or degraded.

For example, recent studies in early 2008 showed that the economic value of Lake Tana sub-basin wetlands and its biodiversity in Amhara region of Ethiopia was estimated as follows: Direct use values yield 737.5 million birr[2] per year; Fish yield 8.3 million birr, water saves 41.7 million birr, the cultural value of trees is at a cost of 904 million birr, pasture for animals is 308.8 million birr.

While in Cyohoha sub-basin at the Rwanda – Burundi border in the Nile Basin, the wetland resources contribute a lot to the livelihoods by saving US$ 188,913 in domestic water, US$1.43million for water

2 1 USD = 9.5 Birr as of June 2008 (Birr is currency used in Ethiopia)

for livestock, US$ 272,727 in fish products and US$ 142,320 in fuel wood. Nakivubo wetland in Uganda, the wetlands is saving the Kampala City council 1.7billion Uganda shillings per month (About 1.7 million dollars) to perform the function of tertiary treatment of waste water while the local users get US$ 200 per month in direct goods and products.

The economic value of wetland conservation is also being appreciated elsewhere. In the United States, for instance, the value of wetlands in preventing serious flooding has been put at US$13,500 per hectare per annum. Fur trapping in North American marshes is thought to be worth from US$151 – 401 per acre, while reed cutting in East Dongting Lake, China, generates about US$1.25 million each year to riparian communities. A study of recreational values of wetlands in England has suggested that they are worth from US$100-210 per visitor each year. Policy and decision makers are normally more attracted to economically valuated projects; this is why it is important to attach economic value to wetlands goods, services and functions for conservation interventions to be implemented.

The economy of many African countries is largely based on the natural resources of which water resources including lakes, rivers and wetlands are essential. For conservation and sustainable development to co-exist in Africa, natural resource economics is vital to create a sense of management responsibility for all stakeholders.

Learning objectives

By the end of this Module, you should be able to:

- Explain the rationale of valuing wetlands products, services and functions
- Describe techniques of valuing wetlands products, services and functions.
- Justify the need for wetland economic evaluation.
- Understand the relationship between wetlands conservation and poverty alleviation especially in rural communities.
- Identify challenges of wetland economic valuation

3.2 Economic valuation and its significance

Economic valuation of wetlands is an attempt to assign quantitative values to goods and services provided by wetlands where or not the market value is available, taking into account that the economic value is measured in terms of willingness to pay for the commodity less what it costs to supply it.

3.2.1 The Rationale for economic valuation

Economic valuation of wetlands is carried out to compare the value of various use options and provide the answer to basic wetland management questions such as whether there is a need to invest, where to invest, how much should be invested, and who to pay the investment and management costs. Economic valuation is a powerful tool to aid and improve wise use and management of global wetland resources by providing a means for measuring and comparing the various benefits of wetlands. The following are some of the terms used while quantifying the wetland benefits.

- **Wetland Processes**:
  The fundamental hydrological, chemical and physical activities that occur in a wetland that are linked to its biological productivity. For example, the role of wetlands in the global carbon cycling.
- **Functions**: The results of the interaction of the wetland's ecological processes. Functions are the physical, chemical, and biological processes occurring in and making up an ecosystem. Processes include the movement of water through the wetland into streams or the ocean; the

decay of organic matter; the release of nitrogen, sulphur, and carbon into the atmosphere; the removal of nutrients, sediment and organic matter from water moving into the wetland; and the growth and development of all the organisms that require wetlands for life.

- **Benefits**: The goods and services made possible by a wetland's functions. For example, by reducing wave energy and stabilizing shorelines, the wetland reduces the chances of property damage. This reduced risk is a benefit to society.
- **Value**: The economic worth of goods or services, generally measured in terms of what individuals are willing to pay for (the wetland has value because it supports commercial fishery, building materials like sand).
  The value of the benefit is determined by its price, the amount of money for which it will be exchanged. The value of a benefit is the price of that product in the open market.

Placing monetary values for wetland goods and services help to ensure that wetlands are not under valued or ignored when economic decisions are made. Therefore, economic valuation provides a basis for rational decisions about the best use of a wetland, taking into account its real economic value.

The economic value of environmental goods and services/commodity is measured by the summation of many individuals' willingness-to-pay for it. In turn, this willingness-to-pay (WTP) reflects individuals' choice for the goods in question. Therefore, economic valuation in the environment context is about measuring the preferences/choices' of people for an environmental benefit or against environmental degradation. Valuation is therefore in relation to preferences held by people. Moreover, the use of economic values permits the comparison that is required between environmental' and 'developmental' values. The latter is expressed in fiscal/monetary terms, either in dollars/pounds/shillings or as economic rate of return.

Exercise 3.1 Millennium Development Goals
a) Explain the relevance of Economic Valuation of Wetlands to the Millennium Development Goals.

Remember:
The underlying the principles of the Ramsar Convention is that wetlands have great value. Conservation can be achieved if wetlands can be shown to be of value and, in some cases, of greater value than proposed alternative uses of the wetland site itself or of the water feeding the wetland. In line with this, Contracting Parties are asked to provide physical and social values of wetlands as part of the information for designation of Wetlands of International Importance.

Specific major reasons for economic valuation of wetlands goods and services include:

(i) The need for economic valuation of wetland impacts and assets arises in pursuing efficient policies and investing in efficient projects and programmes. At the most general level of intergenerational concern, valuation is still required. If transfers of resources are to be made between generations with the current generation sacrificing for the future, or future benefits being lost for the sake of present gain. It is essential to know the monetary value of what is being sacrificed to give an indication of what is being lost or surrendered.

(ii) Macroeconomic management records, monetary flows and transactions within the economy. The national accounts are widely used to indicate well-being and rates of change, and national aggregates such as Gross Net Production (GNP) are widely construed as measures of 'development'. Whether the accounts are designed to record economic activity or measure well-being, or both, they are deficient with

respect to their treatment of the wetlands. Economic activity involves the use of materials and energy, and, once transformed into products, the same resources can still be of value after they become waste products. Any measure of economic activity, which ignores these materials and energy flows, will fail to record important activities that affect the sustainability of the economic activity. For these reasons, there is a need for widespread consensus so that the national accounts are modified and wetland 'stocks' and 'flows' are recorded. Depreciation in the stocks of natural resources requires proper valuation to ensure sustainability.

(iii) Information on the economic values and policy changes (with regard to the wetlands) can greatly assist in identifying the policy and sectoral priorities. Economic valuation incorporating environmental aspects including wetlands helps in evaluating developmental projects, programmes and policies.

Activity 3.1:
Economic valuation of water use.

- Identify a wetland water source where people draw water for domestic use.
- Make a simple water requirement budget per person per day or per week based on the average cost of water per liter in your locality.
- Calculate the minimum amount of money that must be spent on water for domestic use per person per day or week on average.
- Estimate the total population that depends on the wetland water source
- Calculate the minimum amount of money that population would need to spend on water bills with out a wetland per day, week, month or year. *Note: That water is only being given a direct value here but there are so many other things it does in hydrologic and ecosystem functioning which are worth considering.*
- Calculate the value for other goods as well

3.2.2 Techniques and procedures for wetland valuation

In simple terms, wetland valuation means putting a monetary value on the products that are sold like firewood, papyrus, fish, sand and other products. Economists and decision makers normally focus on these values. The Total Economic Value (TEV) of wetlands however extends far beyond the value of raw materials and physical products. A holistic economic valuation technique must therefore be employed.

If researchers value wetland uses and decision-makers take the values into account when making policies that affect wetlands, then a framework for distinguishing and grouping these values must be acceptable. The concept of *Total Economic Value* (TEV) provides such a framework and there is an increasing consensus that it is the most appropriate one to use. Simply put, TEV distinguishes between *use* values and *non-use* values, the latter referring to those current or potential) values associated with an environmental resource which rely merely on its continued existence and are unrelated to use. Typically, use values involve some human 'interaction' with the resource whereas non-use values do not. The TEV framework, as applied to wetlands, is illustrated in the table below.

Table 1: The total economic valuation framework for wetlands

Use Values			Non-Use values
Direct Use Value	Indirect Use Value	Option and Quasi-option Value	
Fish	Nutrient retention	Potential future (direct and indirect) uses	Biodiversity
Agriculture	Flood control	Future value of information	Culture, heritage
Fuel wood	Storm protection		Bequest values
Recreation	Groundwater recharge		
Transport	External ecosystem support		
Wildlife harvesting	Micro-climatic stabilization		
Peat/energy	Shoreline stabilization, etc.		

Source: adapted from Barbier (1989b, 1993, 1994) and Scodari (1990). Other modules can be found in Emerton et al (1999) and Degroot

Economic Value

This is determined by and in a market. In the market, the potential buyer sets a price they are willing to pay, and the seller sets the price they are willing to accept. An acceptable price for both parties is taken to be the market price hence the economic value of a given product. This applies to scarce goods according to the economic theory. For services of wetlands not traded in the market including non consumptive products, other valuation techniques are employed to determine their economic value.

The economic value of a given wetland includes direct values, indirect values, option values, heritage values and existence values. To determine the TEV of a wetland, the values of all the components of the wetland must be established.

Activity 3: Wetland market products value assessment.

- With reference to a local wetland, identify possible market products.
- Make a list of these products and attach a market price for each.
- Make a simple survey of the market products value of your local wetland in a specified period.

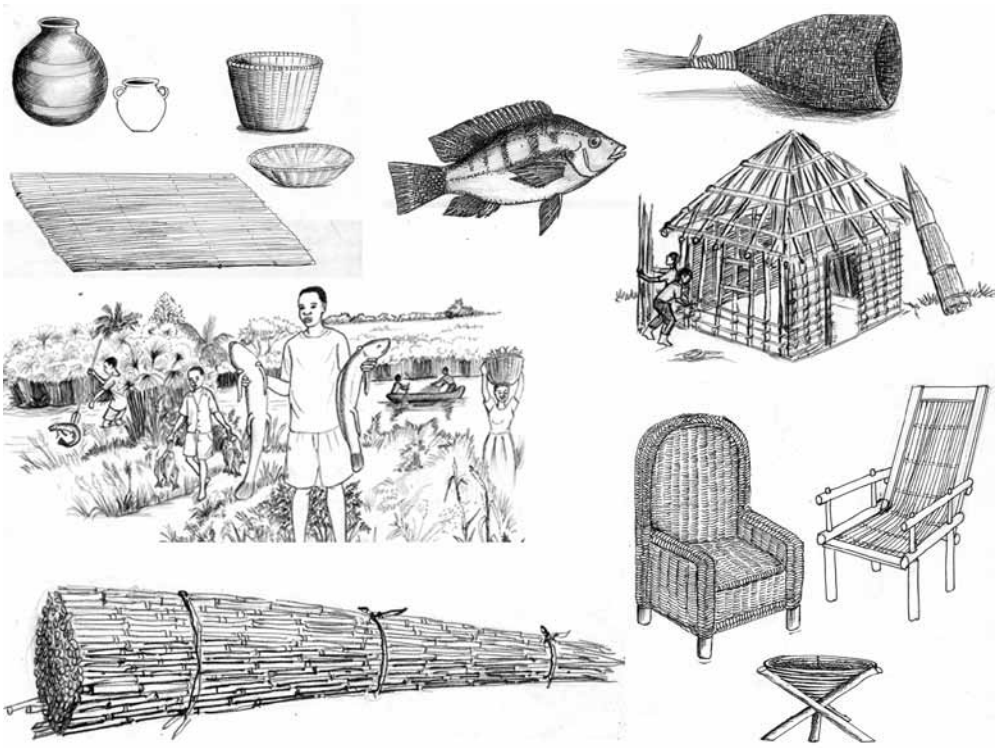

Figure 4. Wetlands Products

Valuation techniques

- Market Prices method

This involves the use of prevailing market prices for goods and services traded in domestic or international markets. Market prices reflect the private willingness to pay for wetland costs and benefits that are traded (like fish, timber, fuel wood, recreation). They may be used to construct financial accounts to compare alternative wetland uses from the perspective of the individual or company concerned with private profit and losses. Price data are relatively easy to obtain. The advantage of this method is that the Market imperfections and/or policy failures may distort market prices which will therefore fail to reflect the economic value of goods or services to society as a whole. Seasonal variations and other effects on prices need to be considered when market prices are used in economic analysis.

- Efficiency (Shadow) Prices method

The efficiency prices method involves the use of market prices but, adjusted for transfer payments, market imperfections and policy distortions. May also incorporate distribution weights, where equality concerns are made explicit. Shadow prices may also be calculated for non-marketed goods. Efficiency prices reflect the true economic value or opportunity cost, to society as a whole, of goods and services that are traded in domestic or international markets (like fish, fuel wood, peat). The disadvantage of this method is that the derivation of efficiency prices is complex and may require substantial data. Apparently, decision-makers may not accept 'artificial' prices.

- Hedonic Pricing method

In this method, the value of an environmental amenity (such as a view) is obtained from property or labour markets. The basic assumption is that the observed property value (or wage) reflects a stream of benefits (or working conditions) and that it is possible to isolate the value of the relevant environmental amenity or attribute. Hedonic pricing has potential for valuing certain wetland functions (like storm protection, groundwater recharge) in terms of their impact on land values, assuming that the wetland functions are fully reflected in land prices.

The disadvantage of this method is that application of hedonic pricing to the environmental functions of wetlands requires that these values are reflected in surrogate markets. The approach may be limited where markets are distorted, choices are constrained by income, information about environmental conditions is not widespread and data are scarce

- Production Function approach

This method estimates the value of a non-marketed resource or ecological function in terms of changes in economic activity by modeling the physical contribution of the resource or function to economic output. Production function approach is widely used to estimate the impact of wetlands and reef destruction, deforestation and water pollution, or on productive activities such as fishing, hunting and farming. This method however, requires explicit modeling of the 'dose-response' relationship between the resource or function being valued and some economic output. Application of the approach is most straightforward in the case of single use systems but becomes more complicated with multiple use systems. Problems may arise from multispecification of the ecological-economic relationship or double counting.

- Related Good method (The Value of Alternatives)

It involves the use of information about the relation-ship between a non-marketed good or service and a marketed product to infer value. The *barter exchange approach* relies on actual exchange of non-marketed goods. The *direct substitute approach* simply assumes that a marketed good can be substituted for a non-marketed good. The *indirect substitute approach* also relies on a substitute good, but if the latter is not exchanged in the market, its value is inferred in terms of a change in economic output (like the direct substitute approach combined with the production function approach). These approaches may provide a rough indicator of economic value, subject to data constraints and the degree of similarity or substitutability between related goods. The barter exchange approach requires information on the rate of exchange between two goods. The direct substitute approach requires information on the degree of substitution between two goods. The indirect substitute approach requires information on the degree of substitution and on the contribution of the substitute good to economic output.

- Constructed Market techniques

This involves the measure of Willingness to Pay by directly eliciting consumer preferences. This technique directly estimates Hicksian welfare measure - provides best theoretical measure of Willingness to Pay. However, practical limitations of constructed market techniques may detract from theoretical advantages, leading to poor estimates of true Willingness to Pay.

- Cost-based valuation

This is based the on assumption that the cost of maintaining an environmental benefit is a reasonable estimate of its value. To estimate willingness to pay, it is easier to measure the costs of producing benefits than the benefits themselves, when goods, services and benefits are non-marketed. Approaches are less data and resource intensive. The disadvantage of this technique is that these second-best approaches assume that expenditure provides positive benefits and net benefits generated by expenditure match the original level of benefits. Even when these conditions are met, costs are usually not an accurate measure of benefits.

- Travel Cost approach

The Travel Cost approach derives Willingness to Pay for environmental benefits at a specific location by using information on the amount of money and time that people spend to visit the location.

- Other techniques include;
  - *(i)* *Damage Costs avoided* (DC) approach, which relies on the assumption that damage estimates are a measure of value. It is not a cost-based approach as it relies on the use of valuation methods described above.
  - *(ii)* *Contingent Valuation method* (CVM) constructs a hypothetical market to elicit respondents' Willingness to Pay.
  - *(iii)* *Contingent Ranking* (CR) ranks and scores of relative preferences for amenities in qualitative rather than monetary terms.
  - *(iv)* *Indirect Opportunity cost* (IOC) method uses wages foregone by labour in production of non-marketed goods.
  - *(v)* *Restoration Cost* (RSC) method uses costs of restoring ecosystem goods or services.
  - *(vi)* *Return to Yields* Very important for agriculture

3.3 A Systematic Guide to Undertaking a Valuation Study

There are seven practical steps, which must be followed to undertake an economic valuation of a wetland. These are presented and described below.

Seven steps to conducting a valuation study

1. ***Choose*** the appropriate assessment approach (Impact Analysis, Partial Valuation, Total Valuation)
2. ***Define*** the wetland area and specify the system boundary between this area and the surrounding region
3. ***Identify*** the components, functions and attributes of the wetland ecosystem and rank them in terms of importance (e.g., high, medium, low)
4. ***Relate*** the components, functions and attributes to the type of use value (direct use, indirect use and non-use)
5. ***Identify*** the information required to assess each form of use (or non-use) which is to be valued and how to obtain the data
6. ***Use*** available information to quantify economic values, where possible.
7. ***Implement*** the appropriate appraisal method, like Cost Benefit Analysis (CBA).

Step 1: choosing the appropriate assessment approach

There are three approaches: Impact Analysis; Partial Valuation; and Total Valuation. If the problem is a specific external impact, such as effluent polluting a wetland, ***Impact Analysis*** will be appropriate. If the problem is the necessity of making one choice between wetland use options, including conversion of the wetland to residential land or diversion of water upstream of the wetland to intensive irrigation,

then **a *Partial Valuation*** would be the correct approach. Sometimes the problem is more general. For example, developing a national conservation strategy may require assessment of the total net benefits of the wetland system. In this case**, *a Total Valuation*** should be undertaken.

- **Step 2: defining the wetland area**

The boundary of the wetland may already have been defined for political purposes, such as gazettement as a National Park or Ramsar site. No definitive methodology exists to delineate the boundary scientifically. This will be the first task for the multi-disciplinary team based on maps of flood extent, soils, agricultural use and vegetation.

- **Step 3: identifying and prioritizing components, functions and attributes**

The third step involves using various data sources, including scientific studies, consultancy reports and national resource inventories, to produce a more definitive list of components, functions and attributes present in the wetland, and then to place them in order of importance. This may be in rank order, say 1 to 10, or expressed as being of high, medium or low importance. The major components, functions and attributes are discussed in other chapters. Clearly, no single wetland will exhibit all of these, and it is important for the multidisciplinary team to work together to identify the key components, functions and attributes of the wetland being studied and to use all available ecological, hydrological and economic information to score these various characteristics.

The distinction between components, functions and attributes is directly useful from an economic perspective, but scientists from other disciplines may have some difficulty with these concepts. Regardless of whether these characteristics or others are used, it is important that all members of the team understand their meaning and work together to establish priorities for valuation amongst themselves.

- **Step 4: relating components, functions and attributes to use value**

The fourth step is to determine whether each of the components, functions and attributes is associated with a direct use, indirect use or non-use. Interviews with local communities, census data and consultancy reports are usually good sources of information on direct use. More detailed scientific investigation is usually required to uncover the indirect use values, concentrating on the physical links between wetland system functioning and the economic activities affected. Some of the intangible values – option and existence values require a good experience to determine, and it will often be up to the multidisciplinary team to use its best judgment, keeping in mind the difficulties of quantifying these values.

- **Step 5: identifying and obtaining information required for assessment**

The fifth step involves identifying and obtaining information required for the valuation. Different physical, chemical and biological data will be required depending on the values that are to be assessed and the methodology for collecting and analyzing the data must be specified. The range of data to be collected can be extremely diverse. For example, it may include fish population status, numbers of rare species, rates of groundwater recharge, and amounts of flood storage, degree of nutrient retention or coastal protection and so forth. Information on the extent and rate of various human uses of the wetland must also be collected.

The types of data may again be diverse, including agricultural yields, fish catches, tourist use or reduction in annual damage from storms or floods. A variety of collection methods and sources may be required. Obtaining agricultural and fisheries yields, for example, may involve interviews with people involved in fishing and farmers, collection of statistics from government offices and visits to markets. Travel agents or tour companies could provide data on tourism in general, whilst parks and protected areas will know visitor numbers. Insurance agencies may have information on flood and storm damage in the area, whilst environmental authorities may collect water quality data.

Information is required on all inputs and outputs for all economic activities that are either directly or indirectly supported or protected by wetland ecological functions. This will include the economic costs of the inputs (such as labour-time, materials, and physical assets) and the prices of the outputs (products). On the inputs, a distinction needs to be made between purchased inputs (like tools, licenses, hired labour) and non-cash inputs (like use of their own or family labour and borrowed tools). Similarly, distinction must be made between outputs which are marketed (like rice sold at the local market) and those which are non-marketed (like fish eaten at home).

Information is required on the producer prices, the final market prices, the transportation, and other intermediary costs of marketed products. For non-marketed products, it is necessary to know their rates of consumption, and it may be helpful to obtain information on the market price of any substitute or alternative product.

The information required to assess non-use or preservation values is extremely difficult to collect for developing countries and may require specific studies to estimate willingness to pay. If such analysis is beyond the scope of the study, assessment of such values may warrant a qualitative rather than quantitative approach. This can be approached through interviews with local people and those outside the area who have a connection with it.
More general social and economic data should also be collected on communities living within the wetlands or where they benefit from, or are affected by, wetland functions. For example, this may include population growth rates, income levels, credit facilities and rates of interest, inflation and exchange rates.

Data collection should begin with ***a literature survey*** of available statistics, existing studies, and their analysis for the region, which may yield some of the required information. Next, any site surveys of specific economic activities should be undertaken. In the first instance, ***a Rapid Rural Appraisal*** based on brief farmer or producer interviews and group participation may be relevant to collecting basic information on human uses and economic data. More detailed ***Baseline Surveys*** may be required for in-depth data collection for actual valuation purposes. In all cases, it is important to be clear in advance about the information required to avoid collecting 'data for data's sake'.

- **Step 6: quantifying economic values**

In this step, the appropriate valuation techniques should be selected and implemented. There are many techniques, such as Contingent Valuation and Hedonic Pricing, which are being applied to value temperate wetland functions, products and attributes, and such methods are increasingly being implemented especially in tropical regions. Although alternative approaches are available, some of these may yield extremely inaccurate valuation estimates. Care must therefore be exercised in choosing a technique which is theoretically sound but which is also appropriate to the circumstances where it will be applied.

- **Step 7: implementing the appropriate appraisal method**

In the final step, the economic analysis of the wetlands should be placed in the appropriate framework as selected during the planning for the study. An example is *Cost-Benefit Analysis* (CBA), which normally involves calculating, on an annual basis the benefits and costs of conserving the natural wetland functions, products and attributes over a selected time period. The three most common methods for comparing costs and benefits are *net present value*, *internal rate of return* and *benefit-cost ratio*. Any valuation should be subject to a sensitivity analysis, which defines the variation in results arising from different assumptions or benchmark values used in the study, such as discount rates.

However, CBA is not the only possible appraisal method available, and other frameworks, such as Environmental Impact Assessment, Multi-Criteria Analysis and Risk Assessment may also require economic valuation as part of the assessment procedure. Initial planning of the study should determine which framework for assessing costs and benefits is desirable, as the choice of framework may affect all seven steps of the analysis.

3.4 Module Summary

In this Module, you have studied:

- The rationale of valuing wetlands products, services and functions
- The techniques of valuing wetlands products, services and functions
- The relationship between wetlands conservation and poverty alleviation especially in rural communities
- The challenges of wetland economic valuation
- Methods and skills of valuing wetlands systems
- Points to consider when selecting methods for valuing wetlands
- Some optional and non use values require a lot of expertise
- When valuing goods considerations for the ecosystem contributions are necessary.

Activity 4
Points for discussion

1. With special reference to your country, describe the importance of wetlands economic valuation.
2. How does economic valuation of wetlands help the economic policy makers in making sustainable development choices?
3. In groups, determine the economic value of a small wetland near your institution.

3.5 Further reading

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The Ramsar Secretariat Website: www.ramsar.org

MODULE 4: WETLANDS AND BIODIVERSITY

4.1 Introduction

Wetlands are among the most productive life-support systems in the world and are of immense socio-economic and ecological importance to humankind. They are critical for the maintenance of biodiversity and perform a great role in the biosphere. Ironically, wetlands have been associated with disease, difficulties and danger. By emphasizing the negative impacts and ignoring their importance, wetland habitats were for a long time considered obstacles in the path of progress. As a result, they were drained, filled, despoiled and degraded for economic gains by converting them for use as dry lands. The wetland loss is responsible for bringing to extinction countless species of animals and plants. Inadequate understanding of the crucial role and utility of wetlands is a matter of serious concern. This module examines the role of wetlands in maintaining biological diversity.

Wetland ecosystems are ecotones between aquatic and terrestrial conditions which puts them at advantage to attract organisms from land and water. Even organisms from extremes will still rely on wetlands for an activity, fulfillment of life cycle or feeding. Adaptations are inevitable in wetlands associated with seasonal or longer-term fluctuations, in relation to regional climate. Therefore, in wetlands one will finds terrestrial organisms, aquatic organisms, and adaptive forms to extreme conditions of aquatic and dry conditions. Consequently, the variety of living organisms that have adapted to the different wetland habitats tends to be higher than in other ecosystems, with major groups of plants and animals present. Therefore, in simple terms, wetlands biodiversity is related to the number and variety of organisms found within wetlands.

Learning objectives

By the end of this unit, learners should be able to:

- Define the term biodiversity with
- State and explain the importance of biodiversity with special reference to wetlands.
- Identify examples and benefits of wetland biodiversity
- Identify threats and impacts to wetlands biodiversity and propose mitigation measures
- Give and explain the benefits of wetland biodiversity to humankind
- Carry out an inventory of Wetlands and biodiversity

4.2 Biodiversity and its importance

4.2.1 What is biodiversity?

Biodiversity is the variation of life forms within a given ecosystem, biome or for the entire earth. It is often used as a measure of the health of biological systems including forests, wetlands, lakes and rivers. Biodiversity refers to the "variation of life at all levels of biological organization". It is a measure of the relative diversity among organisms present in different ecosystems. Some ecologists also describe biodiversity as the "totality of genes, species, and ecosystems of a region".

This description classifies biodiversity into three levels of identification:

- Genetic Diversity - diversity of genes within a species. There is a genetic variability among the populations and the individuals of the same species.
- Species diversity - diversity among species in an ecosystem. "Biodiversity hotspots" are excellent examples of species diversity.
- Ecosystem diversity - diversity at a higher level of organization, the ecosystem.

The 1992 United Nations Earth Summit in Rio de Janeiro defined "biodiversity" as "the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatice system, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems".

For geneticists, *biodiversity* is the diversity of genes and organisms. They study processes such as mutations, gene exchanges, and genome dynamics that occur at the DNA level and generate evolution.

For ecologists, biodiversity is also the diversity of durable interactions among species. It not only applies to species, but also to their immediate environment (biotope) and their larger eco-region. In each ecosystem, living organisms are part of a whole, interacting with not only other organisms, but also with the air, water, and soil that surround them.

4.2.2 Importance of biodiversity

There are no simple answers to this question. Biodiversity itself is a complex, perhaps amorphous concept, extending from genes to ecosystems and biomes, and to interactions and processes. There are a number of ways in which we value biodiversity. our value systems range from purely economic to ecological ones. Cultural values are also prominent but rarely universal. Values of biodiversity may also exist wholly outside the human context, as is the case of inherent values of species. There are, however, ways to bring the question into focus. As in human life, sometimes how we value others comes most into focus when we are about to lose them from our lives. A friend moves to a new city or a grandparent dies. Their passage often provokes reflection upon what they meant to us and the ways in which they were important to us. In other words, we sometimes can most easily articulate the value of something to us when we are about to lose it. Here is a subset of some categories used to examine the value of biodiversity:

- Direct Use Values - Species provide various goods or products to humans, many of which play important roles in human economies. Examples include food, medicine, timber, fiber, etc.

- Indirect Use Values - Species provide services to humans as well as to other species. These include pollination, nutrient cycling, regulation of the atmosphere and climate.

- Ecological Value - Biodiversity provides many ecosystem services that are often not readily visible. It plays a part in regulating the chemistry of our atmosphere and water supply. Biodiversity is directly involved in recycling nutrients and providing fertile soils. Experiments with controlled environments have shown that humans cannot easily build ecosystems to support human needs; for example insect pollination cannot be mimicked by human-made construction, and that activity alone represents tens of billions of dollars in ecosystem services per annum to humankind.

- All species are supported by the interactions among other species and ecosystems, each providing an ecological value to one another. Loss of species makes ecosystems less resilient and often less productive.

- Cultural-social and Spiritual Value. The identity of human cultures around the world is attached to varying degrees to wild species. Wild species are often referred to in religious texts. Outside of formal religion, many people feel connected to species for reasons that can be hard to explain. Some may be inspired by a species' intrinsic beauty, revere it for its strength, or admire it for its cleverness. Whatever the case, cultural diversity is closely linked to wild species. Many people derive value from biodiversity through leisure activities such as enjoying a walk in the countryside, bird watching or natural history programs on television. Biodiversity has inspired musicians, painters, sculptors, writers and other artists. Many cultural groups view themselves as an integral part of the natural world and show respect for other living organisms.

- Intellectual value-Through the field of bionics, a lot of technological advancement has been done which may not have been the case without a rich biodiversity.

Activity 4.1 Field work

Visit a nearby wetland; observe the various flora and fauna. Identify the plants and animals giving their local, common name and scientific name. State the value of each of these organisms to the Wetlands Ecosystem. Present this in a report.

4.3 The Biological Diversity of Wetlands

4.3.1 Wetland flora and fauna

Since plants and animals depend on water for life and substrate to obtain their feed, the wetlands provide both, that is why they are species rich in both flora and fauna. However, because of the dynamic nature of seasonal wetlands, with periods of drying and inundation varying in frequency and duration over time, some plants and animals live active in wetlands at only certain seasons, while others may be hidden or dormant as seeds or bulbs at other seasons. A full inventory of wetlands biodiversity should therefore take into account the seasonality including responses to behavioral change and migrating organisms.

Wetland ecosystems are therefore cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. They support high concentrations of birds (especially waterfowl), mammals, reptiles, amphibians, fish and invertebrate species. Levels of species diversity do however vary considerably between different wetland ecosystems. Some wetlands display high levels of diversity and endemism, whereas others support specialized life. Identification and classification of wetland species should consider that many species spend part of their life cycle in both freshwater and marine ecosystems. Wetlands are a storehouse of plant genetic materials. Rice, a common wetland plant, is the staple diet of more than half of the world's population. West African rice (*Oryza glabberrina*), for example, was domesticated over 2000 years ago and wild rice from other wetlands continues to be an important source of new genetic materials in developing disease-resistant and higher-yield strains. A wide range of important woody species are also found in wetlands: many bear adaptations to changing hydrological conditions (changes in water regimes or increased salt levels) and may be of value in the context of global climate change and rising sea levels. Conserving the genetic variability of such plant resources is therefore essential.

Wetlands are renowned for their high levels of endemic species, especially fish and invertebrates. Nowhere is this more obvious than in the East African Rift Valley lakes (Victoria, Tanganyika, Malawi) which support exceptionally high levels of endemic fish. More than 700 endemic species of cichlids have been recorded. Some 80% of the cichlids in Lake Tanganyika are endemic. A survey conducted by the World Conservation Monitoring Centre showed that 18 "hot spots" for biodiversity contained 737 species of amphibians alone, clearly demonstrating the importance of wetlands in maintaining biological diversity.

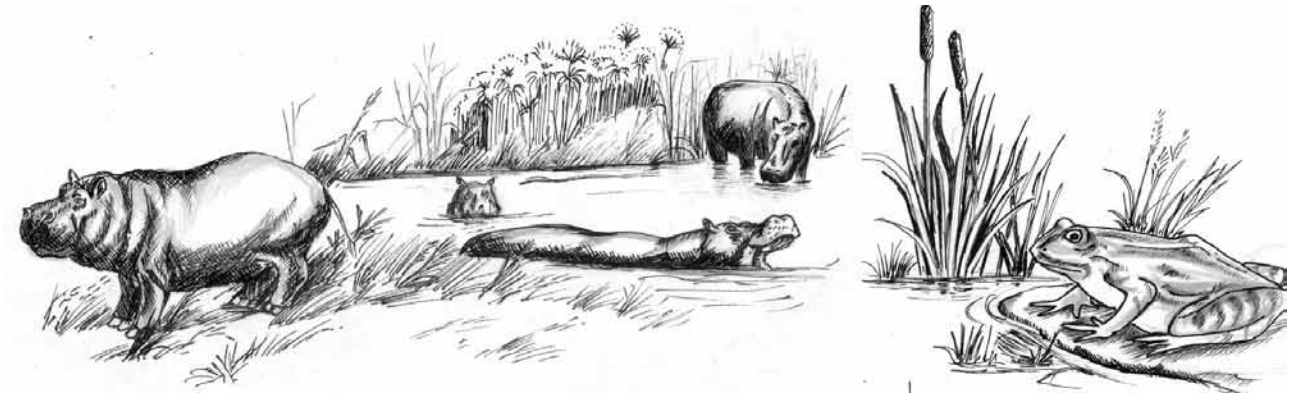

Figure 5.Wetlands plants and animals

4.3.2 Biodiversity in African Wetlands

The biological diversity of wetlands in the continent is unevenly distributed, with some habitats being characterized by a richer range of species than others. The importance of any given wetland from a biodiversity perspective is assessed not only by the overall richness in number of species present, but on the uniqueness of the area in terms of the number of localized species, particularly the endemic species. In this regard, most African wetlands display both characteristics, richness in number of species and endemism. There are, for example, over 2,000 known species of indigenous freshwater fishes in Africa. The Congo River Basin, probably the most diverse area in Africa for its fishes, has over 700 identified species of which 560 are endemic to the basin. There are at least 18 families of endemic freshwater fish fauna many of which are found in the great lakes of east and central Africa.

Some authorities believe that the Inner Niger Delta in Mali, the seasonally inundated floodplain of northern Central African Republic and southern Chad, the Sudd region of southern Sudan are wetlands of highest endemism and of international significance in Africa. Others are Lake Victoria and Kyoga in Uganda, the swamps of western Tanzania and various parts of Zambia and, the Okavango region of northern Botswana. Recent studies in the Lake Tana sub-basin in Ethiopia and Lake Cyohoha sub-basin at the Rwanda – Burundi border show a rich diversity and high endemism of various species.

4.3.3 Wetland flora and their adaptations

Wetland flora is distinctive and varied. It typically includes several different plant forms including algae and periphyton growths attached to substrates; floating macrophytes such as the water lilies, nile cabbage, hippo grass; submerged plants such as sea grasses and pond weeds; emergent macrophytes such as reeds, rushes, sedges, herbs, grasses, trees and shrubs. Trees and shrubs characteristic of wetlands include paper-bark and tea-tree species.

Plants play a critical role in the structure and productivity of wetland environments. In marine shorelines there are reefs described as 'cor-algal' reefs that exhibit close association between the corals (animals) and species of algae (plants). The coral reefs are very important habitats for biodiversity because the algae living in the coral tissues aid in the production of organic matter largely responsible for the high productivity of the reefs.

Adaptations of flora to wetland conditions

Wetland plants have developed adaptations to deal with the challenges posed by wetland ecosystems, the biggest of which may be oxygen deficiency.

For plants to take up nutrients, they have a natural pumping system in the roots. This pump requires energy and in dry land, with the ample oxygen available in the root zone, the energy is provided by oxidation of carbohydrates. Under water logged conditions when the oxygen levels are low in the root zone, there are various strategies a plant can use;

- To bring oxygen from the air to the root zone.
- To use alternative metabolism to generate energy.
- Some wetland plants have a porous stem and root system which allows oxygen to be picked up from the air to travel to the roots.
- Other plants have developed anaerobic respiratory processes and can diffuse the toxic by-products through a fine root system.

4.3.4 Wetland fauna and their adaptations

The species diversity and high production levels of wetland plants support even more diverse animal communities. The vegetation distribution patterns and water level fluctuations make a range of continuously changing wetland habitats available at different times of the year. Wetlands support high concentrations of birds (especially waterfowl), mammals, reptiles, amphibians, fish and invertebrate species. In a wetland one can find grazing and browsing animals, including several large mammals such as, Sitatunga, Otters, African Buffalo *Syncerus caffer* and Hippopotamus, *Hippopotamus amphibious* in Africa. Wetlands habit reptiles including the Nile Crocodiles and a number of amphibians. The fish use wetlands for breeding and because of presence of lots of invertebrates, particularly arthropods, snails and worms which also form food for higher vertebrates. Many of the animals found in wetland areas are considered rare and threatened, like the Shoebill stock, many reptiles and mammals.

Figure 6. Some larger mammals visit wetlands for shelter and food

Seasonal wetlands exhibit ephemeral characteristics due to wetting and drying, and wetland animals are adapted to this. The drying and subsequent re-flooding of a wetland may be the most important impulse for the growth and reproduction of wetland plants and animals. Wetlands that retain water in times of drought may provide valuable wildlife refuge, but the drying phase is equally important, as the organisms affected go into dormancy and continue their life in the following season when the water logs. Many wetland plants also set seed during this dry period. However, the periods of drying that follow the wet seasons are also important for the decomposition of plants and their associated release of nutrients. The re-flooding of a dry wetland triggers prolific growth and breeding of insects as well as the germination of native plants in a presumably new nutrient rich environment. These insects and plants provide food for native fish, water birds and other animals.

Apart from providing habitats for wild fauna, wetlands are used as grazing areas for cattle, goats and sheep and may support species such as pigs, goats, cats, deer, rabbits and foxes. Another unique aspect of wetlands is their potential to provide habitat for transboundary migratory fauna as resting and feeding stations along migratory flyways like the ducks, waders and shorebirds, which benefit from the diversity of food organisms. The seasonal influx of passage migrants serves to increase the biodiversity of many wetland sites.

Adaptations of animals to wetland conditions

The unique wetlands vegetation and fauna has adapted to the special conditions to exploit the wetland habitats. The following are some specific adaptations that animals have evolved; `

Respiration; Many organisms use alternative means of gaseous exchange. The insects use tinny tubes pocking out of the water for breathing; lungfish have a pseudo lung which they use to breathe air to supplement the poor oxygen supply in the wetlands.

Mobility: wetland animals have specialized appendages enabling them to move with speed and agility within the environment. Examples include; the long hooves of the Sitatunga that spread out as the animal moves, the webbed and elongated toes of many wetland birds, and the waterproof body of animals, such as the otter. Streamline and muscular bodies enabling them to move through the water easily.

Feeding; Some wetland animals have adapted to changing water levels by having versatile feeding habits. For example; the sitatunga feeds on a variety of vegetation on wetland margins when water levels are high. When water levels drop, it moves deep into the swamp to feed almost exclusively on papyrus shoots. Wetland birds have elaborately adapted feet and beaks for feeding at different depths in the mud or water. This reduces competition for food and enables a high number of birds to feed in the same physical space. Crustaceans are filter feeders, trapping detritus or plankton from the water.

Dormancy: Due to changes in seasons, some organisms go into dormancy, the lung fish aestivate during dry season using conserved energy until water levels rise. Many insects go into diapause. Aestivation is the period of dormancy by organisms in the dry seasons. During this time growth is suspended, respiration and metabolic rates are reduced, and the animal is inactive until favorable conditions return for animals to resume active life.

4.5 Benefits, threats and consequences of loss of Wetland Biodiversity

4.5.1. Benefits

Wetlands are some of the most productive ecosystems in the world and indeed they are an important, and in many cases the exclusive, source of natural resources upon which rural economies depend, providing food and energy, medicine, building material, dry season grazing and transportation for large human populations. There are many examples of how local communities make use of the diversity and high productivity of wetlands. For example, in the Nile Basin countries, people harvest *Cyperus papyrus* to make mats and baskets but *Cyperus papyrus* has many other uses like being compressed into fuel briquettes that are good for cooking.

Activity 4.2

In a groups, visit a wetland that is nearest to your school and do the following;

a. Observe carefully the various flora and fauna of the wetland.
b. In your record sheets, make a list of the plants and animals
c. Collect a few plants and animals from the wetland, and identify any physical observable features that enable them to survive in the wetland environment.
d. What features do you think make the listed plants survive in the wetlands during in presence or absence of water?
e. What others do you expect to live in this wetlands but are have not been observed during your visit. Give reasons.

4.5.2 Threats to Wetland and their Biodiversity

The Nile basin region has a significant number of precious wetlands, however, some wetland areas are experiencing immense development pressure from human activities. Wetlands are being drainage for industrial development, agriculture and settlement, excessive exploitation many of which are improperly planned.

In spite of the noted importance of wetlands, the pressure on wetlands is expected to increase as populations grow, unless strategic actions are put in place for the conservation of wetlands and their biodiversity. For example the construction of dams prevent upstream movement of migratory fish species. Changes in wetlands' water quality, is also another big threat to wetland biodiversity. This is mainly due to the effects of industrial effluent and agricultural pesticides, siltation from highland catchment areas, and introduction of alien species of flora and fauna leading to colonization by single species and loss of endemic species diversity. The introduction of species also causes ecological imbalances. For example the introduction of the Nile perch *Lates niloticus* in Lake Victoria, caused an ecological imbalance with the endemic cichlids. The future of wetlands lies in a strong political will to conserve them, based on sound wetland policies and encouragement of community participation in their management. Absence of appropriate wetland policies in many Africa countries threaten the existence of wetlands.

Coupled with the absence of policy is inadequate institutions to manage wetlands. In many African countries the management of wetlands is a delegated responsibility with no clear government institutional frameworks to take the lead in management of wetlands and conservation of endangered and fragile sites. Efforts are required to specifically focus on wetlands outside protected areas. In Uganda, a policy, strategy and institution for managing wetlands exists and has lessons that can be used in other countries.

Prioritization and allocation of resources for wetlands management also threaten their existence. This is due to poor understanding of wetlands as resources that can alleviate livelihoods and support sustainable development. The attitude of many people is still that of converting them and this can only be reversed through awareness programs

4.5.3 Consequences of Wetland Biodiversity loss

It is obvious from the large number of resource organisms mentioned earlier, that loss of wetland species has economic implications. The livelihood and culture of large numbers of people, in almost every country of the world, will be endangered if wetland resources become further depleted. A major portion of fisheries production, most hunting, much forest production and a significant part of ecotourism will be lost worldwide, as well as elements of heritage and environmental quality. It is important to stress, however, that it is not sufficient just to protect the populations of plants and animals that are directly exploited: their health and survival, or sustainability, depend on maintaining the whole complex of biodiversity that characterizes wetland ecosystems.

Commercially exploitable wetland plant and animal species will be available only if the biological processes which produce them are maintained. These include primary production, nutrient cycling, pollination, flowering, fruiting, decomposition, food web interactions, grazing, predation, immigration and emigration. Hundreds of inter-related organisms take part in these processes and it is this diversity of wetland species which keeps the ecological equilibrium thus making them productive. Loss of any link in the web of biodiversity will reduce the goods, functions and attributes of a wetland.

Degradation of wetlands causes an imbalance on associated systems namely: loss of nursery habitat, reduction of coastal fishery yields or loss of a wetland on a flyway could disrupt waterfowl migrations, threatening the capacity of individual birds to reproduce and eventually the survival of populations or species. Drainage of wetlands means loosing the water that has been stored, hence animals and biodiversity will move away or die because there will be no water. It is important for maintaining the distinctiveness of plants and animals in different locations which has implications for our appreciation of nature.

The variability, geographic dispersion and biological richness of wetlands globally mean that they contain a tremendous pool of genetic resources (the hereditary or genetic make-up). This genetic diversity is important for a variety of reasons: it determines the ability of individuals and populations to adapt to changing environmental conditions, such as global warming or new diseases; it is essential for the continuing evolution of various species; it provides the basis for the selection and production of new resource organisms.

4.6 Wetland Important Bird Areas (IBAs) in the Nile Basin Region

4.6.1 What are IBAs?

Important Bird Areas (IBAs) are sites of international importance for bird conservation and other biodiversity. They are recognized worldwide as practical tools for bird conservation. IBAs are small enough to be practical targets for conservation management, but large enough to meet the global IBA criteria. Important Bird Areas, provide essential habitats for one or more species of birds. They include sites for breeding, and migrating birds. IBAs may be a few acres or thousands of acres, but usually they are discrete sites that stand out from the surrounding landscape. They may include public or private lands, or both, and they may be protected or unprotected.

4.6.2 Criteria for selection of a site as an IBA

The selection of Important Bird Areas (IBAs) is achieved through the application of quantitative ornithological criteria, grounded in up-to-date knowledge of the sizes and trends of bird populations. The criteria ensure that the sites selected as IBAs have true significance for the international conservation of bird populations, and provide a common currency that all IBAs adhere to, thus creating consistency among, and enabling comparability between, sites at national, continental and global levels.

A set of objective, standardized criteria has been developed for selecting Important Bird Areas (IBAs) of global significance, based on the presence of world wide conservation concern. A site may qualify as an IBA, if it meets one or more of the following criteria;

- *Species of global conservation concern*; A site qualifies to be an IBA if it is known, estimated or thought to hold on a regular basis, significant numbers of bird species categorized by the IUCN Red List as Critically Endangered, Endangered or Vulnerable. In general, the regular presence of a Critical or Endangered bird species, irrespective of population size, at a site may be sufficient for it to qualify as an IBA.
- *Presence of restricted-range species*; if a site has a significant component of the restricted –range bird species whose breeding distributions define an Endemic Bird Area (EBA).

- *Presence of biome-restricted species*; if a site holds a significant number of bird species, whose distributions are largely or wholly confined to one biome.
- *Presence of congregatory birds*; when a site is known to hold on a regular basis, a large number of congregatory water birds, sea birds or terrestrial bird species.

There is growing evidence that networks of IBAs, though identified using information on birds, are disproportionately important for other animals and plants. That is to say, IBA networks are good at conserving threatened, endemic and representative species for other terrestrial groups. The effectiveness of the IBA network has already been shown for terrestrial vertebrates in East Africa; globally threatened wildlife species in the mountains and coastal forests of Kenya and Tanzania, and butterflies, large moths, small mammals and woody plants in Ugandan forests.

4.6.3 Examples of IBAs in the Nile Basin Region

All Nile basin countries have at least identified sites that serve as Important Bird Areas (IBAs), majority of which are wetlands.

Plate 2: Some Wetland bird species

Pied African wagtail

Egret

Marabou Stork

Egyptian geese

African Snipe

Glossy Ibis

Activity 4.3

Nile basin countries all have Important Bird Area (IBAs). With reference to a named country in the Nile basin region;

- Identify the sites that have been selected as IBAs
- How many of the identified IBAs are in wetland areas?
- Which type of bird species are being protected in the IBAs identified?
- What criteria do you think were used to select the identified IBAs?
- What is the importance of biodiversity and having IBAs?

4.7 Module summary

In this Module, you have studied:

- The description of the term biodiversity
- The importance of biodiversity with special reference to wetlands
- Examples and benefits of wetland biodiversity
- Threats to wetlands biodiversity and propose mitigation measures

Photgraph 3: White faced whistling ducks – from Cyohoha sub basin photo by Ronald Mulwa.

4.8 Further reading

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MODULE 5: INVENTORY, ASSESSMENT AND MONITORING OF WETLANDS

5.1 Introduction

Many countries including the Nile Basin countries are faced with the challenge of preventing wetland destruction and are concerned about the quality of the existing wetlands and to restore some if need be. It is therefore important to understand wetland systems in order to assist decision-making and to answer questions related to the role wetlands play in watershed and landscape management, as habitats for fish and wildlife, flood control, water quality and storage, and wise use. How can we plan for development in such a way that we retain the value of the wetlands left? How can important but degraded wetlands be restored?

The questions raised above concern wetland management. Inventory, Assessment and Monitoring are important components of effective wetland management because they provide data and information for management decisions. In addition, they provide feedback on management actions and implementation of principles and frameworks which are vital information for managers and decision makers. Therefore, Inventory, Assessment and Monitoring cannot be treated separately from management processes hence the need to design and implement integrated management programmes. This module discusses Inventory, Assessment and Monitoring of wetlands.

Learning Objectives

By the end of the Module, the learner should be able to:

- Describe wetland assessment techniques
- Examine wetland monitoring techniques and how to use them
- Outline rationale for wetland assessment
- Critique biological monitoring
- Assess the quality of water in the surrounding communities
- Prepare for field visits to wetlands in communities and identify issues threatening their existence
- Suggest mitigation measures to the issues identified

5.2 Wetland Inventory

Wetland Inventory is the collection and/or collation of core information for wetland management, including the provision of information base for specific assessment and monitoring activities. A structured framework for planning and designing a wetland inventory is summarized in Table 5.1 below. The steps in the framework are applicable to the planning and implementation of any wetland inventory and should be followed during the design and planning process. The framework does not provide prescriptive guidance on particular inventory methods; rather it provides guidance to undertake wetland inventory by drawing attention to different methods and wetland classifications already in use and of proven utility under different circumstances. The framework should be used as a basis for making decisions for undertaking a wetland inventory under the circumstances particular to each inventory program.

Table 5.1: A structured framework for planning a wetland inventory

Step	Guidance
1. State the purpose and objective	State the reason(s) for undertaking the inventory and why the information is required, as the basis for choosing a spatial scale and minimum data set.
2. Review existing knowledge and information	Review the published and unpublished literature and determine the extent of knowledge and information available for wetlands in the area being considered.
3. Review existing inventory methods	Review available methods and seek expert technical advice to: a) choose the methods that can generate the required information; and b) ensure that suitable data management processes are established.
4. Determine the scale and resolution	Determine the scale and resolution required to achieve the purpose and objective defined in Step 1.
5. Establish a core or minimum data set	Identify the core, or minimum, data set sufficient to describe the location and size of the wetland(s) and any special features. This can be complemented by additional information on factors affecting the ecological character of the wetland(s) and other management issues, if required.
6. Establish a habitat classification	Choose a habitat classification that suits the purpose of the inventory, using the classification that has been globally accepted.
7. Choose an appropriate method	Choose a method that is appropriate for a specific inventory based on an assessment of the advantages and disadvantages, and costs and benefits, of the alternatives.
8. Establish a data management system	Establish clear protocols for collecting, recording and storing data, including archiving in electronic or hardcopy formats. This should enable future users to determine the source of the data, and its accuracy and reliability. At this stage it is also necessary to identify suitable data analysis methods. All data analysis should be done by rigorous and tested methods and all information documented. The data management system should support, rather than constrain, the data analysis. A meta-database should be used to: a) record information about the inventory datasets; and b) outline details of data custodianship and access by other users.
9. Establish a time schedule and the level of resources that are required	Establish a time schedule for: a) planning the inventory; b) collecting, processing and interpreting the data collected; c) reporting the results; and d) regular review of the program. Establish the extent and reliability of the resources available for the inventory. If necessary make contingency plans to ensure that data is not lost due to insufficiency of resources.
10. Assess the feasibility and cost effectiveness	Assess whether or not the program, including reporting of the results, can be undertaken within under the current institutional, financial and staff situation. Determine if the costs of data acquisition and analysis are within budget and that a budget is available for the program to be completed.
11. Establish a reporting procedure	Establish a procedure for interpreting and reporting all results in a timely and cost effective manner. The report should be concise, indicate whether or not the objective has been achieved, and contain recommendations for management action, including whether further data or information is required.
12. Establish a review and evaluation process	Establish a formal and open review process to ensure the effectiveness of all procedures, including reporting and, when required, supply information to adjust or even terminate the program.
13. Plan a pilot study	Test and adjust the method and specialist equipment being used, assess the training needs for staff involved, and confirm the means of collating, collecting, entering, analyzing and interpreting the data. In particular, ensure that any remote sensing can be supported by appropriate "ground-truth" survey.

Activity 5.1
Using the Table 5.1, Prepare an Inventory of the Wetlands near your institute as guided by the instructor.

5.3 Wetland Assessment

5.3.1 What is assessment?

This is the gathering and analysis of information needed for wetland decision making. Wetland information required by decision makers, regulators, planners, public land use managers is not limited to only functions and values of wetlands but includes a broad range of information such as delineation of wetland boundaries, evaluation of natural hazards like floods, determination of land ownership, and evaluation of existing wetland uses.

5.3.2 Rationale for wetland assessment

Proper wetland management requires a good understanding of their hydrological, ecological and socio-economic environment. To know where they are and what is in them, how they are being used and the actual and possible changes that might take place because of the changes in the surrounding area. In addition there is need to know where, how and at what rate the wetland status is changing in order to propose management interventions/options required and how effective they should be. An estimate about the resources (especially finances and human resource) required to properly manage and monitor essential wetlands at the local, national and regional level is also important.

Remember

There are four levels of wetland assessment, namely;

- The overall assessment of the wetland value and stock
- The detailed assessment of wetland functions and use
- The permanent monitoring of wetland trends and ecological status
- The topical assessment of a cross-section of wetlands that have a common service, function or use of interest

Assessment criteria and procedures are critical because the outcome of wetland protection or destruction is determined by the information available to decision makers. Assessment procedures determine whether activities in wetlands are permitted and the impact reduction and compensation measures (restoration, creation or enhancement).

5.3.3 Techniques

Approaches used in wetland assessment include;

- Wetland mapping based on satellite imagery based on multi-objective landscape level analysis of land and water throughout a geographical area including wetlands. In the process of producing land and water use plans, wetland zones are indicated. Originally, this analysis was done manually and of recent by Geographic Information Systems (GIS) and remote-sensing.
  - This activity is carried out by GIS experts. It is technical and requires specialized people with the ability to interpret satellite images according to colors to produce land use/land cover maps. This approach may not however give some of the essential information such as wetland type, ecological features, present land use, threats, values and functions of the wetland and this requires ground truthing.
  - Local district/province/regional wetland descriptions based on physical observation of the wetlands in a given division/province/region. In this approach regional/district/province wetlands officers make physical observations in the field. Sections of a wetland are observed and general characteristics including vegetation, soils, land use, other human activities and water quality are recorded using a wetland characteristics observation sheet. This information is essential for monitoring interventions and cannot be generated by the satellite imagery approach.

- Wetlands inventory report based on analysis of the wetland descriptions showing the state of wetlands in a given area. Each wetland is given a code, indicating its relative position in the drainage basin, and to other wetlands. This inventory data base can easily be updated with additional data, maps, changes in wetland characteristics and human activities/land use.

There are wide ranges of Wetland Assessment Techniques that have been developed over the past few decades.

1. GIS and Remote-Sensing in Inventory, Assessment and Monitoring

Remote sensing and Geographic Information Systems (GIS) technologies are increasingly being used as integral components of environmental management, assessment and monitoring activities world wide. A GIS is a system for management, analysis, and display of geographic knowledge which is represented using a series of information sets. The information sets include geographic datasets (file bases and data bases of geographic information feature, networks, topologies, terrains, surveys, and attributes); collections of geo-processing procedures for automating and repeating numerous tasks and for analysis and metadata. The conservation, restoration and management of wetlands requires knowledge of wetland relationships and key components soil, elevation, hydrology and hydrophytic plants as well as influencing functions such as climate, wildlife and human interventions. A GIS can spatially represent all these components, compile and store data, analyse, retrieve information, update, query, filter, sort, display, and be used to determine patterns and relationships by theme overlays.

Increasing recognition of the importance of wetland ecosystems to the economic and environmental health of society has stimulated renewed interest in identifying the distribution, characteristics and extent of wetlands. Significantly, the Ramsar Convention on Wetlands advocated for development of wetland inventories. In response, the contracting parties to this Convention are encouraged to develop wetland inventories in their respective countries. However, Global review of wetland resources and priorities for wetland inventory (GroWI), revealed shortage in knowledge of wetland distribution and the manner in which the information for wetland inventories was collected/collated was inadequate. To improve accuracy of quantifying and describing the global wetland resource and provide basic information needed for management, it was recommended that inventory should focus on location and extent of wetlands. In order to achieve this, standardized methods for data collection and storage including use of GIS and remote-sensing was considered essential.

Remote sensing and GIS technology can be used for wetland assessment efficiently. Although remote sensing and GIS can be employed at any stage, they are particularly useful for identifying the extent of the problem and the extent of the risk. GIS and remote sensing together can help to monitor effectiveness of the risk management and reduction techniques. Specifically, the ability to integrate and overlay multiple layers of data over an area of interest which can be modelled, queried and analysed in order to determine the impact and extent of a particular risk is useful to managers doing wetland assessment.

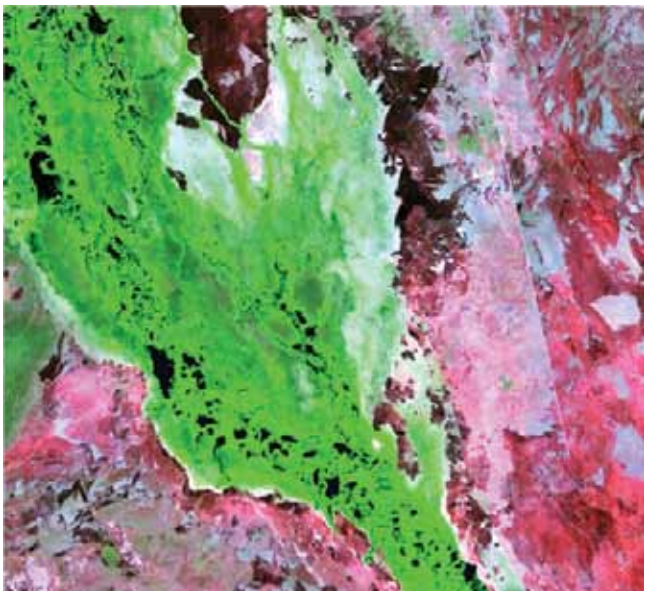


Figure 7: Pilot Site in the Sudd Swamps

The Sudd swamps region satellite images

The integration of remote sensing and GIS provides managers with a set of tolls for monitoring and surveillance of wetland resources. This is enhanced by the fact that new remotely sensed images with spatial, spectral and temporal resolutions are increasingly available. As with GIS data, many remotely sensed data sets can be downloaded through internet. The remotely sensed data available makes it possible to apply hierarchical approach to monitoring. Once the wetland extent or condition has been mapped or classified using remote sensing technology, these can be stored in a GIS. Once in the GIS, it is possible to monitor changes to the environment in the area of interest and relate to other feature datasets like infrastructure, climate and hydrology held in the GIS. Integrating GIS and remote sensing has an added advantage in that ancillary datasets held in the GIS for example soil water logging characteristics, can be used to classify wetland features in the remote sensed image. Furthermore, integrating remote sensing and GIS enables many questions related to wetland monitoring and surveillance to be answered. Such questions include;

1. Where are wetlands being lost or reduced?
2. How quickly are wetlands being destroyed?
3. Where are the remaining wetlands located?
4. Which wetland areas remain flooded all year round?
5. Which sites are priorities for restoration?

Most GIS databases are created for particular uses. The dataset could be for representation of rivers, vegetation communities, lakes or areas subject to flooding. It is important to understand that these datasets are intended to be used within specified scale ranges. The scale at which the dataset has been created reflects that intended use. For example if drainage features have been compiled on a scale of 1:1000,000, such features are intended for broad scale use and should not be used at local or site scale. The accuracy and usefulness of key features of the dataset such as their position, area and shape will be degraded, is applied at an inappropriate scale and will give an erroneous or inaccurate interpretation of the features. Likewise, a dataset at local scale of say <1:50,000-250,000, would be inappropriate for broad scale application as level of detail is too much to be represented clearly. Therefore, consideration has to given to determining the appropriate scale. The key factor to consider is the intended use of application of the data set (local, regional or broad scale application).

2. **Wetland rapid assessment approaches** to assess a broad range of wetland functions and values. There several methods used for above purpose. Such as:
    - Wetland Evaluation Techniques (WET), uses matrices to rate welands as high, medium or low in regard to some wetland functions and values.
    - Hydrogeomorphic Wetland assessment Method (HGM), analyses wetland processes and compares such information with reference to a wetland.
    - Indices of Biological Integrity (IBI). Involves identification of plants and animals which characterise wetland conditions across gradient from natural to highly degraded.

Actors involved in assessment
Government
Community
Scientists/ Researchers
Wetland Managers

Activity 5.2:
Visit a nearby wetland and use the sheet below to make a rapid land use assessment.

Discuss the role played by the different actors named above in Wetland Assessment.

Land use	Potential effects on wetland	Estimated % of wetland catchment/ watershed
Industrial/Commercial/Residential Development		
Agricultural cropland		
Agricultural grazing		
Grassed recreation arrears/parks		
Highway or roads		
Others (Specify)		

5.4 Monitoring and surveillance

5.4.1 Definition

The collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management. The collection of time-series information that is not hypothesis driven from wetland assessment is surveillance rather than monitoring.

5.4.2 Rationale and techniques

Wetlands are aquatic ecosystems. However, many wetlands have been lost due to settlements, agriculture and industrial developments. The remaining wetlands are threatened by habitat loss, toxic chemicals, polluted runoff, hydrologic changes and invasive species, especially in rapidly urbanizing areas. In addition to efforts to track and report wetland quantity, for example, the number of acres filled compared to acres restored, information on the ecological health of wetlands is vital. With ever-increasing pressure from development and other human activities, there is a compelling need for improved scientific information about the current conditions of wetlands, sources and causes of degradation, and long-term trends in wetland health. To make sound decisions in wetland management, planning and regulation, it is essential to understand the relative risks to wetlands from various human activities. Therefore, the desire to measure and quantify wetland degradation as well as the effectiveness of (restoration and mitigation) management and investment are amongst the main driving forces.

Finlayson (1996) provides a general framework for designing a monitoring programme, which is based on the identification of a problem and the resultant steps to gather data and information guided by

a hypothesis that will lead to management action that redresses the situation. Monitoring within this context is a goal-oriented data gathering and analysis exercise and distinctly different from surveillance; the latter is the mere collection of data through time series to ascertain value ranges and variability.

5.5 Water quality assessment in wetlands

5.5.1 Rationale

Wetlands are essential systems that effectively naturally purify water. That is why assessment of water quality is one of the most important aspect of wetland status monitoring as described in this section.

The quality of water entirely depends on the intended use, drinking, cooking, washing, laboratory work. Different uses demand a certain level of quality levels. Distilled water required for laboratory experiments is normally de-ionized, without ions such as Mg^{2+}, Ca^{2+}, Na^{+}, Cl^{-}. The quality of distilled water is therefore good for laboratory experiments. Some ions found in natural water may interfere laboratory experiments. Water for swimming may not be good for drinking. Fish in natural environments requires nutritious green-water with algae, but this kind of water can affect human health if directly used.

5.5.2 Water quality parameters

The quality of water for any intended use is determined by both physical and chemical parameters (characteristics). The physical parameters or characteristics that determine water quality include colour, temperature, smell and turbidity (determined by the number of suspended particles) or TSS (Total Suspended Solids). Some of the essential chemical parameters include; the pH, conductivity, alkalinity ,dissolved oxygen (DO) and percentage oxygen saturation, Biological oxygen demand (BOD), Chemical Oxygen Demand (COD), Total nitrogen including; Nitrates, Nitrites ,and Ammonium ions, Total phosphorus and Total hardness. Selected commonly used water quality parameters in wetlands assessment and monitoring are discussed below.

Temperature

Temperature of water is a very important factor for aquatic life. It controls the rate of metabolic and reproductive activities, and determines which organisms or particular species can survive in a given part of an aquatic system like a wetland. Temperature affects the concentration of dissolved oxygen and can influence the activity of bacteria and toxic chemicals in water. Temperature is measured using a thermometer, and is recorded in either degrees Celsius (^{o}C) or degrees Fahrenheit (^{o}F).

pH

PH represents the effective concentration (activity) of hydrogen ions (H^{+}) in water. This concentration could be expressed in the same kind of units as other dissolved species, but H^{+} concentrations are much smaller than other species in most waters. The activity of hydrogen ions can be expressed most conveniently in logarithmic units. pH is defined as the negative logarithm of the activity of H^{+} ions: $pH = -\log [H^{+}]$ Where $[H^{+}]$ is the concentration of H^{+} ions in moles per liter (a mole is a unit of measurement, equal to 6.022×10^{23} atoms). Because H^{+} ions associate with water molecules to form hydronium (H_3O^{+}) ions, pH is often expressed in terms of the concentration of hydronium ions.

In pure water at 22 ^{0}C (72 ^{0}F), H_3O^{+} and hydroxyl (OH^{-}) ions exist in equal quantities; the concentration of each is 1.0×10^{-7} moles per liter (mol/L). Therefore, pH of pure water = $-\log (1.0 \times 10^{-7}) = -(-7.00) = 7.00$. Because pH is defined as $-\log [H^{+}]$, pH decreases as $[H^{+}]$ increases (which will happen if acid is added to the water). Since pH is a log scale based on 10, the pH changes by 1 for every power of 10 change in $[H^{+}]$. A solution of pH 3 has an H^{+} concentration 10 times that of a solution of pH 4. The pH scale ranges from 0 to 14.

The pH of water can be measured with a pH meter, which is an electronic device with a probe. The probe contains an acidic aqueous solution enclosed by a glass membrane that allows migration of H^+ ions. The electrical potential of the glass electrode depends on the difference in $[H^+]$ between the reference solution and the solution into which the electrode is dipped. pH can also be measured with pH paper or by adding a reagent (universal indicator solution) to the water sample and recording the colour change.

Carbon dioxide (CO_2) enters a water body from a variety of sources, including the atmosphere, runoff from land, release from bacteria in the water, and respiration by aquatic organisms. This dissolved CO_2 forms a weak acid. Natural, unpolluted rainwater can be as acidic as pH 5.6, because it absorbs CO_2 as it falls through the air. Because plants take in CO_2 during the day and release it during the night, pH levels in water can change from daytime to night; an example of how pH typically varies over a daily cycle. Other factors that affect pH of water in a wetland include the *Geology* and *Soils* of the watershed, drainage water from forests and marshes is often slightly acidic, and the presence of organic acids produced by decaying vegetation, gaseous pollutants (nitrogen oxides (NO_2, NO_3) and sulfur dioxide (SO_2). These react in the atmosphere to form nitric acid (HNO_3) and sulfuric acid (H_2SO_4). These acids can affect the pH of streams and wetlands by combining with moisture in the air and falling to the wetland ecosystem as acid rain. Sewage, agricultural and industrial discharge into the wetland.

Dissolved Oxygen (DO)

Dissolved Oxygen (DO) is found in microscopic bubbles of oxygen that are mixed in the water and occur between water molecules. DO is a very important indicator of a water body's ability to support aquatic life. Oxygen enters the water by absorption directly from the atmosphere or by aquatic plant and algae photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter.

Dissolved Oxygen can be measured with an electrode and meter or with field test kits. The electronic meter does not measure oxygen directly; rather, it uses electrodes to measure the partial pressure of oxygen in the water, which is converted to oxygen mass weight concentration. The field test kits (such as a drop bottle, a microburet, or a digital titrator) involve adding a solution of known strength to a treated sample of water from the stream. The amount of solution required to change the color of the sample reflects the concentration of DO in the sample. The amount of oxygen dissolved in water is expressed as a concentration in milligrams per liter (mg/l) of water. Dissolved oxygen levels are also often reported in percent saturation. Temperature affects DO concentrations, and calculating the percent saturation will factor out the effect of temperature. The "saturation level" is the maximum concentration of dissolved oxygen that would be present in water at a specific temperature, in the absence of other factors.

Factors that affect DO include;

- ✓ Velocity and volume of water flowing into the wetland water stream (In fast-moving streams, rushing water is aerated by bubbles as it churns over rocks and falls down hundreds of tiny waterfalls)
- ✓ Climate/Season,-During dry seasons, water levels decrease and the flow rate of a river/steam slows down. As the water moves slower, it mixes less with the air, and the DO concentration decreases. During rainy seasons, oxygen concentrations tend to be higher because the rain interacts with oxygen in the air as it falls.
- ✓ The type and number of organisms in the water body. During photosynthesis, plants release oxygen into the water. During respiration, plants remove oxygen from the water. Bacteria and fungi use oxygen as they decompose dead organic matter in the stream
- ✓ Dissolved or suspended solids - Oxygen is more easily dissolved into water with low levels of dissolved or suspended solids

Amount of nutrients in the water - Nutrients are food for algae, and water with high amounts of nutrients can produce algae in large quantities. When these algae die, bacteria decompose them, and use up oxygen, this process is called eutrophication.

- ✓ Organic Wastes is decomposed by bacteria; these bacteria remove dissolved oxygen from the water when they respire.

Alkalinity

Alkalinity is a measure of the capacity to neutralize natural waters. Measuring alkalinity is important in determining a wetland's/stream's ability to neutralize pollution from rainfall or wastewater. Alkalinity does not refer to pH, but instead refers to the ability of water to resist change in pH. The presence of bicarbonate (HCO_3^-), carbonate (CO_3^{2-}), and occasionally hydroxide (OH^-), usually gives indication of the nature of materials that are available to resist change in pH. Alkalinity not only helps regulate the pH of a water body, but also the metal content. Bicarbonate and carbonate ions in water can remove toxic metals (such as lead, arsenic, and cadmium) by precipitating the metals out of solution.

Alkalinity is measured by titration. An acid of known strength (the titrant) is added to a volume of a treated sample of water. The volume of acid required to bring the sample to a specific pH level reflects the alkalinity of the sample. The pH end point is indicated by a colour change.

Nitrogen

Nitrogen is required by all organisms for the basic processes of life to make proteins, to grow, and to reproduce. Nitrogen is very common and found in many forms in the environment including wetlands. Inorganic forms include nitrate (NO_3), nitrite (NO_2), ammonia (NH_3), and nitrogen gas (N_2). Organic nitrogen is found in the cells of all living things and is a component of proteins, peptides, and amino acids. Nitrogen is most abundant in the Earth's environment as N_2 gas, which makes up about 78 percent of the air we breathe.

Activity 5.3:
Describe the various processes by which nitrogen is converted into the various inorganic and organic forms in the nitrogen cycle

Common Forms of Nitrogen in Water

- ➢ *Nitrate and Nitrite*
  - Nitrate (NO_3) is highly soluble (dissolves easily) in water and is stable over a wide range of environmental conditions. It is easily transported in streams and groundwater. Nitrates feed plankton (microscopic plants and animals that live in water), aquatic plants, and algae, which in turn are eaten by fish. Nitrite (NO_2) is relatively short-lived in water because it is quickly converted to nitrate by bacteria. Excessive concentrations of nitrate and/or nitrite can be harmful to humans and wildlife.
  - If excessive amounts of phosphorus and nitrates are added to the water, algae and aquatic plants can be produced in large quantities. When these algae die, bacteria decompose them, and use up oxygen. This process can lead to eutrophication. Dissolved oxygen concentrations can drop too low for fish to breathe, leading to fish kills.

- ➢ *Ammonia*
  - Ammonia, another inorganic form of nitrogen, is the least stable form of nitrogen in water. Ammonia is transformed to nitrate in waters that contain oxygen and can be transformed to nitrogen gas in waters that are low in oxygen. Ammonia is found in water in two forms - the ammonium ion (NH_4^+), and dissolved, unionized (no electrical charge) ammonia gas (NH_3). Total ammonia is the sum of ammonium and un-ionized ammonia. The dominant form

depends on the pH and temperature of the water. Unionized ammonia (NH_3) is much more toxic to aquatic organisms than the ammonium ion (NH_4^+).

Measurement of Nitrogen Forms

- Total nitrogen can be determined by adding chemicals to convert all of the nitrogen forms in a sample to nitrate, and then measuring nitrate concentration. Nitrate and nitrite can be measured together or separately. Nitrate and nitrite are most often measured using a **colorimetric method**, which means the color of treated sample reflects the concentration of the parameter. A chemical is added to the water sample and the darker the color of the sample, the more nitrate and/or nitrite present. This test can be done visually, comparing the treated sample to a set of reference colors. However, it is more accurate to use an **electronic colorimeter**, which uses a light source and a **photo detector** to find the concentration based on how much light is absorbed by the sample

- Total ammonia (ammonium ion (NH_4^+) plus unionized ammonia gas (NH_3)) is often measured in a laboratory by **titration.** Ammonia and organic nitrogen compounds are separated by distillation, and then an acid (the titrant) is added to a volume of the ammonia portion. The volume of acid required to change the color of the sample reflects the ammonia concentration of the sample.

Factors Affecting Nitrate and Nitrite Concentrations

- *Wastewater and Septic System Effluent*

Human waste is significant contributor of nitrogen to water. Ammonia, nitrite, and nitrate are decomposition products from urea and protein, which are in human waste. Ammonia is an ingredient in many household cleaning products and is sometimes used to remove carbonate from hard water. Therefore, these and other forms of nitrogen go down the drains in our houses and businesses, and can enter streams from wastewater treatment plant (WWTPs) effluent, illegal sanitary sewer connections, and poorly functioning septic systems. Make reference to the Nitrogen Cycle.

- *Fertilizer Runoff*

Use of fertilizers is a major influence on nitrogen concentrations in the environment. Commercial nitrogen fertilizers are applied either as ammonia or nitrate. Ammonia may be rapidly converted to nitrate in the soil. Animal manure is used as a nitrogen fertilizer in some areas. Organic nitrogen and urea in the manure are converted to ammonia and, ultimately, to nitrate in the soil. Nitrate that is not used by plants washes from farmlands and residential and commercial lawns into storm drains and nearby streams, or seeps into groundwater.

- *Animal Waste*

A significant amount of nitrogen is released in the wastes produced by animals. This can be a serious problem in waters near cattle feedlots, hog farms, dairies, and barnyards.

- *Industrial Discharge*

Many industries use nitrogen during processing. Nitrite is sometimes used as a corrosion inhibitor in industrial process water. Ammonia is used in the production of nitric acid, urea and other nitrogen compounds, and in the production of ice and in refrigerating plants. Ammonia is also used in cleaning supplies and to remove carbonate from hard water. Water from industries is usually discharged to a wastewater treatment plant (WWTP), and may end up in a downstream wetland or water body if not completely removed in the WWTP.

Phosphorus

Phosphorus is a nutrient required by all organisms for the basic processes of life. Phosphorus is a natural element found in rocks, soils and organic material. Phosphorus clings tightly to soil particles and is used by plants. Phosphorus is used extensively in fertilizer and other chemicals, so it can be found in higher concentrations in areas of human activity. Many seemingly harmless activities added together can cause phosphorus overloads.

If excessive amounts of phosphorus and nitrogen are added to the water, algae and aquatic plants can be produced in large quantities. The effects of increase of Nitrogen and phosphorus in aquatic ecosystems can cause eutrophication**.** Dissolved oxygen concentrations can drop too low for fish to breathe, leading to fish kills. The loss of oxygen in the bottom waters can free phosphorus previously trapped in the sediments, further increasing the available phosphorus.

There are several forms of phosphorus which can be measured. Total phosphorus (TP) is a measure of all the forms of phosphorus, dissolved or particulate, that are found in a sample. Soluble reactive phosphorus (SRP) is a measure of orthophosphate, the filterable (soluble, inorganic) fraction of phosphorus, the form directly taken up by plant cells.
Both phosphorus and orthophosphate are often measured using **a colorimetric method,** which means the color of treated sample reflects the concentration of the parameter.

If total phosphorus is being measured, all forms of phosphorus are converted to dissolved orthophosphate with acid, persulfate, and heat. A chemical is then added to the water sample. The darker the color of the sample becomes, the more phosphorus present. This test can be done visually, comparing the treated sample to a set of reference colors. Phosphorus can also be determined using an **electronic colorimeter**, which uses a light source and a **photo detector** to find the concentration based on how much light is absorbed by the sample.

Did you know that?
Eutrophication is a process that results from accumulation of nutrients in lakes or other water bodies. Eutrophication can be greatly accelerated by human activities that increase the rate at which nutrients enter the water. If excessive amounts of nutrients are added to the water, algae and aquatic plants can grow in large quantities. These compete for light at the surface and prevents photosynthesis in water. At the same time when they die, they are decomposed by bacteria, which use dissolved oxygen, making it difficult for aerobes to live in the water.

Activity5.4:
Discuss the role of wetlands in prevention of Eutrophication of large water bodies in Africa like Lake Victoria

Water hardness

Hardness is measure of polyvalent cations (ions with a charge greater than +1) in water but generally represents the concentration of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions, because these are the most common polyvalent cations. Other ions, such as iron (Fe^{2+}) and manganese (Mn^{2+}), may also contribute to the hardness of water, but are generally present in much lower concentrations. Waters with high hardness values are referred to as "hard," while those with low hardness values are "soft".

Hardness is generally measured by titration by adding a buffer and a color indicator to a volume of water. An acid (the titrant) is then added to the water, and it reacts with the Ca^{2+} and Mg^{2+} in the water. The volume of acid required to change the color of the sample reflects the Ca^{2+} and Mg^{2+} concentration of the sample. The more acid needed, the more Ca^{2+} and Mg^{2+} in the sample. Hardness is generally expressed in units of milligrams per liter (mg/l) or parts per million (ppm) of $CaCO_3$ (calcium carbonate).

Conductivity

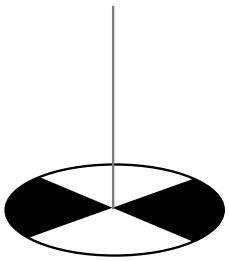
Specific Conductance (SC) is a measure of how water can conduct an electrical current. Conductivity increases with increasing amount and mobility of ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Therefore, SC is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution.

The measure of water to conduct an electrical current for a unit length and unit cross-section at a certain temperature. is defined as the "reciprocal (opposite) of the resistance in ohms measured between opposite faces of a centimeter cube of an aqueous solution at a specified temperature" (Hem, 1985). That is, **Conductance = 1 / resistance**

Specific conductance is measured using a sensor which measures resistance.

Transparency and Turbidity

Transparency is a measure of how much visible light enters the water. Turbidity, which is related to transparency, is the measure of the substances that make the water cloudy. Turbidity in water is caused by suspended matter such as clay, silt, and organic matter and by plankton and other microscopic organisms that interfere with the passage of light through the water. Turbidity is also closely related to total suspended solids (TSS), but which includes plankton and other organisms. Turbidity affects the amount of light traveling through water. The visible light penetration can be measured using a device called a Secchi disk. A Secchi disk is a black and white, 20-cm diameter disk.



The disk is lowered into the water until it just disappears from sight and is lifted to reappear. The average of the depths at which the disc disappears and reappears is called the Secchi depth. In fast-moving streams a turbidimeter (sometimes called a nephelometer) is used. A turbidimeter measures the scattering of light, and provides a relative measure of turbidity in Nephelometric Turbidity Units (NTUs). Another method of measuring turbidity is to evaluate the fuzziness of a mark at the bottom of a clear tube when a water sample is poured in the tube. Units are reported in Jackson Turbidity Units (JTUs). This method can only be used in highly turbid waters.

Total Suspended Solids (TSS)

Total Suspended Solids (TSS) are solids in water that can be trapped by a filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

High TSS can block light from reaching submerged vegetation. As the amount of light passing through the water is reduced, photosynthesis slows down. Reduced rates of photosynthesis causes less dissolved oxygen to be released into the water by plants. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and will die. As the plants are decomposed, bacteria will use up even more oxygen from the water. High TSS can also cause an increase in surface water temperature, because the suspended particles absorb heat from sunlight. This can cause dissolved oxygen levels to fall

even further (because warmer waters can hold less DO), and can harm aquatic life in many other ways. **To measure TSS, the water sample is filtered through a pre-weighed filter**. The residue retained on the filter is dried in an oven at 103° to 105°C until the weight of the filter no longer changes. The increase in weight of the filter represents the total suspended solids. TSS can also be measured by analyzing for total solids and subtracting total dissolved solids.

Total and Feacal Coliform Bacteria

The coliform bacteria group consists of several genera of bacteria belonging to the family *enterobacteriaceae*. These mostly harmless bacteria live in soil, water, and the digestive system of animals. Fecal coliform bacteria, which belong to this group, are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste. If a large number of fecal coliform bacteria (over 200 colonies/100 milliliters (ml) of water sample) are found in water, it is possible that pathogenic (disease- or illness-causing) organisms are also present in the water. Fecal coliform by themselves are usually not pathogenic; they are indicator organisms for fecal contamination, hence indicate presence of other pathogenic bacteria.

Swimming, drinking or bathing in waters with high levels of fecal coliform bacteria increases the chance of developing illness (fever, nausea or stomach cramps) from pathogens entering the body through the mouth, nose, ears, or cuts in the skin. Diseases and illnesses that can be contracted in water with high fecal coliform counts include typhoid fever, hepatitis, gastroenteritis, dysentery and ear infections. Fecal coliform, like other bacteria, can usually be killed by boiling water or by treating it with chlorine. Washing thoroughly with soap after contact with contaminated water can also help prevent infections.

Measurement of Fecal Coliform

Bacteria are single-celled organisms that can only be seen with the aid of a very powerful microscope. However, coliform bacteria form colonies as they multiply, which may grow large enough to be seen. By growing and counting colonies of coliform bacteria from a sample of water, it is possible to determine approximately how many bacteria were originally present. There are several ways coliform bacteria are grown and measured. Methods commonly used include the **most probable number** (MPN) method and the **membrane filter** (MF) method.

- In the MPN method, a "presumptive test" is performed first. A series of fermentation tubes that contain lauryl tryptose broth are inoculated with the water sample and incubated for 24 hours at 35 ° C. Fermentation tubes are arranged in 3 or more rows, with 5 or 10 tubes per row, with varying dilutions of the samples in the tubes. The fermentation tube contains an inverted tube to trap gases that are produced by the coliform bacteria. After 24 hours, the fermentation tube is examined for gas production. If there is no gas production, the samples are incubated for another 24 hours and reexamined. If gas production is observed by the end of 48 hours, the presumptive test is positive; coliform bacteria are present in the sample. A "confirmed test" is then performed to determine if fecal coliform bacteria are present. For the confirmed test, some of the content of the fermentation tube is transferred with a sterile loop to a fermentation tube containing another broth. The sample is incubated in a water bath at 44.5° C for 24 hours. Gas production in the fermentation tube after 24 hours is considered a positive reaction, indicating fecal coliform. Based on which dilutions showed positive for coliform and/or fecal coliform, a table of most probable numbers is used to estimate the coliform content of the sample. The results are reported as most probable number (MPN) of coliform per 100 ml (American Public Health Association, 1998).

- The MF method is more rapid than the MPN method, but the results are not as reliable for samples that contain many non-coliform bacteria, high turbidity, and/or toxic substances such as metals or

phenols. The water sample is filtered through a sterile membrane filter. The filter is transferred to a sterile Petri dish and placed on a nutrient pad saturated with broth. The plates are inverted, placed in watertight plastic bags, and incubated in a water bath at 44.5°C for 24 hours. Colonies produced by fecal coliform bacteria are blue, and are counted using a microscope or magnifying lens. The fecal coliform density is recorded as the number of organisms per 100 ml.

Activity5.5: Field study

- With a Laboratory technician, visit a wetland and sample water to determine parameters used in wetlands monitoring
- Make a checklist of wetland activities within the catchment area to that are having potential impacts on quantity, quality of water entering the wetland
- A visit to a reference laboratory is recommended to observe how water samples are analysed.
- Make report of the status of the wetlands you have visited based on the results of your water samples analyses and observations.
- Suggest how to mitigate on the areas where the results indicate a potential impact.

Exercise 5.1

1. Discuss the importance of water quality assessment in wetland monitoring.
2. Write a simple newspaper article to create awareness to your local community about the importance of wetland assessment, monitoring and conservation.
3. How is wetland assessment and monitoring important in the development of your country?

5.6 Module Summary

In this Module the following have been covered:

- Definition of the terms wetlands inventorying, assessment and monitoring
- Rationale for assessing wetland status
- Techniques used to assess wetlands
- Application of the various techniques learnt to assess water quality

5.7 Further reading

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MODULE 6: WETLAND MANAGEMENT

6.1 Introduction

The degradation of wetlands over the years has continued mainly through unguided agricultural, industrial encroachment and conversion to other uses, reducing their capacity to provide ecological, social and economic services. Wetland management is aimed at sustaining the biophysical and socio-economic values of wetlands for present and future generations. Frameworks that enhance the capacity of the national, district and local structures to implement the National Wetlands policy are central to their conservation and management. This unit discusses the concept of conservation and management of wetlands.

Learning Objectives

By the end of the Module, you should be able to

- Gain skills in wetland management
- Discuss the relationship between wetlands and sustainable development
- Identify and examine stakeholders in wetland management
- Solve problems related to conservation of wetlands and make responsible decisions using critical and creative thinking
- Design ways of promoting wetland conservation

6.2 Wise use concept

The concept of wise use refers to the use of wetlands on sustainable basis. Sustainable uses do not harm the natural properties and functions of wetlands meaning that they are aimed at conserving wetlands for the benefits of now and future generations. Such use requires a good understanding of the wetlands functions and their ecosystem interactions. The concept of wise use seeks both the formulation and implementation of general wetland policies, and wise use guidelines to specific wetlands. It is desirable in the long term that all Ramsar Contracting Parties shall have comprehensive national wetland policies that are appropriate to their national institutions in implementing the wise use concept.

In an effort to address further degradation and loss of wetlands, and in response to Article 3.1 of the Ramsar Convention, the signatories have elaborated the `Wise Use' concept and accompanying guidelines to provide a basis by which the wise use of wetlands can be attained.

The wise-use concept is particularly relevant due to its recognition of wetland values to local communities for meeting their needs. It is based on the fact that wetlands are useful for meeting many direct and indirect human needs. People use the wetlands in many ways such as dry seasonal grazing, and extract reeds to weave mats and baskets. Wetlands provide fuel wood and timber for building houses, provide drinking water and food. Wetlands are also recreation areas and provide excellent tourism areas. Wetlands are therefore vital to our lives and we must use them in a way that ensures their continued existence and reliability to meet the needs of present without compromising the future generations.

The principal measure in the Wise Use concept is the formulation and implementation of comprehensive national wetland policies and integration of these policies into the national planning processes. Furthermore, the guidelines to the wise use concept outline measures that member states ought to take in the process of formulating National Wetland Policies. These include regulations to address legislation and government policies (such as a review and harmonization of existing legislation), to increase knowledge and awareness of wetlands and their values; to review the status of wetlands and priorities for wetlands and to address problems at particular wetland sites. A few countries including Australia, Canada and Uganda already have such policies in place, while several others are in the process of formulating policies

or have incorporated wetland conservation concerns in National Biodiversity Strategies or into National Environmental Action Plans as measures to protect wetlands from degradation and/or loss.

It is important that any land use planning exercise which aims at allocating uses of various wetland types be viewed in the context of whether a wetland policy exists or not, and it should also take into consideration the multiple functions and benefits of wetlands in the national, regional and global context. Furthermore, it is imperative that land use planning in wetlands involves careful consideration of an integrated approach to wetland use, recognizing that more often than not, wetlands transcend different ecological zones and often undergo impacts whose source is often far removed from them.

6.3 Considerations for Wetland management

The key challenge in developing countries is to promote economic growth and equitable income distribution without degrading the natural resource base including wetland resources. In spite of difficult economic conditions, developing countries should strive to make wetland issues a priority. Efforts to reduce poverty at local, regional and national level should be done while conserving wetlands. Development should aim at promoting sharing of wetland resources, securing rights of access especially for poor communities, diversifying livelihoods, improving the income earning potential of stakeholders and creating incentives for wetland conservation. Initiatives for development of capacity in wetland conservation skills of institutions and community-based organizations are important. Therefore, conservation of wetlands should focus on actions that either increase or sustain functions and values of wetlands such as hydrology, nutrients and biodiversity.

Until recently (about 20 years ago), wetlands in Africa were still viewed as undesirable, unappealing infestations harboring snakes, insects and rodents. In agricultural areas, wetlands were drained, cleared and put under crop production. In expanding urban areas, wetlands were filled to provide land for more houses, office buildings, industrial facilities and sanitary landfills. However, wetlands values and functions directly or indirectly benefit society and these are the ones to promote their sustainable management.

Wetlands Protect and Improve Water Quality

Healthy wetlands remove and retain excessive nutrients, such as nitrogen and phosphorus, from the water by creating environments, which use the nutrients. Hence, the wetlands remove the effects that would move with the water and contaminate downstream. In so doing they absorb the sediment loads, excess nutrients and organic pollutants before they can enter lakes, rivers, streams or oceans.

Wetlands Help Control Flooding and Erosion

Wetlands often are referred to as natural sponges that absorb flooding waters. By temporarily storing floodwaters, wetlands help protect adjacent and downstream property owners from flood damage. Wetlands in urban areas are especially valuable for flood protection, since urban development increases the rate and volume of surface water runoff, thereby increasing the risk of flood damage. Wetlands are often located between rivers and high ground and, therefore, are in a good position to buffer the land against erosion. Wetland plants can reduce erosion by binding soil with their roots.

Wetlands Provide Habitat for Terrestrial and Aquatic Wildlife

Wetlands provide vital habitat for animals and plants. Many invertebrates, fish, amphibians, reptiles, birds and mammals live in wetlands. Marine fish and shellfish depend on estuarine wetlands as their home. Wetlands foster the presence and production of many species. Forested wetlands supply valuable timber products.

Recreation in Wetland Areas

Waterfowl hunting, fishing, and crabbing are popular activities in these areas, but wetlands also provide rich opportunities for bird-watching, swimming, boating and nature photography.

Activity 6.1

- Identify the management options that are available for a wetland near your institution.
- Learn about habitat values of the wetlands plants and animals that inhabit or frequent the area.
- What activities are going on in the wetlands
- Prepare a detailed stakeholder list of those to be involved in the management

Simple conservation activities can improve the health of a wetland. Before you think of activities to improve the heath of the wetland, you need to be aware of the factors that contribute to the degradation of a wetland in order to help correct them.

Activity 6.2

Identify activities have contributed to degradation of the wetland you have visited.

a) List these activities in order of their magnitude.

Classify activities into those to;

Protect the wetland (tourism eg bird watching, canoeing, and hiking).

Conserve the wetland (water fetching, fishing).

Convert the wetland (fish ponds, cultivation).

Destroy/lead to loss of wetland (channeling water, clay/sand, infilling).

Some important conservation and management activities include;

Buffer Zone

Does the wetland you are observing have a buffer zone?

Before human activities altered the landscape, a continual expanse of uninterrupted vegetation linked uplands and wetlands. Historically, land use practices have tended to alter or develop upland areas, creating abrupt boundaries between upland and wetland at the wetland edge. By establishing a buffer zone, you can recreate the vegetation continuum and minimize the abrupt boundary between cultivated or grazed lands and wetlands. A buffer area can protect wetlands from siltation, excess nutrients, and pollution from chemicals such as pesticides and herbicides applied to neighboring agricultural fields.

Vegetation on Edges of Lakes or Streams

Does the lake/stream have any vegetation around it? What kind of vegetation is it?

The vegetated wetland edge of a lake or stream is important habitat for fish, reptiles, amphibians, songbirds, waterfowl, and mammals. The shoreline plants of all water bodies should not be disturbed as their roots hold the soil to reduce erosion and stabilize the banks. Presence of shoreline plants also protects water quality by filtering and slowing runoff from the upland areas.

Livestock

Do cattle or sheep or goats graze in this wetland? What kinds of plants can you see around areas where cattle, sheep or goats are grazing? Are these native wetland plants? If not, how did they get there?

Cattle trampling can destroy sensitive wetland plants. The actions in the wetlands cause for invasive species to become established through dispersion of seeds that clanged on skin or hooves of the animals. Some of the seeds can disperse through the intestinal tract. Some species of wetland grasses and wildflowers are favorite food items of grazing livestock and may quickly disappear under grazing pressure. Manure can quickly become a source of excess nutrients and unwanted seeds. Undesirable plants, like reed canary grass, often establish themselves in grazed wetlands and along their edges.

6.4 Wetlands and sustainable development

What is Sustainable Development?

Sustainable development is development that meets the needs of the present without compromising the ability of the future regenerations to meet their own needs.

Wetlands and sustainable development

Wetland resources are important for our existence. Our health and well-being are closely linked to the quality of our water, air, soil and biological diversity. Their landscape and wildlife is inseparable from our culture, economy and industrial sectors which either directly or indirectly reliant on functioning of wetland ecosystems. The role of wetlands in sustainable development can be summarised under wetland services and human well –being.

Wetlands services and human well-being

(i) Fisheries

Wetland ecosystems including rivers, lakes, marshes, and coastal areas provide many services that contribute to well being and poverty alleviation. Some people particularly those living near wetlands are highly dependent on those services. Fish and water supply are among the important wetland services that affect human well-being. Fisheries are important in developing countries because they are the primary source of protein which rural communities can easily access. Wetland related fisheries make important contribution to local and national income.

(ii) Water supply

Physical and economic water scarcity, limited or reduced access to water is a major challenge facing society, and are key factors limiting development of many countries. However, the principle supply of fresh water for human use comes from wetlands including lakes, rivers, swamps and groundwater aquifers. Groundwater often recharges through wetlands, playing an important role in water supply with estimated 1.5-3 billion people depending on it as source of drinking water.

(iii) Wastewater purification and detoxification

Wetlands play a major role in treating and detoxifying waste products. As these move through the wetlands system some of them are absorbed while others are modified through various chemical changes.

(iv). Climate regulation

One of the important roles of wetlands is regulation of global climate change through sequestering and releasing of fixed carbon in the atmosphere. For example, peat lands are estimated to hold more carbon than is present in terrestrial vegetation. Presence of wetlands also modulates climate through presence of their vegetation.

(v) Mitigation of climate change

Sea level rise and increase in storms associated with climate change will result in erosion of shores and habitats, increased salinity of estuaries and bays and increased coastal flooding. Wetlands can play a critical role in physical buffering of climate change impacts.

(vi). Cultural services

Wetlands provide aesthetic, educational, cultural and spiritual benefits as well as a variety of opportunities for recreation and tourism. Recreational activities generate income at local and national level.

6.5 Conservation strategies/approaches

Strategies/approaches

Wetland Conservation strategies provide for the use and management of wetlands so that they can continue to provide a broad range of functions on a sustainable basis. Strategies/approaches are set to ensure wetlands conservation and public awareness actions both nationally and internationally which are deemed critical to the implementation of the Wetland Policies by governments.

Ecosystem approach

The ecosystem approach to wetland conservation is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use of wetlands in an equitable way. This is because wetland ecosystems are interconnected communities of living things, including humans, and the physical environment within which they interact. Healthy and well-functioning wetland ecosystems are vital to the protection of biodiversity and to sustaining our economies and communities that rely on their products. Ecosystem approach recognizes the interrelationship between the natural environment and healthy, sustainable economies, and emphasizes the integration of planning for the protection and conservation of both. The ecosystem approach is characterized as a method for sustaining or restoring natural wetland ecosystems and their functions and values. It is goal driven, and is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors. It is applied within a geographic framework defined primarily by ecological boundaries. Ecosystem approach is the primary framework for action under the Convention on Biological Diversity (CBD).

Community approach

Community approach to wetland conservation involves a local community taking the lead, initiating interventions, and achieving results for the long-term conservation and wise use of wetlands. It is an approach aimed at demonstrating how to implement two major objectives of the Ramsar Convention: conservation and wise use of wetlands for the well-being of local populations, by building consensus on major issues to be addressed, and increasing commitment on the steps to be taken by various stakeholders the community inclusive.

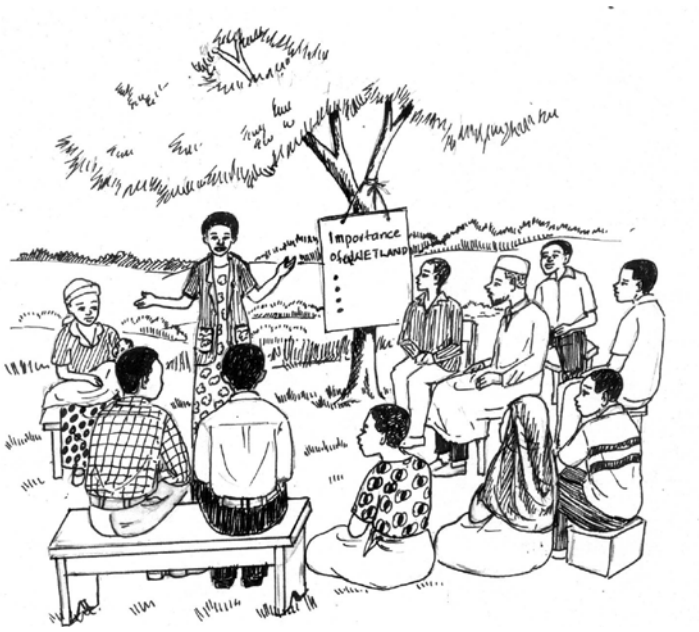

Figure 8: Communities planning for Wetland management

Resource User Approach

This approach aims to management of specific wetland resources by involving members of the community who use a specific resource. Members of the community who have a stake in a particular resource are assumed to have interest in it and hence are motivated to conserve the resource. Other approaches to wetland conservation include;

Developing Public Awareness

The Government should

- promote public awareness and understanding of the wetland resource in the country and actively encourage participation of the public, including
  -landowners,
  -non-government organizations,
  - Institutions,
  -and the private sector in wetland conservation.
- Design and deliver a national public awareness program on wetlands in cooperation with other government(s), non-government organizations and the private sector.
- Inform citizens of the health of the wetland resources on a regular basis through State of the Environment Reporting. Ensure that results of wetland research are available in formats suitable for public use and education.
- Provide information and expertise concerning sustainable land use management and conservation practices, particularly as they affect soil, water and wetland conservation and management.
- Provide suitable opportunities for public review and evaluation of the Government's performance relative to its wetland conservation goals.
- Promote development of targeted wetland education and outreach materials.

Promoting Wetland Conservation

The Governments should

- Coordinate the management practices of Protected Areas and other established for ecosystem conservation purposes so as to sustain their wetland functions and natural processes.
- Promote the development and implementation of management plans, which adequately reflect the special role of the wetland resource on lands secured for ecosystem conservation purposes, and ensure periodic review and update of these plans. Management of such wetlands should only support those activities which are compatible with sustaining wetland functions.
- Control the net loss of wetland benefits in all areas secured for conservation purposes.
- Conserve wetlands from impacts resulting from land or water use and environmental quality changes, both internal and external to the boundaries, by applying the Environmental Assessment and Review Process, enforcing compliance with regulations, work cooperatively with other levels of government, non-government organizations and the private sector and, if required, intervene in legal or decision-making processes.
- Encourage recreational, scientific, and educational uses of wetlands as long as these uses are not detrimental to wetland functions and do not conflict with the designated uses of the area.
- Develop, implement and review, where necessary, new and existing policies and legislation so as to enhance wetland conservation within areas established for ecosystem conservation purposes.

Enhancing Cooperation

The Governments should;

- Create joint regional wetland inventory, evaluation, and monitoring programs in support of: the identification of geographic areas within which the continuing loss or degradation of wetlands have reached critical levels; the identification of significant wetlands requiring protection; and the

identification of management strategies for the sustainable use of wetland resources.

- Encourage and support regional policies that promote wetland conservation, and promote the development of other related strategies. Encourage recognition of wetlands in the development and implementation of regional conservation strategies.
- Encourage consultation with interested regions and other parties whereby senior levels of government ensure that their wetland conservation policies and programs are supportive of each other.
- Enhance and, where necessary, develop new mechanisms for the resolution of inter-jurisdictional wetland problems.

Conserving Wetlands of Significance to Citizens

The governments should

- Participate and promote the establishment of a systematic and coordinated national networks for wetlands management to be achieved in cooperation with regional governments and other stakeholders. Such an approach will lead to a comprehensive network of secured sites or complexes of exemplary and strategically important wetlands of significance to nations together representing the full range of wetland functions and types.
- Develop national and regional criteria for identification and promote listing of wetlands of significance to nations in the regions using a standardized approach primarily on the basis of existing information.
- Promote use of a national network of secured wetlands as benchmark sites for environmental monitoring, scientific research, education and public awareness.

Ensuring a Sound Scientific Basis for Policies

The governments should

- support and promote the development of expertise for a sound technical and scientific basis for wetland conservation, ensuring that the information necessary for making decisions regarding wetlands is accessible to planners, managers, regulators, and other decision-makers at all levels.
- Encourage research that is directed towards advancing wetland conservation and sustainable use of wetland resources and ensure that the results of such research are effectively integrated into decision-making.
- Encourage the establishment of wetland centres of research and expertise in the country and foreign educational institutions.
- Undertake, support and promote the development of guidelines and standards aimed at establishing regional target levels for the quantity and quality of wetlands required to safeguard the range of wetland functions across the country. Such standards must refer to the level at which wetland loss or degradation threatens the health of regional ecosystems and species survival.
- Support research and demonstration projects on mitigating the impacts of inappropriate development on wetlands, and on the restoration and rehabilitation of degraded wetlands.
- Encourage the development of techniques for the integration of wetland functions into natural resource allocation decisions, reflecting the full range of wetland functions and values in such techniques, and demonstrate the appropriate roles of wetland conservation in solving land use problems.
- Promote research to better define the role of wetlands in the hydrologic cycle (groundwater recharge, water purification, flood control, and the maintenance of flow regimes), and the effects on wetlands of global atmospheric cycles, shoreline erosion, renewable resource production, management of exotic species such as purple loosestrife, and the provision of fish and wildlife habitat.

Promoting International Actions

The governments should

- Promote conservation and sustainable use of wetlands internationally, and encourage the involvement of other nations and international organizations in wetland conservation efforts.
- Provide technical and advisory assistance to wetland conservation efforts in other countries, particularly for those wetlands used by wildlife populations shared with country
- Strengthen the country's role in international wetland conservation, by requiring regular review of the country's progress on international conventions with relevance to wetlands, and by identification of gaps or weaknesses in honouring international commitments and responsibilities.
- Promote wetland conservation through continued strong commitments to the Ramsar Convention on Wetlands of International Importance, the World Heritage Convention and international agreements and treaties.
- Create and support the implementation of bilateral and multilateral agreements and similar arrangements that promote conservation and sustainable use of wetlands such as the International Biosphere Reserves Program, and new or existing agreements on marine and estuarine environmental quality, and emerging issues such as biodiversity and climate change.
- Ensure that representatives on international inquiries and commissions have an adequate understanding of wetland issues so as to promote wetland conservation in their consideration of the implications of transboundary management issues and opportunities for the sustainable use of wetland resources.

6.6 Wetland management planning

6.6.1 What is a management plan?

A wetland management plan outlines the direction and actions which are required to use the wetlands while ensuring that it remain health. Therefore a management plan helps in achieving the benefits that wetlands bring. Wetlands function as integral parts of the general landscape. Understanding how wetlands work is essential to the process of developing a wetland management plan. Most actions taken to protect wetlands involve both the wetland and their catchment in order to take care of the negative effects of land use practices may have on the wetlands. Management plans for wetlands involve bringing various stakeholders together and are the best options for their conservation because many of them are outside the Protected Area jurisdictions.

The following are the basic summarized steps involved in preparing a wetland management plan:

a) Review of existing information on Wetland Management Plan Development

This usually involves a good search of literature together with consultations on what is known about the area to be managed. A rapid survey of the ecosystems and the socio economic analysis is recommended to generate useful information. A report usually generated as product is a rapid assessment report

b) Reconnaissance

The Planners Visit to the site to carry out the following

- Identify and define the extent of the planning area
- Identify existing and potential institutions to be involved in the process

The key output is a Situational analysis report.

c) Stakeholder analysis

The following categories of people will be involved in a workshop or community meetings to develop who the stakeholders are. The village leadership, district technical staff, district extension staff and the facilitators. The main output is to generate a planning team composed of the key stakeholders and resource users.

d) Participatory Resource Analysis;
This an activity carried out by the planning team under close facilitation of the planners. During the resource analysis, the following are done:

- Resource listing
- Drawing a resource map
- Resource trend analysis
- Impact analysis
- Conflict/problem analysis
- Developing the activity calendar

The Key outputs to be included in the planning are the

- Resource list
- Resource map
- Resource trend
- Resource calendar
- Problems and coping strategies
- Conflicts and coping strategies

e) Visioning, objective formulation and management measures
The various categories of the resource users will get together into a workshop to discuss the resources they analysed. In the process they will Set visions, objectives and management actions. In cases of transboundary management of wetlands that cur across border, it is important for the various groups to harmonise the vision, objectives and actions.

f) Development of;
When the actions have been formulated, they are followed by development of an agreed work plan, budgets and indicators. The Key output of this process is to have a management plan with a Workplan specifying who to do the actions, a budget (usually it is possible to identify possible sources of funding), also gives an indication of how much resources are require to carry out the planned activities. The indicators provide a measure to use for Monitoring and Evaluation strategy.

g) Compilation of the draft management plan, Presentation
When the above 6 phases have been accomplished, a draft management plan is prepared, discussed and if agreed with all stakeholders involved can be launched.

h) Lay out of the management plan
A good Management plan will have the contents covering the following:

- Introduction
- Background information
- Description of wetland to be managed
- Objectives of management plan
- Aspects covered about the wetlands
- Methods used (qualitative and quantitative)
- Analytical procedures

Field findings

- Ecological and socio economic issues of the wetlands
- Present uses of the wetlands
- Opportunities and constraints
- Problem analysis and ranking
- Zoning of the wetlands

- Present and potential wetland users
- Strategic objectives, actions and options
- Monitoring and Evaluation
- Financial implications
- Problems encountered
- Recommendations
- Annexes

The management plan must have a time limit in which it should be reviewed.

Activity 6.2:
From the responses of the interactions you have had since the beginning of this course, develop an outline for a management plan for a particular wetland

Highlight the gaps to fill in order to come up with a participatory management plan.

6.7 Management of trans-boundary wetlands

Trans-boundary areas could be politically fragmented or transitional wetland areas. The viable option would be to bring the different communities together in formulating moral obligations that can make them responsible for management of the resources thay have always depended on. It calls for harmonization of legal frame works (e.g. ownership), access to information, encouraging coordinated management and positive cooperation.

Many natural wetlands are trans-boundary, the establishment of cross border cooperation on wetland management is required. While management of wetlands on a national scale has challenges, the management of trans-boundary wetlands is more complex because of wetland connectivity across the borders, which calls for shared responsibility. Trans-boundary wetland management needs to take into consideration the role wetlands play in restoring the natural discharge and recharge patterns of the water system of the overall catchment. In addition, trans-boundary wetland management needs to acknowledge the role wetlands play to purify water and to trap sediments. Creating awareness, fostering a sense of shared responsibility, cooperation, and opening common and a broader view on management is vital for the survival of trans-boundary wetlands.

Trans-boundary cooperation

Many challenges have to be surmounted before successfully establishing a trans-boundary co-operation. These challenges are due to a number of factors such as;

- Differences in legislation
- Differences in policy goals
- Political differences
- Differences in governing structures
- Knowledge of each others language
- Different funding requirements
- Social and cultural differences
- Structural agreements on the implementation of trans-boundary co-operation

In most cases, cooperation begins informally, with private contacts between wetland managers on both sides of the border, based on a common interest in the sustainable management and/or protection of the area concerned. However, to formalize a trans-boundary cooperation agreement, governmental level support is required. Due to the difficulties mentioned above, this requires a good understanding to avoid set backs in involving communities in managing what they have set themselves to do. Managers, scientists

and planners concerned with trans-boundary wetlands must be encouraged to cooperate directly with their colleagues across the border as a bottom-up approach appears to be the best guarantee for successful trans-boundary cooperation. International workshops, exchange programmes, conferences and training courses provide excellent opportunities for initiating cooperation.

Supporting and facilitating trans-boundary wetland management

Trans-boundary cooperation is not only important because of conservation of biodiversity values, but is also required for political stability. However, mechanisms to support projects aiming to enhance trans-boundary wetland management may be a challenge. Cooperation on the development and implementation of joint projects on integrated trans-boundary wetland management, including the establishment of a trans-boundary wetland monitoring network would be a good.

6.8 International, regional and national institutions involved in wetland management

6.9.1 Institutions

Worldwide, environmental institutions exist. However, the management of wetlands is a relatively new concept to a majority of these institutions. The following are some of the examples of institutions involved in wetland management in Africa;

Local and national institutions

- Universities
- Ministry of Agriculture
- Ministry of Water (and irrigation),
- Ministry of Environment
- Ministry of Land and Mineral resources
- Ministry of Tourism and Wildlife
- Ministry of Education
- NGOs

Regionally

- East African Community
- Lake Victoria Fisheries Organization
- Global Environment Facility
- IGAD
- Nile Basin Initiative
- Horn of Africa

Internationally

- The World Conservation Union
- Ramsar Conventions on wetlands,
- UNESCO Man and Biosphere Programme
- Convention of Biological Diversity
- Birdlife International
- World Wildlife Fund

6.9.2 Institutional Challenges

(i) First, there is the challenge arising from empowerment of a lead institution that is mandated to coordinate other institutions sharing roles in wetlands management within a country. Examples of wetland abuses have been made by other government departments without consultations of national wetlands lead institutions Decisions on how to use the wetlands are taken under the pretext of providing their communities with economic growth opportunities and for fighting poverty, but this the requirement should be that before any use the lead institution in would provide the technical guidelines for their use.

(ii) The other important issue relates to ownership, user rights and access. The issue of ownership has been subjected to various interpretations to the extent that enforcement attempts regarding wetland resource utilization by technocrats are often challenged. The Complex wetland ownership issues include the need to clarify the difference between owning a piece of land and its use, which has to be done in accordance with other laws. This is more important in wetlands whose use could have far-reaching negative consequences both down and upstream. Issuance of ownership to wetland areas by governments contravenes the efforts of conserving them unless guidelines clearly spell out the use for which the wetlands is intended for, which should in line with the wise use principles of wetlands management.

(iii) Enforcement of the legal requirements for protection of wetlands is often a challenge. It is now largely accepted that wetlands are an important resource worth protecting, and environment policies, actions, regulations, including those on management of wetlands have been formulated in many countries. But to enforce these regulations has gaps usually created by inadequate enforcement team and lack of understanding of the regulations as they are still new. It should be stressed that this state of affairs for a dispersed resource such as wetlands requires an enforcement and intervention mechanisms that is closer as possible to the community level if tangible results are to achieved.

(iv) The "anonymous", "holiday" and "awkward hour" dumping syndrome

Without an effective grassroots enforcement mechanism, it has been extremely difficult to control indiscriminate dumping of materials in wetlands along the roads and other remote areas by anonymous individuals such as truck drivers who probably view wetlands as "good" open space to dump in rather than drive long distances to designated dumping sites. Time and again, people living in and around wetland areas where murrum (earth dumping) and waste dumping has taken place have indicated that the dumping is done by unknown truck drivers at awkward hours.

(v) Transfer management and enforcement responsibility to local authorities and to resource users' level

With the expansion of Central Government enforcement machinery not likely to happen in the foreseeable near future, it is plausible to believe that increased local authority and local community role on matters of wetland management planning and enforcement, including stopping wetland abuse through community policing could be a more sustainable way to stem further degradation. A community management plan ensures equitable role for all stakeholders in management of a wetlands.

(vi) Need to harmonize urban planning and land–use in general with modern wetland conservation goals. Until now, environment lead agencies continue to receive development proposal on wetland areas that have been demarcated as plots by planning authorities. This apparently continues to send wrong signals to other wetland users who seem to perceive a sense of no action being taken in especially urban areas where wetland encroachment continues. A clearing house that assist decision makers is very important before proposals of these kinds are brought up.

(vii) Poverty and wetland resources use relationship. Over the recent years, there appears to be increasing cases of activities being implemented in wetlands in the name of fighting against poverty. While some of these activities are out-rightly not compatible with wetland conservation nor wise use goals, their promoters have vigorously defended them as intended to assist in the fight against poverty. Activities such as brick making in wetlands which are done for economic gains should have proper programs to conservation and restoration the affected wetlands.

(viii) Inadequate funding of all major activities for wetlands and biodiversity management. This scenario has also led to institutional un-sustainability and in most cases it has been a challenge for such institutions to retain competent staff.

(ix) The available alternatives land use activities are not lucrative to attract the communities to engage in them yet the latter is currently very destructive to the wetland.

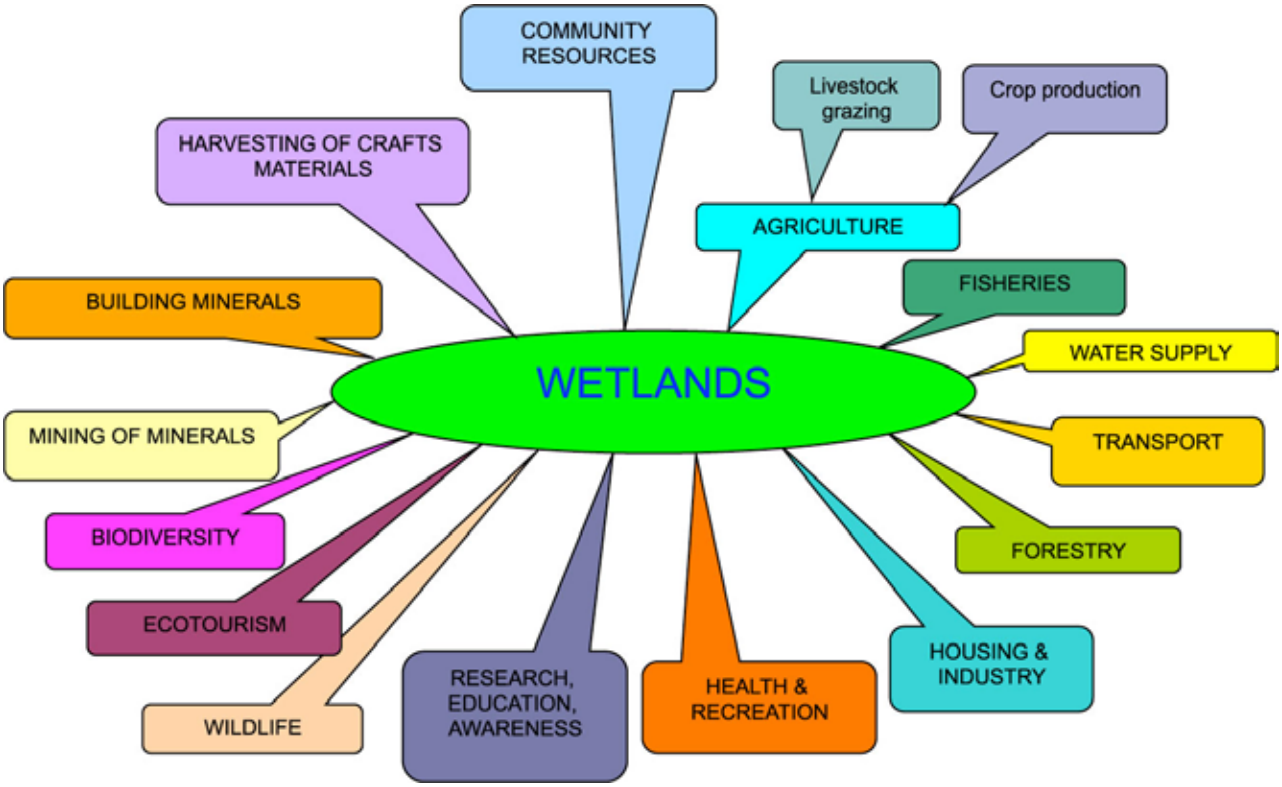

Figure 9: One resource and many interests which requires coordination: (identify other key stakeholders) Slide from Uganda Management Department, Ministry of Water and Environment.

Note:

Many sectoral institutions have a stake in wetland conservation, and this require a lot of coordination in order to harmonise their mandates. For example, in Uganda, the Ministry of Water and Environment is the lead agency of water and environment issues. However, the Ministry of Agriculture is mandated to provide water for production. The Fisheries Department has the authority over fish. Some lakes are located in protected areas, the mandate of the Wildlife Authority in the Ministry of Tourism. This multi-sectoral coordination for management of wetlands is a big challenge. The Government of Uganda established the Wetlands Department in the Ministry of Water and Environment to spearhead the coordination of wetlands management as the Lead Institution of all the key sectors that are dealing with wetlands management. This ensures that the other departments are guided in the use of wetlands for agriculture, water for production, fisheries and other uses. The resource is one with Many Interests

6.10 Module Summary

In this Unit, you have been able to:

- Define the term sustainable use and wise use concept
- Give the rationale for conserving and managing wetlands properly
- Identify the actors in the management of wetlands
- Explain why it is important to have policies that govern wetlands management and give examples of such policies in your country
- Critically examine ways of strengthening wetlands management in your country as well as the trans-boundary wetlands
- Relate what has been achieved on wetlands management elsewhere in the world to our own situation in the Nile basin region.

6.11 Further Reading

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MODULE 7: INTERNATIONAL AND NATIONAL OBLIGATIONS FOR WETLANDS MANAGEMENT

7.1 Introduction

Wetlands are cradles of biological diversity, providing the water and primary productivity upon which large numbers of plant and animal species depend for survival. They are also important locations of plant genetic diversity and support large numbers of bird, mammal, reptile, amphibian, fish and invertebrate species. Unfortunately, they are also among the world's most threatened ecosystems, owing mainly to continued drainage, pollution, over-exploitation or other unsustainable uses of their resources. This wetland is responsible for bringing to the verge of extinction countless species of animals and plants. Inadequate understanding of the crucial role and utility of wetlands is a matter of international concern.

Recognizing the importance of wetland resources, the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971) has been instrumental in worldwide action at the governmental level for conservation and the wise use of wetlands. The Ramsar Convention has played an important role in promoting awareness of wetlands and providing technical support to governments for conservation and management of these ecosystems on a sound ecological basis.

In this module, the various national and international policies and laws put in place to ensure the conservation and wise use of wetlands shall be discussed including agreements and conventions such as the Ramsar convention on wetlands of international importance.

Learning objectives

By the end of this Module, you should be able to:

- Explain the Ramsar convention
- State aims and objectives of the Ramsar convention
- Describe the extent of implementation of Ramsar obligations
- Give international and national policies and laws that govern wetland conservation
- Give examples of national policies on wetland conservation
- Explain the African Eurasia Waterbird Agreement (AEWA)
- Use the knowledge obtained on wetland laws and policies to enhance wetland conservation in their local areas and in the region at large.

7.2 Ramsar and wetlands of international importance

7.2.1 The Ramsar Convention

(i) What is the Ramsar Convention?

The *Convention on Wetlands of International Importance, which started as a convention for Waterfowl Habitats,* was adopted in 1971 in the Iranian city of Ramsar, hence the name *Ramsar Convention and came into force in 1975*. It is an intergovernmental treaty, which provides the framework for national action and international cooperation for the conservation of and wise use of wetlands and their resources. It was the first global instrument to address the conservation of a particular habitat. It reflected a new international legal efforts aimed at conservation by protecting a habitat rather than a species. The convention's origin was mainly the research activities conducted by a non-governmental organization, the *International Waterfowl Research Bureau.*

The convention had its emphasis on the conservation and wise use of wetlands primarily to provide habitat for water birds, however, over the years, the convention expanded in scope to cover all aspects of

wetland conservation and wise use. In this regard, wetlands are recognized as ecosystems that are highly important for biodiversity conservation and for the well-being of human communities.

Contracting parties meet tri-annually as a Conference of Parties (COP) to review and discuss issues pertaining to the convention and their obligations. The 9th COP and the first in Africa took place in Uganda in 2005, the 10th COP took place in South Korea while the 11th COP will take place in 2011 in Romania.

Ramsar Convention Mission

> The mission of the Ramsar Wetlands Convention is the conservation and wise use of wetlands through local, regional and national actions and international co-operation, as the means for achieving sustainable development throughout the world.

The convention recognizes the fundamental ecological functions of wetlands, including biological, productivity and their economic, cultural, recreational and scientific values (including biodiversity conservation). This convention directly addresses the conservation of biological diversity. It seeks to secure the maintenance of the ecological integrity of wetlands, and to promote resource development.

(ii) Aims and Objectives of the Convention

The Convention aims to ensure the conservation and wise use of wetlands. For this purpose, it contains four major commitments that Contracting Parties have agreed to by joining the treaty which include**;**

- The first obligation under the Convention is to designate at least one wetland for inclusion in the *List of Wetlands of International Importance* (the "Ramsar List") and to promote its conservation, including, where appropriate, its wise use. Selection for the Ramsar List should be based on the wetland's significance in terms of ecology, botany, zoology, limnology, or hydrology. The Contracting Parties have adopted specific criteria and guidelines for identifying sites that qualify for inclusion in the List of Wetlands of International Importance. As of April 2009, the number of Contracting Parties is 159 and have designated 1,842 Ramsar sites, with a total surface area of about than 180 million hectares.

- Under the Convention, there is a general obligation for the Contracting Parties to include wetland conservation considerations in their national land-use planning. They undertake to formulate and implement this planning to promote, as far as possible, "the wise use of wetlands in their territory". The Conference of the Contracting Parties (COP) approves guidelines and provides additional guidance on how to achieve *"wise use"*, which has been interpreted as being synonymous with "sustainable use".

- Contracting Parties also undertake to establish *Nature Reserves in wetlands,* whether or not they are included in the Ramsar List, and they are also expected to promote training in the fields of wetland research and management.

- Contracting Parties also agree to *consult with other Contracting Parties* about implementation of the Convention, especially about transfrontier wetlands, shared water systems, and shared species.

(iii) Institutional structure of the Ramsar convention

It has become apparent in recent years that, the prospects of success of any treaty, which has the protection of the environment as its principal objective, will depend to a considerable extent upon the effectiveness of the institutional mechanisms, which it incorporates. The Convention made provision for the creation of only one new institution - *the Conference of the Contracting Parties*. To be strictly accurate, Article 6(1) merely provided that:

'The Contracting Parties shall, as the necessity arises, convene Conferences on the Conservation of Wetlands and Waterfowl.'

The first Wetlands Conference following the Convention's entry into force was duly held at Cagliari, Italy, in November 1980. The second meeting, held at Groningen in the Netherlands in May 1984, was referred to as a Conference of the Contracting Parties and all the later meetings have been similarly titled.

The 1987 amendments to Article 6(1) do in fact expressly now refer to these meetings as Conferences of the Contracting Parties, as well as regularizing their occurrence by providing that ordinary meetings shall no longer be convened 'as the necessity arises', but rather 'at intervals of not more than three years, unless the Conference decides otherwise'. Such meetings have been duly held in accordance with this timetable ever since Groningen. The functions of ordinary meetings of the Conference have already been described in the context of implementation mechanisms. Provision is also made in the amended Article 6 for the holding of extraordinary meetings at the written request of at least one third of the Contracting Parties.

The principal reason for convening an extraordinary meeting would be for the adoption of amendments to the Convention in accordance with Article 10 but there would seem to be no reason why such meetings could not be convened for other purposes also. The only reference in the text of the Convention to the question of participation in meetings of the Conference is to be found in Article 7(1), which states that:

'*The representatives of the Contracting Parties at such Conferences should include persons who are experts on wetlands or waterfowl by reason of knowledge and experience gained in scientific, administrative or other appropriate capacities.'*

It is apparent that this provision expressly neither authorizes nor excludes the presence of other participants, but, given the substantial role of NGOs in the Convention's formative stages, it would have been surprising had they been denied participation in the implementation phase. Given, furthermore, that the original text spoke only of Conferences on the Conservation of Wetlands and Waterfowl, there was no obvious reason to exclude them.

Conservation of wetlands and of their flora and fauna, whether national or international, governmental or non-governmental, is also to be admitted unless the Parties decide otherwise, though national non-governmental agencies must first secure the approval of their government for this purpose. Once admitted, observers are entitled to participate but not to vote. They may even submit proposals for deliberation if they secure the sponsorship of a delegation, and there appear to be some examples of this having occurred.

The C*onference of the Contracting Parties (COP)* has the following roles:

Every three years, government representatives of the Contracting Parties meet as the Conference of the Contracting Parties, the policy-making organ of the Convention, which reviews the general trends in the implementation of the Convention as reflected in the National Reports and adopts decisions to improve the way in which the Convention works. The programme of each meeting of the COP also includes a series of technical sessions, which analyze issues of importance in the field of wetland conservation and wise use, including further interpretation and development of the key Convention concepts. Ramsar

COPs have gained the reputation of being highly effective events, allowing an active involvement and participation of the non-governmental and academic community.

Other forms of institutional arrangements to which express reference is made in the text of the Convention concerns the performance of Secretariat duties, such as the convening and organization of conferences, the maintenance of the Ramsar List and the receipt of information concerning changes in the ecological character of designated sites, and the transmission to the parties of such details, together with any recommendations of the Conference adopted in response.

- *Standing Committee:*

The Standing Committee meets annually to carry out interim activities between each COP on matters previously approved by the Conference; prepare documentation for consideration at the next COP; supervise implementation of policy by the Ramsar Bureau (see below) and execution of the Bureau's budget; and decide upon applications for project support from the Ramsar Small Grants Fund (see below). The Standing Committee consists of Contracting Parties elected on a proportional basis from the six Ramsar regions – Africa, Asia, Europe, Neotropics, North America, and Oceania – as well as the host countries of the most recent meeting and the next meeting of the COP. The Contracting Parties that host the Ramsar Secretariat and Wetlands International, are invited to participate as permanent observers, and the International Organization Partners (see below) are invited to participate in an advisory capacity.

- *Scientific and Technical Review Panel (STRP):*

The Scientific and Technical Review Panel provides scientific and technical advice to the Conference of the Contracting Parties. The STRP is composed of 13 individual members with appropriate scientific and technical knowledge, selected from the six Ramsar regions, and representatives of the four International Organization Partners (see below). Other relevant organizations also contribute to the work of the STRP as observers.

- *Ramsar Secretariat:*

The Ramsar Convention Secretariat carries out the day-to-day coordination of the Convention's activities. It is headed by a Secretary General, who supervises the work of technical, communications and administrative staff, as well as interns and outposted members of the Secretariat.

- *International Organization Partners (IOPs)*:

The Conference of the Parties may confer the status of International Organization Partner to international organizations, both intergovernmental and non-governmental, that "contribute on a regular basis and to the best of their abilities to the further development of the policies and technical and scientific tools of the Convention and to their application". So far, four international non-government organisations that have been associated with the Convention since its inception have been recognized as IOPs. They are Birdlife International, IUCN–The World Conservation Union, Wetlands International, and the World Wide Fund for Nature (WWF).

- *Ramsar Small Grants Fund (SGF)*:

The Small Grants Fund for Wetland Conservation and Wise Use was established by the 1990 Conference of the Contracting Parties (at that time under the name "Wetland Conservation Fund"). The SGF provides financial assistance in the form of small grants (maximum Swiss Francs 40,000 per project) for projects in developing countries and countries with economies in transition. At present, funding is provided for activities related to the implementation of the Convention's Strategic

Plan 2003-2008 (see below), including requests for emergency assistance. So far, some 166 projects have been funded in about 80 countries, for a total amount of about Swiss Francs 5,475,000. The fund relies entirely upon voluntary contributions for its operations.

(iv). Implementation of Ramsar Obligations

The prospects for the achievement of Ramsar's aims lie in achieving a successful blend and balance between action at the national and international levels. An interesting illustration of this approach may be found in the process of enhancing awareness of wetland values and functions. This has been confirmed as a key objective of the Ramsar system and is pursued through its Outreach Programme, embracing activity at a variety of levels.

This includes the development at the national level of educational programmes concerning wetlands, both through formal academic instruction and, more generally, through provision of information to the public at zoos, museums, and dedicated wetland centres; the organization at the regional level of conferences and workshops devoted to wetland issues; and, globally, the dissemination of information by the Ramsar Secretariat itself. The development of an impressive website, together with the preparation of a regular newsletter and numerous specialist publications, demonstrate that the secretariat has been particularly active in this regard. Nevertheless, when it comes to the implementation of substantive commitments to sustainable development, experience of conservation treaties generally suggests that the practical limitations of international institutions in terms of powers, finance, and resources, reinforced by the still strong attachment to the concept of national sovereignty, tend to result in the primary emphasis being placed upon national activities and agencies.

The role of international agencies lies principally in monitoring. An effective system of reporting by states upon national measures adopted in implementation of their obligations provides the necessary link between these two aspects.

7.2.2 Implementation of the Ramsar convention at the National Level

1. Site Designation

An important first step is to designate one site as a Wetland of International Importance. The COP has continually encouraged parties to go beyond the minimum obligation of listing one site, and several have added repeatedly to their original list of designations. In the Nile Basin there are many sites that are worth listing and efforts to meet the criteria are necessary especially if some of the sites can be managed as Transboundary Ramsar sites. This will promote the domestication of the Ramsar obligations for conservation and wise use is an important priority for designation of more sites in the Nile Basin and Africa at large.

2. Site Management

An obvious indicator of the extent to which contracting parties have successfully implemented their Ramsar obligations, concerns the ongoing ecological condition of sites on the list, the preservation of which represents one of the principal objectives of the Ramsar system. The achievement of this goal clearly depends upon effective management at site level, and the identification and implementation of conservation and management priorities for each site consequently constitutes an important aspect of the wise-use concept. Where effective management is lacking, there is an obvious risk that environmental quality will deteriorate, and it is in these circumstances that the duty to report adverse changes may come into play.

7.2.3 Overview of the implementation of the Convention in Africa

The achievements and major challenges towards the implementation of the convention in the Nile basin region and Africa at large are as follows;

1. Achievements

The major achievements of the convention include the following;

- Increased membership and acceptance worldwide that wetlands are important resources
- Increased interest in Ramsar site designations, confirmed or in the process. The numbers keep rising every year
- Development of national wetland policies and strategies, finalized or in the process
- Development and implementation of management plans, already in place or being prepared Most countries have developed or are in the process of developing management plans for their Ramsar sites.
- Establishment of coordination mechanisms at national level, including National Ramsar/Wetlands Committees
- Progress in capacity building in some countries
- Most countries have designated more than one Ramsar Site since the last COP.
- Most countries are in the processes of developing or reviewing wetland policies and legislation. For example, South Africa is preparing specific legislation to enable full Ramsar implementation, including designation of Ramsar sites that are not protected areas.
- Most countries have National Ramsar/Wetlands Committees and others are in the process of having one, for example, Kenya is considering establishing a broader Kenya Wetlands Forum.
- For those countries with environmental legislation, Environmental Impact Assessment (EIA) has been incorporated in the legislation.
- Previous efforts in designation of Ramsar Sites have been directed at designating protected areas, as observed in Kenya, South Africa and Zambia. However, a focus to designating unprotected wetlands as Ramsar sites is gaining momentum.
- Most countries are in the process of or are planning to undertake inventories
- Most countries are involving local communities at the lowest appropriate level and other sectors in wetlands conservation and management through formation of management committees, and have developed awareness and sensitization exercises.

2. Challenges

The main challenges still prevailing include:

- Domestication of the Ramsar actions in the countries in the sub-region is still a challenge that can be addressed through institutionalization.
- Need for further policy development and implementation
- Adoption of legislative frameworks to allow full implementation of the Convention.
- Communication within the region which can be addressed through regional platforms like the NileWet
- Conflicting sectoral policies nationally and regionally and these need harmonization.
- Inadequate information and knowledge of wetland values
- Further increasing the profile of the Convention to ensure more political support for wetland conservation and wise use.
- The need to mainstream wetland issues.
- To put policies into practice.
- How to effectively enforce environmental legislation.
- Cross-sectoral cooperation in implementing the wise use principle.
- How to balance development activities and wise use.
- How to enhance local communities' livelihoods as an incentive to wetlands management.

3. What do we need?

- To have an overall legislation for management of wetlands in the region.
- To emphasize stakeholder's involvement in wetland management, in particular the local communities and the private sector, including using incentives to do so.
- To build capacity in terms of training and funding for wetland management.
- To reinforce education and public awareness in wetland management.
- To harmonize existing policies and legislations
- To combat alien invasive species in wetlands constitute a high priority to address.
- Legal status of the Convention and Ramsar Sites in Contracting Parties: need for specific enabling legislation for the implementation of the Ramsar Convention.

Activity 7.1

- *Briefly give an overview of the Ramsar convention, stating clearly its mission and objectives.*
- *With reference to any country in the Nile basin region, find out the extent to which the Ramsar convention has been implemented*
- *Suggest ways in which countries in the Nile basin region can implement the convention..*

7.3 Wetlands of international importance

The Ramsar convention requires contracting parties to designate at least one wetland of international importance. Some criteria have been put in place for identifying these wetlands.

Article 2.2 of the convention provides that;

"*Wetlands should be selected for the List on account of their international significance in terms of ecology, botany, zoology, limnology or hydrology" and indicates that "in the first instance, wetlands of international importance to waterfowl at any season should be included".*

The process of adopting specific criteria for the identification of internationally important wetlands began in 1974, but the first official Criteria were agreed at COP1 in 1980. In 1987 and 1990, the Conference of the Parties revised the Criteria further, and at COP6 in 1996, the Parties added new Criteria based on fish and fisheries. The Criteria were reorganized into two groups – based upon representativeness/ uniqueness and upon biodiversity – by the *Strategic Framework and guidelines for the future development of the List* and at COP9 (2005) a ninth Criterion was added to cover wetland-dependent non-avian animal species.

Recognizing that cases may arise where a Ramsar site was designated for the List prior to the adoption of the latest version of Criteria, and it may no longer meet any of those current Criteria, or where a Ramsar site has subsequently lost the ecological values for which it was originally designated, the Secretariat in consultation with the Contracting Party concerned, evaluates what measures might be necessary to extend, enhance or restore the wetland's functions and values to the degree that it would qualify for inclusion in the List.

Where there is no possibility of extension or enhancement/restoration of its functions or values, the Contracting Party concerned instructs the Secretariat to remove the site from the List, and the Party then applies the provisions for compensation, as provided in Article 4.2 of the Convention. This has only occurred in a very few cases.

The designation of a wetland in this respect is governed by eight specific criteria. A wetland should be considered internationally important if it:

- Contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
- Supports vulnerable, endangered, or critically endangered species or threatened ecological communities;
- Supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographical region.
- Supports plant and/or animal species at a critical state in their life cycles, or provides refuge during adverse conditions;
- Regularly supports 20,000 or more water birds.
- Regularly supports one percent (1%) of the individuals in a population of one species or sub-species of water bird;
- Supports a significant proportion of indigenous fish subspecies, species or families, life-history stages,

species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity;

- Either is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, within the wetland or elsewhere, depend.
- Regularly supports one percent (1%) of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Basing on the above criteria, some of the following sites in the Nile Basin countries have designated as Ramsar sites as wetlands of international importance (See table 1 in module 1).

Unit Activity 7. 2

- Using the websites find out other ramsar sites in the Nile basin countries that are not in the Nile Basin Catchment
- What criteria have been considered for listing Ramsar Sites?
- Using the knowledge obtained, which other wetlands in the country of your choice do you think can qualify as Ramsar sites.

7.4 International and regional policies on wetlands

Little has been done in formulating regional policies, but internationally, various conventions related to conservation of biological diversity have helped in providing policy guidelines for wetland conservation.

7.4.1 International agreements and conventions related to wetlands

Six international conventions that focus on biodiversity issues including wetland conservation have been put in place. They include;

1. Convention on Biological Diversity (CBD)
2. Convention on Conservation of Migratory Species (CMS)
3. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
4. International Treaty on Plant Genetic Resources for Food and Agriculture
5. Ramsar Convention on Wetlands
6. World Heritage Convention (WHC)
7. African Eurasian Waterbird Agreement (AEWA)

Each of the above conventions and agreements works to implement actions at the national, regional and international level in order to reach shared goals of conservation and sustainable use. In meeting their objectives, the conventions have developed a number of complementary approaches (site, species, genetic resources and/or ecosystem-based) and operational tools (for example, programmes of work, trade permits and certificates, multilateral system for access and benefit-sharing, regional agreements, site listings and funds).

CBD

The objectives of the Convention on Biological Diversity (CBD) are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from commercial and other utilization of genetic resources. The agreement covers all ecosystems, species, and genetic resources including wetland resources.

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Through its three appendices, the Convention accords varying degrees of protection to more than 30,000 plant and animal species, including those that inhabit wetlands.

CMS

The Convention on the Conservation of Migratory Species of Wild Animals (CMS, or the Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. Parties to the CMS work together to conserve migratory species and their habitats by providing strict protection for the most endangered migratory species, by concluding regional multilateral agreements for the conservation and management of specific species or categories of species, and by undertaking co-operative research and conservation activities.

International Treaty on Plant Generic Resources fro Food and Agriculture

The objectives of the Treaty are the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. The Treaty covers all plant genetic resources for food and agriculture, while its Multilateral System of Access and Benefit-sharing covers a specific list of 64 crops and forages. The Treaty also includes provisions on Farmers' Rights.

WHC

The primary mission of the World Heritage Convention (WHC) is to identify and conserve the world's cultural and natural heritage, by drawing up a list of sites whose outstanding values should be preserved for all humanity and to ensure their protection through a closer co-operation among nations. Wetlands are also regarded as heritage and cultural sites.

While each convention stands on its own and with specific objectives and commitments, inter-linkages between the issues each addresses, and potential complementarities in their monitoring and implementation processes, provide a basis for cooperation.

AEWA

What is AEWA?

The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is the largest of its kind developed so far under CMS. It was concluded on 16 June 1995 in Hague, Netherlands and entered into force on 1 November 1999 after the required number of at least fourteen Range States, comprising seven from Africa and seven from Eurasia had ratified.

The African Eurasian Waterbird Agreement works on the protection of the migratory birds in the region. Most countries along this route signed the agreement. Wetlands International is actively involved in the meetings of this agreement in order to induce the right decisions. The countries that signed the African Eurasian Waterbird Agreement (AEWA) meet regular to discuss the state and to take decisions about the protection of the migratory birds following the route from West and North Asia, Europe to Africa. Wetlands International plays a very active role in providing the data about waterbirds and to propose the right measures to protect the birds and their sites.

Objectives and approach

Parties to the Agreement are called upon to engage in a wide range of conservation actions that are described in a comprehensive Action Plan (2003-2005). This detailed plan addresses such key issues as species and habitat conservation, management of human activities, research and monitoring, education and information, and implementation.

Work areas

With the productive outcome of 20 adopted resolutions, the Third Meeting of the Parties to AEWA (23 – 27 October 2005 in Dakar, Senegal) paved the way for a host of activities to be implemented within the next three years. An important issue was the adoption of the Communication Strategy, which is expected to bring major improvements in internal and external communication, capacity building and public awareness.

Parties to AEWA (Africa)
A number of countries in the Nile basin region are parties to the African Eurasian Waterbird agreement (AEWA), including Egypt, Kenya, Sudan, Tanzania and Uganda.

The list of African countries that are a party to the AEWA are as follows;

i.	Benin	ii. Congo
iii.	Djibouti	iv. Egypt
v.	Equatorial Guinea	v. Gambia
vi.	Gambia	vii. Ghana
viii.	Guinea	ix. Kenya
x.	Libya	xi. Mali
xii.	Mauritius	xiii. Niger
xiv.	Nigeria	xv. Senegal
xvi.	South Africa	xvii. Sudan
xviii.	Tanzania	xix. Togo
xx.	Tunisia	xxi. Uganda

7.5 National Wetland Policies

A significant proportion of the activities undertaken within the Ramsar system has been directed towards the establishment of a clear policy framework for the conservation and wise use of wetlands, and a crucial indicator of the success achieved by the Convention concerns the extent to which such principles have been embraced at the national level.

The adoption and implementation of a national wetland policy has emerged as one of the highest Ramsar priorities, and recently approved guidelines are intended to assist in that regard. While in 1993 only two parties (Canada and Uganda) had formally adopted such policies, by 1999 the number had expanded to 22. A further 31 indicated that such policies were currently under development, while 24 others advised that such instruments were planned for the near future.

Uganda is the only country in the Nile basin region known to have a stand alone national wetlands policy. Other countries such are in the process of making one.

Countries with National Wetland Policies **or National Wetlands Action Plans** include;

- **Canada:** The Canadian Federal Government Policy on Wetland Conservation, 1991
- **Australia:** The Wetlands Policy of the Commonwealth Government of Australia, 1997
- **Ghana:** A National Wetlands Conservation Strategy, **2008**
- **Greece:** National Strategy for Wetland Resources, **1999**
- **New Zealand:** New Zealand Wetlands Management Policy, **1986**
- **Trinidad and Tobago:** National Policy and Programs for Wetlands, **2002**
- **Turkey:** 2003-2008 National Wetlands Strategy for Turkey, **2002**
- **Uganda:** National Policy for the Conservation and Management of Wetlands Resources, Uganda, 1995
- **Tanzania:** Wetlands and Wildlife policy (2008)

Activity 7. 3:

Before you read further, identify any national, regional or local policy that your country has put in place in response to the need to conserve wetlands. Study it to see whether is addresses the issues that enhance wetland management.

7.5.1 Major Steps in formulating National Wetlands Policies

The following are the main Key steps in formulation of National Wetlands Policies. The **Obligations of Contracting Parties** Under Article 3.1 of the Convention, Contracting Parties agree to **"formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory".**

The 'Wise Use Guidelines' call upon Contracting Parties to: adopt national wetland policies, involving review of their existing legislation and institutional arrangements to deal with wetland matters (either as separate policy instruments or as part of national environmental action plans, national biodiversity strategies, or other national strategic planning);

Why the need for Policies

- ✓ Create awareness of wetland values (*during formulation and implementation*)
- ✓ Recognise wetlands as unique ecosystems
- ✓ Define responsibilities for different stakeholders at various levels
- ✓ Commit government to conserve wetlands
- ✓ Set goal and objectives for wetland management

Steps recommended by Ramsar Secretariat.

Step 1 Establishing a lead agency
Step 2 Considerations for a National Wetland Committee
Step 3 Local Government or National issues statement and background paper
Step 4 Defining wetlands at a National level
Step 5 Defining stakeholders
Step 6 National Consultations
Step 7 Implementing National and Local wetland policy workshops
Step 8 Creating a Wetland policy writing team
Step 9 Ensuring political support for the next steps
Step10 Completing consultations and preparing additional drafts of the policy
Step 11 Developing a Cabinet Memorandum
Step 12 Government endorsement and approval, announcement
Step 13 Prepare implementation strategy and launch the policy

Step 1. Establishing a lead agency

- Development of an issues statement,
- Planning of meetings and workshops
- Writing of a policy or strategy, requires coordination and resource support (e.g. staff time, office support, travel costs).
- Coordinate and facilitate advocacy and lobbying because probably not many understand what it requires to get members

Step2: Issues statement & background paper

"think piece" generates discussion paper on

a) of wetlands and resources present in the nation's existing wetlands;
b) an historical review of the uses and impacts of development on wetlands;
c) a review of existing statistics on inventory and wetland loss;
d) an examination of the relationships of wetlands to other sectoral resource management issues
e) "a summary of existing legislative and government responsibilities for wetlands;
f) an examination of opportunities for programme development, partnerships and support; and
g) the value of wetlands to the environment and people, with quantified economic values. Adoption & Implementation.

Step 3 Defining wetlands at a National level

In Uganda, wetlands are nationally defined as areas that are either seasonally or permanently logged with water where specific plants and animals have become adapted

- A definition interpreted to suit local situation of wetlands in Uganda.
- There are other definitions like wet feet etc
- The definitions is in line with Ramsar but is not the same

Step 4:Defining stakeholders

- Identifying people with a stake in the wetlands – on or off site
- Identifying actual resource users
- Other resource users

Step 5 National Consultations

- Indirect contacts not involving visits or locally arranged meetings.
- Inter-ministerial consultations with potentially affected or influential government agencies at this stage is quite important.
- Public consultation may require sophisticated public media programmes that can be very costly

Step 6 Hold National and Local wetland policy workshops

- workshops may be organized at several levels.
- local and informal meetings are essential as people in small communities
- getting commitment from government
- developing a focal point for discussion of land use planning and community-based issues affecting wetland resources.

Step 7 Creating a Wetland policy writing team

- lead writing drafts of the Policy
- Writing Team should have central government agency experience,
- having a strong awareness of "how government system works" is an important advocacy issue

Step 8 Ensuring political support for next steps is serious advocacy issue

- interaction with senior government staff and media
- releases at the minister, prime minister or presidential level can be used to demonstrate the Government's support
- Press releases or major policy speeches by the Minister or Head of Government (Prime Minister, etc.)
- For every step the Minister responsible for the development of the Policy should be in regular contact with colleagues in the Cabinet

Step 9: Developing a Cabinet Memorandum

- Prepare a white paper that must be endorsed by all Ministers on the advice of senior departmental experts and managers.

- Adoption by Parliament, enactment of new legislation or creation of a constitutional amendment,
- These require careful political maneuvering at the Cabinet level during this final Ministerial review

Step 10 Government endorsement and approval, announcement

Step 11: Prepare an implementation Strategy, Launch and implement Policy
Spin-offs of the policy making process

- ✓ Creates political will
- ✓ Creates awareness and appreciation
- ✓ Enlistes support from other Natural Resources sectors

Lesson: the process is as important as the product

Implementation of the policy includes efforts that?

- ✓ Continue selling the policy
- ✓ Harmonisation with other policies
- ✓ Operationalising the policy
- ✓ Reviewing the policy
- ✓ Turn policy into legislation
- ✓ Establish institutional frameworks

Lesson: the policy formulation process is a continuous process, it is important to go through the above steps

7.6 Module summary

In this Module, we have studied:

- What the Ramsar convention is
- The aims and objectives of the Ramsar convention
- The extent of implementation of Ramsar obligations
- International and national policies and laws that govern wetland conservation
- Examples of national policies on wetland conservation
- The African Eurasia Waterbird Agreement (AEWA)
- Use the knowledge obtained on wetland laws and policies to enhance wetland conservation in the local areas and in the region at large.

7.8 Further reading

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MODULE 8: WETLANDS AND CLIMATE CHANGE

8.1 Introduction

Wetlands have the capacity to trap and lock away huge quantities of carbon dioxide. Plants assimilate carbon dioxide from the atmosphere, but hold onto that carbon after they have died because decomposition leads to an accumulation of the partially decayed plant material that is called peat. The process of accumulating plant carbon is often described as carbon sequestration and has resulted in peatlands contributing to a major global carbon sink. Warmer conditions speed up reactions - including decomposition reactions - and so this could release carbon that would be previously stored away. This unit gives an overview on the nature of climate change issues related to wetlands. It is intended to examine and explore ways of incorporating climate change issues into wetlands conservation efforts.

Learning Objectives
By the end of the module, you should be able to:

- Define climate change
- Examine impact of climate change on wetlands
- Discuss role of wetlands in climate change
- Examine existing policies (national, international) in relation to climate change and wetlands

8.2 What is Climate Change?

Climate is the average patterns of weather over long periods. Global climate change therefore refers to the variation in the earth's global climate or in regional climates over time scales ranging from decades to millions of years. These changes can be caused by processes internal to earth or external (variation in sunlight intensity) as well as human activities.

The main human activity that is most likely to have a large impact on the climate is the burning of "fossil fuels" such as coal, oil and gas. These fuels contain carbon. Burning them makes carbon dioxide gas. Carbon dioxide gas traps solar heat in the atmosphere, partly in the same way as glass traps solar heat in a sunroom or a greenhouse. For this reason, carbon dioxide is sometimes called a "greenhouse gas." As more carbon dioxide is added to the atmosphere, more solar heat cannot get out of the atmosphere leading to increase in temperature of the atmosphere.

8.3 What is the role of wetlands in mitigating climate change?

Wetland ecosystems provide a range of functions such as climate regulation, carbon recycling, flood control, purifying water, breeding grounds for fish. To society, wetlands are a source of products such as fish, water, building materials, wild game meat.
However, the nature of wetlands is determined by factors such as climate, land form, hydrology, biotic factors and mineral characteristics of the catchment soil.

The climate determines the amount of water received through precipitation. In addition, the morphology of the land surface is important because it determines the distribution of the excess water from runoff to valleys where the wetlands are located. The physical and mineralogical characteristics of the surface materials are important. The texture of the soil determines the porosity of the soil and affects the proportion of water that can percolate into the soil.

The link between peatland degradation and climate change is that clearance, drainage and fires in peatlands emit more carbon dioxide every year, contributing to global emissions from fossil fuels. Protection and restoration of peatlands are among the most cost- effective options for climate change mitigation.

Degraded wetland ecosystems have no capacity to withstand extreme climate conditions such as heavy rainfall, wind, storms and flooding. Extreme flood conditions are experienced worldwide. However, these extreme disasters can be used to raise awareness of the role of wetlands in mitigating severe impacts of global climate change.

8.4 Effect of climate change on wetland ecosystems

Climate change must affect the formation, distribution and functioning of wetlands, however, it is has not been established the impact climate might be on wetland ecosystems. This is because of the multiple nature of causes and/or impacts of climate change on the wetlands diverse nature of wetlands. However, potential issues can be highlighted.

Changes in hydrology

Wetland ecosystems may significantly be affected by changes in hydrology. Increase in runoff from catchments can also influence biological and biogeochemical functions of wetlands. The wetlands can exist when they have water. Presence or absence of water flowing to wetlands as a result of climate change can affect the dynamics of existing wetlands.

Diversity of wetland ecosystems

Climate change can cause a shift in wetland distribution accompanied by changes in species composition of wetlands as individual species respond to changes in climate, leading to loss of adaptive diversity. Some species will find it difficult to adapt while others may emerge due to the changes that may occur onto the wetlands.

Wetlands as carbon sinks

Wetlands play a major role in the carbon cycle. Carbon dioxide taken by plants and the organic matter trapped by the wetlands during their filtration functions. Some Carbon leaves the wetland in form of methane gas while other carbon is turned into peat or dissolved in water. However, changes in temperature will affect these processes in carbon and organic mater transformation and way the water leaves the wetlands, hence affecting the role of wetlands in the carbon cycle.

8.5 Policies and programmes

There are policies and programmes on wetlands, nationally and internationally. Scrutinizing these policies to identify whether they incoportate climate change issues and how they are addressed is important. For example; how does the policy on wetland conservation address issues on how climate change may affect wetlands and how wetland degradation may influence climate change? Programmes on wetland conservation (awareness of communities of the link between wetlands and climate change).

Activity 8.1 Group Discussions

- Think of issues of global climate change related to wetlands
- What wetlands issues face your community?
- Is your community aware of any issues of wetlands that related to climate change?
- Any potential effect of global climate change on wetlands that may impact on socio-economic values of wetlands to society?
- Does your country have a policy on wetlands and climate change? What does it say and, how is it being implemented?

Activity 8.2

- Discuss the importance of climate change to in Nile basin countries.
- Write a simple newspaper article to create awareness of your local community about the importance of climate change and wetlands.
- Draw up a programme to raise awareness among the students and the community in the area surrounding the school about climate change and how it could impact on development.
- How is wetland assessment and monitoring important in the development of your country?

8.6 Module Summary

In this Unit, you have learnt about:

- Global climate change
- Importance of wetlands in global climate change
- Impact of global climate change on wetlands
- Policies (national and international) in relation to wetlands and climate change

8.7 Further reading

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2. NEPAD, (2003). Action Plan for the Environment Initiative. New Partnership for Africa's Development, Midrand.
3. Ntambirweki, J. and Dribidu, E., (1998). The Legal and Policy Instruments for Sustainable Management of Natural Resources in Uganda: The Case of Implementation of Uganda Water Action Plan. SSC Africa Project, Paper 20. Proceedings of the Harare Workshop on African Perspectives on the Policies and Practices Supporting Sustainable Development in Sub-Saharan Africa, Harare, Zimbabwe, 28-30 September.

MODULE 9: WETLAND RESTORATION

9.1 Introduction

The educational package presented here is aimed acquiring knowledge and develop suitable skills and shape attitudes and values on wetlands. This package focuses on the wetlands restoration, combines recent scientific knowledge about wetlands, and creates a rich and attractive training environment that encourages exploratory, collaborative, active and creative learning that is supported by the interactive approach of this subject.

The restoration starts with activities that degrade wetland and the steps to avoid them. Symptoms of degraded wetlands the pointers on such wet lands in your community. The principles and guidelines on restoring wetlands are used to design and implement restoration projects in your community. Case studies of restored wetlands have been laid out to draw examples to learn from.

The information has been packed into small themes and where possible, there are activities to handle. Choice to carry out two to three research projects from the given activities to provide data to guide individuals and policy makers on the steps to take towards wetland restoration.

Learning Objectives

By the end of the Module, you should be able to:

1. Identify a degraded wetland
2. Design your own wetland restoration projects
3. Cite and describe successful case studies of restored wetland

9.2 Human activities that lead to loss and degradation of wetlands and their impacts

Activities resulting in wetlands loss and degradation include: agriculture; commercial and residential development; road construction; impoundment; resource extraction; industrial development and waste disposal; silviculture; and mosquito control. The primary pollutants causing degradation are sediment, nutrients, pesticides, salinity, heavy metals, weeds, low dissolved oxygen, pH, and selenium.

Although wetlands can improve watershed water quality, their capacity to process pollutants can be exceeded. Many wetlands have suffered functional degradation, whose magnitude is difficult to calculate. Wetlands continue to be threatened especially by activities that change their performance. Below is description of the activities that can lead to degradation of wetlands. Restoration therefore means that alternatives for the actions that destroy wetlands must be identified so as to leave the wetlands to continue with their valuable functions because restoration is very expensive.

Photograph 4: An abused wetland.

9.2.1 Hydrologic Alterations of Wetlands

Wetlands exist as a result of hydrologic conditions which cause the water table to saturate or flood the soil for a certain amount of time each year. The frequent or prolonged presence of water at or near the soil (hydrology) is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands can be identified by the presence of those plants (hydrophytes) that are adapted to life in the soils that form under flooded or saturated conditions (hydric soils) characteristic of all wetlands. Thus alteration of wetland hydrology can change the soil chemistry and the plant and animal community. Alteration which reduces or increases the natural amount of water entering a wetland or the period of saturation and inundation can, in time, cause the ecosystem to change to an upland system or, conversely, to a riverine or lacustrine system. Wetland loss and degradation through hydrologic alteration by man has occurred historically through such actions as: drainage, dredging, stream channelization, ditching, levees, deposition of fill material, stream diversion, ground water withdrawal, and impoundment.

Implications of hydrologic alterations of wetlands

1. Habitat fragmentation

As wetlands are drained or hydrologically altered, there may be changes in species composition as these are replaced by upland species; loss of large, wide-ranging species; loss of genetic integrity when isolated habitats are too small to support viable populations; reduced populations of interior species that can only reproduce in large tracts; and increased numbers of competitor, predator, and parasite species tolerant of disturbed environments

2. Water diversion structures

Water diversion structures, such as canals (channels), ditches, and levees have been used to modify wetlands

to control floods, drainage, mosquito control, irrigation, timber harvest, navigation, transportation, and industrial activity. Canals and channelization change the hydrology of wetlands and increase the speed with which water moves into and through wetlands. As a result, patterns of sedimentation are altered and wetland functions and values that depend on the normal slow flow of water through a wetland can be affected. High sediment loads entering wetlands through channels, irrigation ditches and drainage ditches can smother aquatic vegetation, and contribute to increased turbidity. Channelization and channel modification alter in-stream water temperature and diminish habitat suitable for fish and wildlife.

3. Impoundments

Impoundment of natural wetlands for stormwater management or wildlife and habitat management may exploit one function of wetlands at the expense of others. Impoundment alters the natural wetlands' hydrology and decreases water circulation. Decreased water circulation causes increased water temperature, lower dissolved oxygen levels, and changes in salinity and pH; prevents nutrient outflow; and increases sedimentation. Sedimentation reduces the water storage capacity, smothers vegetation, reduces light penetration, reduces oxygen content and affects the entire ecosystem richness, diversity, and productivity. Toxic substances, adhering to sediments, may accumulate impoundments because of decreased water circulation and bioaccumulation of contaminants by wetland biota may occur.

9.2.2 Urbanization

People who go to urban centers exert more pressure on the remaining wetlands, due to the demand expand towns using available space in urban centers. Wetlands are targeted because they are the remaining areas that are free or whose ownership is not clear. When wetlands are occupied there are inevitable changes in water quality, quantity, flow rates; increases in pollutant inputs; and changes in species composition probably due to introduction of non-native species and disturbance. The major pollutants associated with urbanization are sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, hydrocarbons, bacteria, and viruses (USEPA 1994b). These pollutants may enter wetlands from point sources or from nonpoint sources. Construction activities are a major source of suspended sediments that enter wetlands through urban runoff.

Activity 9.1

- ✓ Investigating the effect of urbanization to your local wetland may be beneficial to the restoration of that wetland. Determine the level of inflows entering the area over a given period. You may limit yourself to some parameters like measuring the temperature pH of the water, nutrient loading, and oxygen demanding substances.
- ✓ What is the effect of absence of the wetland
- ✓ Explain the best restoration plan for the wetland based on your results

As roads, buildings, and parking lots are constructed, the amount of impervious surface increases. Impervious surfaces prevent rainfall from percolating into the soil. Rainfall carries sediments; organic matter; pet wastes; pesticides and fertilizers from lawns, gardens, heavy metals; hydrocarbons; road salts; and debris into urban streams and wetlands. Increased salinity, turbidity, and toxicity; and decreased dissolved oxygen, all affect aquatic life and, therefore, the food web. Excessive inputs of nutrients can lead to eutrophication or result in the release of pollutants from a wetland into adjacent water resources.

Impervious surfaces decrease ground water recharge within a watershed and can increase water flow into wetlands. Increases in storm water peak flow rates, and longer-term causes changes in wetland hydrology, because storm water discharge, can cause erosion and channelization in wetlands, as well as alteration of species composition and decreased pollutant removal efficiency. In addition, the reduced size of the wetland also affects the time the storm would remain in the wetland and this has adverse multiple effects

that would affect the water quality, spawning, migration, species composition, and the food web in a wetland as well as in associated ecosystems.

9.2.3 Wastewater and storm water

Wastewaters and urban storm water are a source of pollutants that continue to degrade wetlands. The "aging" of wetlands can occur when wetlands filter organic matter. "Aging" is the saturation of the ecosystem by nutrients and sediment enrichment over time that results in the reduced effectiveness and degradation of the wetland. Wastewater and storm water can alter the ecology of a wetland ecosystem if high nutrient levels cause extended eutrophication and metals cause plant and aquatic organism toxicity. Iron and magnesium, in particular, may reach toxic concentrations, immobilize available phosphorous, and coat roots with iron oxide, preventing nutrient uptake.

Photograph 5: Building carelessly in Wetlands Cause Floods.

Urban and industrial storm water, sludge, and wastewater treatment effluent, rich in nitrogen and phosphorus, can lead to algal blooms in estuaries. Algal blooms deplete dissolved oxygen, leading to mortality of benthic organisms. Some algae are toxic to aquatic life. Excess algae can shade underwater sea grasses (part of the coastal wetland ecosystem), preventing photosynthesis and reduce turbidity by stabilizing sediments and provide critical food, refuge, and habitat for a variety of organisms, including many commercially harvested fish, the death of these plants profoundly impairs the estuarine ecosystem.

Because of disturbance and habitat degradation, wetlands can be invaded by aggressive, highly-tolerant, non-native vegetation. Particularly in constructed wetlands, including restored wetlands, non-native and tolerant native species may out compete other species leading to a reduction in species diversity. For example, the Water hyacinth has been noted for its ability to sequester nutrients and can used for wastewater purification in water hyacinth infested areas. However, water hyacinth and other evasive species can rapidly fill the wetland and can be a threat to presence of water in some areas.

Activity 9.4
Carry out an investigation to find out if there are any non-native plants or animals in your local wetland. Report your finding to a nearby nature recourse urgency and suggest ways this plant can be controlled. Are there any reports of plants that used to be common and have become rare?

9.2.4 Roads and bridges

Roads and bridges are frequently constructed across wetlands. However, roads can impede the hydrology of wetlands, even if culverts are used. Such inadvertent impediment and hydrologic alteration can

increase sediment loading and disrupt habitat continuity, which may affecting the indigenous speecies and providing habitat for hardier opportunistic edge and non-native species. Roads can impede movement of certain species or result in increased mortality for animals crossing them. Innovative methods of constructing roads and bridges, are recommended in order to reduce the impacts of urbanization on wetlands.

9.2.5 Mosquito control programmes

Mosquito control efforts in urbanized and other areas has resulted in wetlands loss and degradation through drainage, channelization, and use of toxic pesticides. Mosquito control is one reason that wetlands have historically been drained and, it is a major cause of wetlands loss today. Although natural wetlands, as well as restored and created wetlands, are habitat for many types of mosquitoes, they hostile to the mosquitoes that cause malaria. The malaria causing mosquitoes due to co-existence with people stay in well moist warm places near people houses; hence do not bleed in wetlands which whose water is usually anoxic. Instead, the drainage of wetlands creates conditions that increase bleeding areas for malaria mosquitoes. Mosquito control does not have to cause wetland impacts or loss. It is important to understand the lifestyle of the malaria mosquitoes and the functions of wetlands. Biological control that includes manipulation of the wetlands food web can be of much help.

Activity 9.4
What mosquito control methods are being used in your community?
How would you sensitize the public about safe methods for mosquito control?
What natural mosquito control methods would you adopt for your community?

9.2.6 Industries

Adverse effects of industries on wetlands can include: reduction of wetland acreage, alteration of wetland hydrology due to industrial water intake and discharge, point and non-point source pollutant inputs, pH changes as a result of discharges. There are many cases where industries and other developments are already existing or built in wetlands and these affect the wetlands functions. Hence, such area will be prone to floods and accumulation of wastewater or run off which can be potential danger to people living in the area.

Activity 9.5
Is there an industry near your home? Find out how they dispose off their waste. Are any effluents finding their way in the wetland? What is contained in the industrial effluents?

9.2.7 Agriculture

Historically, agriculture has been a major factor in freshwater and estuarine wetland loss and degradation. Certain activities performed in wetlands can degrade wetlands and these require good guidelines in order to sustainably use the wetlands: Guidelines are necessary for the following:

- harvesting food, fiber, or forest products;
- maintenance of ditches;
- construction and maintenance of farm or forest roads;
- maintenance of dams, dikes, and levees;
- maintenance of irrigation channels;
- application of pesticides (herbicides, fungicides, insecticides, fumigants);
- and ground water withdrawals;

Without guidelines these activities can alter a wetland's hydrology, water quality, and species composition. Excessive amounts of fertilizers and animal waste reaching wetlands in runoff from agricultural operations, including confined animal facilities, can cause eutrophication. Irrigation ditching can increase contamination of wetlands receiving irrigation drainage water, particularly where soil is alkaline or contains selenium or other heavy metals. Agricultural pesticides entering wetlands in runoff, as well as through atmospheric deposition may bio-accumulate in fish and other aquatic organisms.

Activity 9.6

- What pesticides does the farming community around your local wetland use?
- Are the pesticides entering the water?
- What is the effect of these pesticides on the living organisms in the wetland?
- Determine the level of contamination to biodiversity.
- How would you sensitize the farming community about your findings?

9.2.8 Grazing

Grazing livestock is an activity which if not wisely used, can degrade wetlands that livestock use as a food and water source. Overgrazing of by livestock may reduces streamside vegetation, preventing runoff filtration. The vegetation in wetlands should therefore be well managed so that it is used by livestock while it is performing the wetlands function which benefits both the farmers and the environment.

9.2.9 Timber Harvest

If best practices and careful monitoring are used in wetlands management, the wetlands can be used for goods such as provision of timber. Poor understanding of wetlands has resulted into drainage, clearing, haul road construction, rutting, and ditching of forested wetlands, which affect wetlands in many ways. Adverse effects of timber harvest in the wetlands and in catchments include a rise in water table due to a decrease in transpiration, soil disturbance and compaction by heavy equipment, sedimentation and erosion from logging decks, skid trails, roads, and ditches, and drainage and altered hydrology from ditching, draining, and road construction. By utilizing best management practices, hydrology and biogeochemical processes of wetlands may be altered.

9.3 Wetland Loss and Degradation

The Ramsar Convention was established to address the issue of the loss and degradation of wetlands through concerted and coordinated action by the Contracting Parties, so that wetlands can contribute to the process of sustainable development. Almost the entire list of obligations that are undertaken by the Contracting Parties relate to addressing this issue: the designation of sites to the Ramsar list, maintaining the ecological character of listed Ramsar sites; the establishment of reserves on wetlands, and making wise use of wetlands. Undoubtedly, the Ramsar Convention has succeeded in raising awareness and the level of actions for conservation of wetlands. The Ramsar Convention has put in place specific recommendations that nations can use to reverse the effects of Wetlands loss and degradation.

A Strategic Approach is one of the ways to address the issue of the global loss and degradation of wetlands. A comprehensive strategy should incorporate the following vital steps, which are applicable both to sites (through a management plan, as covered well by the Ramsar guidelines) and to whole countries.

1. Set a measurable goal

A measurable goal should be included in all national wetland policies. At present, the Ramsar Convention contains a measurable goal for the listed Ramsar sites, which is "to maintain their ecological character". While potentially measurable, the issue of "change in ecological character" is still inadequately understood.

At national and international levels, the Convention text and the draft Strategic Plan encourages to set measurable goals, inorder to measure success of the Convention in future years. It is strongly recommended that each Contracting Party, and perhaps the Ramsar Convention as a whole, should include a measurable goal as it develops and adopts its national wetland policy.

2. Measure the resource baseline

Whether the goal is to maintain the ecological character of a wetland site, or to stop the loss and degradation of wetlands across the landscape as a whole, it is essential to measure the baseline of the wetland resource under consideration. This is achieved through a wetland inventory programme. A wetland inventory is one of the key elements in a conservation strategy for wetlands (WWF 1992). This is because, such inventories:

- identify where the wetlands are;
- assist in identifying priorities;
- provide the baseline for status and trends reports;
- provide a tool for planning and management;
- permit comparisons at national and international levels;
- provide information for awareness programmes;

The Convention, through the wise use guidelines, already calls upon Contracting Parties to execute national wetland inventories.

3. Identify operational objectives, and prescribe and undertake actions

These two critical steps are the main subject of the Ramsar Convention Strategic Plan, and are not discussed here in any further detail. (See www.ramsar.org)

4. Monitor performance against baseline

Monitoring the effects of the conservation actions undertaken should be an important feedback mechanism within any site management plan or national wetland policy. It is only through such monitoring programmes that the extent and causes of loss and degradation of wetlands can be determined, and the success of conservation actions be measured. However, the complexity and diversity of wetlands has been a serious constraint to the development of effective monitoring schemes, and it is notable that it is only after 25 years that the Convention is beginning to address this issue systematically.

Monitoring programs need to address both the issue of wetland integrity (i.e. change in wetland area) and change in wetland quality. While the Convention is addressing these needs at the level of individual Ramsar sites, a serious gap remains in the lack of quantitative information on changes in these parameters at national and international level. In the Nile basin countries, efforts have been made to develop a regional strategy for the management of the wetlands in the Nile Basin.

5. Regular reporting

The quality and quantity of information about the state of wetlands must be increased and communicated more effectively at all levels. Information on the loss and degradation of wetlands, and the consequences of this for people and for biodiversity, provide powerful tools for influencing public opinion and decision-makers.

It is recommended that at both national and international levels, formal mechanisms are established for reporting on the status of the wetland management. At international level, a first step would be to compile and publish a review of all the quantitative studies of wetland and their biodiversity as baseline for continued monitoring.

6. Impact of wetland degradation

Healthy, functioning wetlands are vital for protection of the environment and public health. Wetlands are transitional areas that act as buffers between open waters and uplands and provide functions and values. Degradation leads to loss of wetland functions and Values such as;

- recharge groundwater aquifers
- absorb floodwaters, protecting coasts and homes from floods;
- habitat for plant and animal species, including threatened or endangered
- local tourism industries with opportunities to engage in activities associate with such wildlife.
- filter pollution, purifying our drinking water, and protecting rivers, lakes, and coastal waters from pollution, such as sediment, nutrients, chemical contaminants, and bacteria
- biodiversity loss, migratory species and endemics
- increased poverty and vulnerability
- climate mitigation roles

Efforts to monitor and report on abover are very useful.

9.4 Wetland Restoration

Goal of restoration

In recognition of benefits associated with wetland restoration, there are numerous restoration projects initiated globally. Degraded wetlands present restoration opportunities for improvements to water quality, habitat, water storage and other functions, and these opportunities can be particularly useful for watershed-scale environmental planning.

The goal of restoration is typically to reestablish wetland ecosystems to levels that existed prior to human influence. Wetland creation can include regulatory mitigation or commercial and private creation efforts outside of regulatory requirements.

Wetlands Restoration is sometimes used interchangeably with Wetlands Rehabilitation. Within Ramsar documentation and the conservation literature, while "restoration" implies a return to pre-disturbance conditions and that "rehabilitation" implies an improvement of wetland functions without necessarily returning to pre-disturbance conditions, Restoration is used in its broadest sense to include both projects that promote a return to original conditions and projects that improve wetland functions with aim of promoting a return to pre-disturbance conditions.

Principles to follow during restoration

The Ramsar convention recommendation urged "the Scientific and Technical Review Panel [STRP], in collaboration with the Secretariat and concerned Contracting Parties and partners, to define guidelines on principles for wetland restoration".

The principles you will find below provide the underlying ideas that form the foundation of a successful restoration project. However, you should remember that every restoration project is unique. These principles and guidelines are designed to be useful in many situations and they are outlined as follows:

1. A national programme and priorities for wetland restoration should be established, based on a national inventory of wetlands with potential for restoration, as a component of the national wetland policy, plan or strategy, so as to maximise the benefit to the overall conservation status and wise use of wetlands of the efforts and resources applied to wetland restoration.

2. Clear understanding of statement of goals, objectives, and performance standards for wetland restoration projects is a critical part of restoration success.

In keeping with Ramsar Resolution on restoration as an element of national planning for wetland conservation and wise use, goals and objectives should recognize that wetlands perform multiple functions. "Multiple purposes such as conservation of biodiversity, provision of reliable food resources, fresh water supply, purification, flood control and recreation may often increase the sustainability and total benefits of a restoration project." If a project hopes to promote a return to pre-disturbance conditions, this should be stated as part of the project goals.

3. Careful planning will limit the possibility of undesirable side effects. For example, careful planning can allow restoration projects to avoid problems such as increased numbers of mosquitoes, unwanted flooding, or saltwater intrusion into sources of drinking water. To assist in planning, an assessment should be made of the features of the site under consideration, and the factors that may affect its feasibility and success.

4. Natural processes and existing conditions should be considered during project selection, design, and development. To the extent that is possible, ecological engineering principles should be applied in preference to methods requiring hard structures or extensive excavation.

5. Restoration schemes must not weaken efforts to conserve existing natural systems. However, restoration of individual sites can contribute to ongoing management of existing high quality wetlands by, for example, improving overall catchment condition and contributing to improved water allocation management.

6. Whenever possible, the minimum acceptable scale for wetland restoration planning should be within the context of the catchment. The planning should not ignore the value of upland habitats and linkages between upland and wetland habitats.

7. Wetland restoration planning should consider water allocation principles and the role that restoration can play in maintaining ecological functions of wetlands.

8. Wetland restoration should be an open process that involves local community stakeholders as well as stakeholders who will be affected by a project even though they may be geographically distant from the project, for example, stakeholders living well downstream. All stakeholders, including local communities and indigenous people should be fully involved in a wetland restoration project from its earliest stage of consideration through its implementation to its long-term stewardship.

9. Restoration requires long-term stewardship, including ongoing management and monitoring. Successful restoration should be designed, as far as possible, for self-maintenance. Development of incentive measures can make a valuable contribution to the long-term success of a restoration project.

10. Wetland restoration planning should incorporate, where practicable, knowledge of the traditional resource management that contributed to shaping the landscape. Incorporation of traditional

environmental knowledge, management, and sustainable harvesting practices by local people should be an integral component of restoration.

Activity 9.7

What issues would you consider in the assessment of the usefulness and feasibility of wetland restoration projects?

9.5 Restoration Guidelines

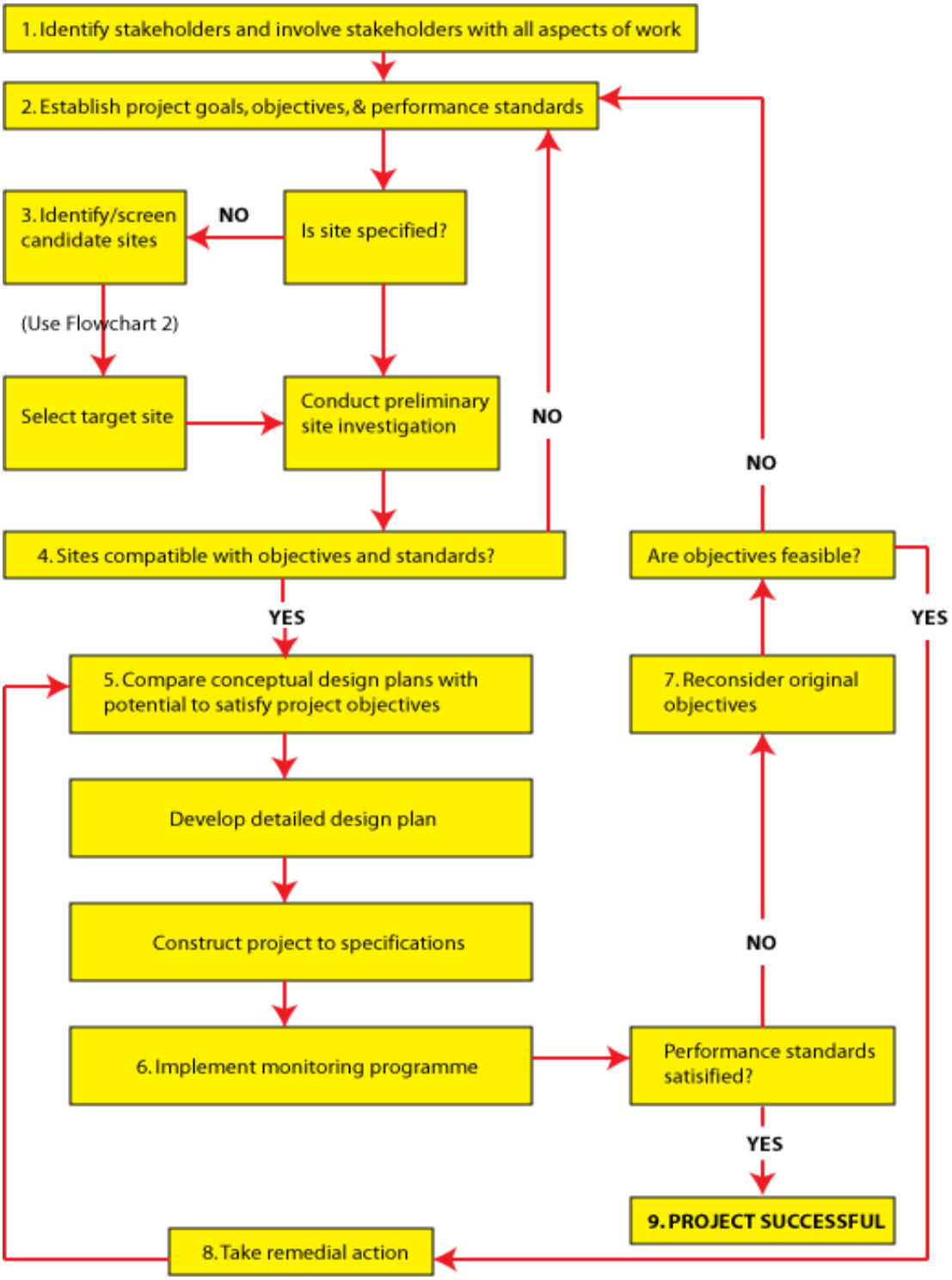
The guidelines presented here will take you step-by-step in the process of identification, development and implementation of a restoration project, and as such they can be integrated into administrative guidelines. The flowcharts below will lay out guidelines for your wetland restoration projects.

9.5.1 Landscape Considerations in Wetland Restoration and Creation

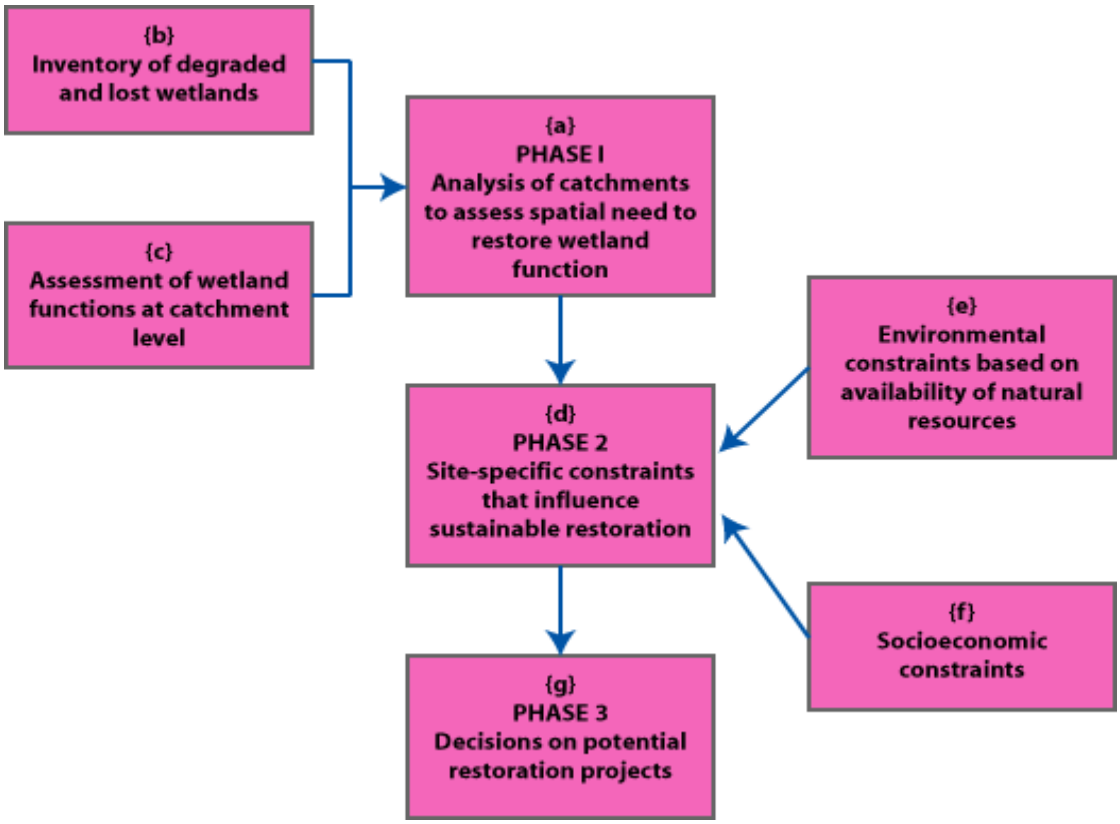
Created wetlands for nonpoint source pollution control are advocated as an important part of any watershed or floodplain restoration plan. Location of constructed wetlands in the landscape is an important factor in determining their role. The most important wetlands to manage and protect as stream quality buffers may be those along first- and other low-order streams. Wetlands along first-order streams are very efficient at nitrate removal from groundwater and runoff, and sediment removal from surface water. Constructed wetlands bordering agricultural fields can be designed to intercept tile drainage with high nutrient levels that otherwise often flows directly into receiving streams, bypassing even riparian areas. Placing wetlands in a distributed pattern high in the watershed may incur less total runoff and erosion for the entire watershed than the same acreage put into large wetlands low in the watershed.

Wetlands (floodplains) along higher-order streams influence water quality to a much smaller degree, since the upland runoff that passes through them and joins the stream is a much smaller fraction of the total stream flow than it is for headwater wetlands. Wetlands along large streams do, however, provide water quality benefits during flood events, a function that headwater wetlands do not provide. The downstream wetlands could retain more mass of nutrients than upstream systems, and a placement tradeoff might be optimum.

From a management standpoint, creating many smaller wetlands around a watershed would mean dealing with more landowners, but taking less land out of production on any one farm than creating a few large wetlands, and is more fair in terms of not asking any landowner to contribute more than what is needed to treat the runoff from their land.



Flow Chart 1 **Guidelines for wetland restoration**



Flowchart 2: Process for identification of potential wetland restoration projects

Activity 9.8

Use flow charts 1 and 2 to develop a project that you would implement in a chosen degraded wetland in your locality.

9.5.2 Riparian Restoration Guidelines

The U.S. Forest Service has published guidance on reforesting previously cleared riparian areas and renovating degraded riparian areas for the protection of receiving water quality. The guidance is directed toward agricultural and silvicultural land uses and emphasizes that riparian buffers are meant to be used as part of a sound land management system including upland best management practices, and can be damaged and functionally impaired otherwise.

The design of the riparian buffers described above includes three zones intended to filter surface runoff and shallow groundwater flow. Beginning at the edge of the receiving water body, the first zone is a fixed 15 ft. wide, undisturbed native forest/shrub zone to provide a stable ecosystem at the water's edge, to perform nutrient buffering, to provide shade, and to contribute detritus and large woody debris to the water body. Landward of zone 1, zone 2 is the heart of the riparian buffer. A minimum of 60 ft. wide, it is composed primarily of native trees and shrubs, and it provides contact time and carbon energy source for buffering processes and for long-term sequestering of nutrients by trees. Periodic timber harvesting and stand improvement is acceptable in this zone. Livestock are to be excluded from both zones 1 and 2. At the landward margin, zone 3, a minimum of 20 ft. wide, is a graded, dense grass/forb strip for sediment control and nutrient uptake. Shaping into diversions, basins, and level spreaders toward this end

is appropriate. This zone should be actively managed; mowing is recommended, grazing is acceptable, and periodic sediment removal, reshaping, and revegetating are necessary to maintain performance. Actual zone widths beyond the minimum can be determined based on the ratio of buffer area to source area.

9.5.3 Coastal Wetland Restoration

Coastal marsh restoration and creation efforts have been more successful than similar inland attempts. This success appears to be due largely to researchers' ability to predict more accurately the key component, hydrologic patterns, in tidally influenced areas than in freshwater settings. Also, coastal restoration efforts have perhaps had a longer history than freshwater wetland restoration.

Restoration of coastal marshes and creation of salt marshes on dredge spoil has been found to facilitate shoreline aggradation, stabilize beach erosion, and protect landowners from the impacts of storms. Restoration of wetlands on eroding shorelines can protect critical habitat for marine life and freshwater aquatic life as well as reduce land subsidence.

9.5.4 Urban Wetland Restoration

Wetland restoration can be an important contributor to downstream habitat and water quality recovery in urbanized landscapes. Restored urban wetlands can help protect floodplains and streambeds that are otherwise degraded by urbanization forces, and can help to minimize downstream flooding that results from urbanization. Such wetlands can also reduce sedimentation of lagoons, bays, and other downstream water resources. Larger restoration projects are more cost effective and are typically more beneficial ecologically as well. Larger areas may provide habitat for interior species that an equivalent acreage of smaller parcels cannot support.

Upland buffer zones adjacent to urban restoration projects are important to protect them from degrading forces and provide important habitat used by many wetland species. Such projects require other protective measures as well to sustain their functions long-term.

9.5.5 Management for Wildlife

Wetlands are especially critical habitats for wildlife, and exceed all other land types in wildlife productivity. Historically, wetland wildlife management was overwhelmingly concerned with maximizing production of waterfowl and furbearing mammals, and was focused largely on game species.

Marsh creation or restoration is a good opportunity to manage wetlands for broad wildlife habitat goals. Not only can a restored marsh provide enhanced wildlife benefits, but other functions can be improved concurrently. Whether created or restored, wetlands designed for wildlife should take into consideration: minimum habitat area of anticipated species, their tolerance for disturbance, and the system's functional relationship to other water resources and adjacent ecosystems.

It should be noted that while created wetlands can be suitable for some species, such as waterfowl, other, particularly threatened and endangered, species do not colonize artificially created wetland systems as readily or consistently do for natural wetlands.

For a given wetland site, a restoration or creation management strategy must involve determination of the most important values to be obtained, and of whether a single, exclusive value outweighs the suite of values to be obtained from historic restoration. If a single-purpose wildlife use is sought, such as certain fish utilization, management may result in manipulation of marsh hydrology at the expense of other species and wetland functions. For example, game fish species require consistently deep water, yet shallow, emergent-plant-depth water levels provide the highest plant species diversity and greatest overall wildlife use of marshes.

Managing of a wetland adjacent to agriculture will likely stimulate productivity and, if not too great, facilitate establishment of the wetland community while improving downstream water quality.

9.5.6 Additional Considerations for all Types of Restoration

Several long-term management issues accompany successful wetland restoration, including grazing and browsing control, pest control, and weed control.

Grazing and Browsing Control

Grazing or browsing by domestic and wild animals in a wetland regulates plant communities. Control is based on site-specific conditions. If alternative feeding and denning sites are available nearby, grazing and browsing problems will be easier to address than if they are available only at the restoration site. If grazing or browsing becomes a problem, controls will be necessary until the wetland community is well enough established that it can withstand these impacts.

Fencing may restrict animal access to sites, plant communities, or individual plants. The type of fence and design will vary according to objectives. Livestock can often be excluded from an area by a simple single-wire electric fence. These fences need to be strong enough to prevent animals from pushing them over. They can also be defeated by both nutria and beavers, which have the ability to dig under them, and waterfowl, which can fly over them. Areas where exclusion of birds is necessary can be covered with the nylon netting available at most farm supply and builder supply stores. PVC pipe or electrical conduit can be used to support netting above the ground.

Fencing to prevent geese from swimming into smaller areas can be constructed by driving posts into the soil and connecting them with 1/8-inch nylon line rails spaced 6 inches apart. Rails should extend from 6 inches above the low water mark to 6 inches above the high water mark. Highly visible materials should be used.

Animals can be discouraged from digging up tubers and rhizomes by fastening chicken wire directly over them after planting. Wire should be removed after plants become established.

9.6 Case Studies of Restored Wetlands in the Nile Basin Region

1. Lake George in Uganda

Uganda ratified the Ramsar Convention in 1988, and designated Lake George a Ramsar site. Located astride the equator, the lake and associated wetlands support a wide variety of biological resources. The reasons for this are varied, ranging from the good climate to shallow stratified waters (average 2.4m) which allow for a thorough mixing of the different layers, and a high alkalinity and photosynthetic activity.

The status of Lake George is varied with most of the wetlands fringing the Lake being part of the Queen Elizabeth National Park. The open water of the lake is not part of the National Park and is managed by the Fisheries and Water Departments. This has had implications for management because of inter-sectoral inconsistencies.

Lake George is renowned both for its high productivity and its flagship species such as the Shoebill *Balaeniceps rex*. Over the years the lake has attracted a lot of attention: it was part of the International Biological Programme in the late 1960s; it is located within the Queen Elizabeth National Park which is a Man and the Biosphere Reserve of UNESCO; and finally the listing of Lake George as Uganda's first Ramsar site was further recognition of the importance of the lake as a centre for biological diversity. Decades ago the initial management interest was in commercial fisheries on the lake. Today, the commercial fisheries are on a much smaller scale supplying mainly local needs, the management focus has changed considerably, and the lake has become an important tourist destination.

Diversity of the Wetland

Seen from the air, the waters of Lake George appear green as a result of thick concentrations of blue-green algae. The entire lake can be considered as a wetland since its average depth is about 2.4m and it hosts a mosaic of wetland types dominated by Papyrus swamps *Cyperus papyrus*. Around the edge of these swamps is a dense fringe of the wetland grass *Vossia cuspidata*. *Vossia* forms mats which are anchored to the lake bed whereas Papyrus is either emergent in shallow water or forms thick, floating mats which extend into deeper waters. These support Black Crakes *Amaurornis flavirostra* and Malachite Kingfishers *Alcedo cristata*.

A rare plant found in the area is the cycad *Encephalartos hildebrandtii*. This primitive fern-like plant is known only from the gorge of the Mpanga River to the east of Lake George and from an area on the East African coast. The other plant not commonly found in Uganda is the sedge *Cladium mariscus* which forms swamps around Lake George; its only other known location is in some pockets in the Kigezi region of southwestern Uganda.

Lake George wetlands provide habitat for over 150 species of birds including some rare species. These include the Saddle-billed Stork *Ephippiorhynchus senegalensis*, seven 'papyrus endemics' including Papyrus Gonolek *Laniarius mufumbiri*, Papyrus Canary *Serinus koliensis*, and the threatened Papyrus Yellow Warbler *Chloropeta gracilirostris* (IUCN Red List, 1994). The Madagascar Squacco Heron *Ardeola idae* has also been recorded within the Lake George Basin. The associated crater lakes provide the only habitat for Greater and Lesser Flamingos *Phoenicopterus ruber* and *P. minor* in Uganda.

The most spectacular of all is the Shoebill, a very large, grey water bird with a gigantic shoe-shaped bill. It is often confused with members of the stork family because of its resemblance to storks but it is in fact the only species within the family Balaenicipitidae. It is found in an enclave of the Lake commonly referred to as Shoebill Swamp.

Utilization of Lake George's Resources

The potential of Lake George is not yet fully exploited largely because of its inaccessibility. Nevertheless, Lake George wetlands are utilized in several ways. The Lake supports a thriving fishery with more than 50 species recorded in catches. Most of these are cichlids of which the most abundant is the phytoplankton-eating *Haplochromis nigripennis*. Up to 3,500 tonnes of fish were recorded annually between 1952 and 1972, and the catches are equally high in recent years. There is low endemicity compared to other lakes in the region. The most common fish include; tilapias, the catfish *Clarius lazera* and *Bagrus docmac*, a species of lungfish *Protopterus* sp., the electric fish *Mormyrus kannume* and the cichlid *Haplochromis squamipinis*. The presence of large quantities of fish led to the establishment of a fish factory in the 1960s to process tilapia. Although the factory is now disused and the scale of commercial fisheries has diminished, the lake still supports important fishery activities. Fishing villages are established in several of its bays, supplying fish locally to Kasese town and the surrounding area and to far destinations such as Kampala (450km away) and Zaire to the west.

The other important human activity is the harvesting of Papyrus and the woody plant Ambatch, *Aeschynomene elaphroxylon* which grows in marshy soil, in swamps and on the edge of the lake. Papyrus is used for roofing material and screens while Ambatch stems, with their cork-like texture, are used as floats and buoys for fishing nets.

Tourism is another activity that occurs in the area, but to a lesser extent because most of the wetlands are inaccessible due to the impenetrable swamp forest.

Threats to the Diversity of the Area

There are some problems which threaten the high diversity of the area and could jeopardize its existence if appropriate measures are not taken in time to address them:

The lake is affected by pollution from copper and cobalt pyrites as the site is close to a copper mine and many of the rivers and streams that feed into the lake go past the mine. However the establishment of Kilembe Cobalt Company to carry out cobalt production using bioleaching and solvent extraction and electro-winning is expected to address some of the problems of cobalt pollution through rehabilitation of the degraded environment.

There is uncontrolled charcoal burning to the east of the Lake George wetlands which could become disastrous if not checked: this is bound to deplete the tree resources of Lake George leading to loss of the natural organisms which they support.

Horticultural activities such as vegetable growing to supply the fast growing Kasese town, also pose a threat to the lake and its associated wetlands. Many of these activities involve modification and in some cases drainage of wetlands and could reduce the buffering capacity of the wetlands. In addition the use of pesticides and agrochemicals in horticulture pose a danger to Lake George's biodiversity.

There is a potential problem of silting from poor management practices in the water catchment area of the wetland as a result of intensive agricultural activities in the surrounding slopes of Mt Ruwenzori to the north, and the Bunyaruguru escarpment to the south.

Although Lake George supports a high diversity of biological resources and a high human population which is dependent on the fishing, the future of the lake, in the face of these threats, is uncertain. However recent government policy on wetlands in particular and the environment in general provide hope for the future.

2. Dinder Mayas wetlands in Sudan

Sudan's obligatory first Wetland of International Importance was effected on 7 January 2005 by Ramsar. This was **Dinder National Park (DNP)** (1,084,600 hectares, 12°19'N 034°47'E), a very large complex of about 40 wetlands, or "mayas", and pools formed by meanders and oxbows that are part of the Rahad and Dinder river drainage systems bordering the frontier with Ethiopia in southeastern Sudan. Both rivers and their tributaries, coming from the Ethiopian highlands across the flat plain of the Park, are seasonal and flow from June to November, peaking in August. The wetlands are vital as a source of water and of the most nutritious grasses for herbivores, especially during the most severe part of the dry season. A large number of animal species are supported, some of which, like the tiang *Damaliscus korrigum*, are endangered. Located in the center of migration routes among three continents, the site is visited by a large number of species of migratory birds, and some of the mayas contain quantities of fish throughout the dry season. Recent archaeological investigations at many locations within the park show promise of important finds from ancient Meroitic and medieval Fung sultanate periods. The local population practices agriculture and pastoralism and many are nomadic within the park during dry and rainy seasons. Illegal fires set by non-local nomadic grazers, poachers, and honey collectors are cited as among the chief threats to the site.

9.7 Constructed Wetlands

Constructed wetlands have received the greatest attention for treatment of point source pollution. They have been further defined as: engineered systems designed to simulate natural wetlands to exploit the water purification functional value for human use and benefits. Constructed wetlands consist of former upland environments that have been modified to create poorly drained soils and wetlands flora and fauna for the primary purpose of contaminant or pollutant removal from wastewaters or runoff (Hammer, 1992).

Constructed wetlands can provide many of the water quality improvement functions of natural wetlands with the advantage of control over location, design, and management to optimize those water quality functions. Constructed wetlands are not typically intended to replace all of the functions of natural wetlands, but emphasize certain features to maximize pollutant removal efficiency and to minimize point source and non-point source pollution prior to its entry into streams, natural wetlands, and other receiving waters. Wetlands created for habitat, water quantity, aesthetic and other functions as well as water quality functions typically call for different design considerations than those used solely for water quality improvement.

This tailored design approach to constructed systems generally makes them less suitable as wildlife habitat than natural wetlands. Nevertheless, constructed wetlands are often designed with ancillary wildlife values in mind, for example, incorporating open water for waterfowl usage. While species diversity of vegetation and microflora and fauna are lower in treatment wetlands, bird usage can be higher than that in adjacent natural wetlands because of the more eutrophic, and hence more productive, aquatic conditions in the loaded systems.

A major concern with the use of constructed wetlands for wildlife habitat is the potential for concentrating accumulated pollutants up the food chain, with deleterious effects to birds and other consumers. While wildlife impacts have been observed in several instances with wetlands created for habitat these appear related to agricultural irrigation return flows. So far, no similar problems are documented for constructed treatment wetlands but the potential for harm exists with some metals and other compounds and the issue requires continued evaluation.

Constructed wetlands are becoming an increasingly common method for treatment of all forms of water pollution, including confined animal wastewater, cropland runoff, urban stormwater, septic tank effluent, municipal wastewater effluent, acid mine drainage, industrial process waters, and landfill leachate. The beginnings of constructed wetland technology are dated to the 1950's in Germany for municipal wastewater treatment. This use is the most established and advanced, with hundreds of systems in place in Europe and the United States.

Most constructed wetlands installed to date are used for advanced (nutrient reduction) treatment of municipal wastewater, with a large number also in place for secondary (solids and BOD) wastewater treatment. Use of these systems for primary wastewater treatment without prior or adequate settling and solids removal quickly overloads them and degrades performance capabilities, and is largely avoided. Other than primary wastewater uses, the range of potential applications for constructed wetlands is great and the record of actual applications is rapidly expanding.

Activity 9.9
Are there any constructed wetlands in your locality? Carry out an investigation to determine the efficiency of a constructed wet on reduction of: suspended solids, BOD, and fecal coliforms, and nutrients, e.g., total Nitrogen and total Phosphorus.

9.8 Module Summary

In this Module, you have studied:

- Characteristics of a degraded wetland
- Wetland restoration projects
- Case studies of restored wetland

9.9 Further Reading

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APPENDIX I: Articles of the Ramsar convention

Article 1

1. For the purpose of this Convention wetlands are areas of marsh, fen, peat land 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 meters.

2. For the purpose of this Convention waterfowl are birds ecologically dependent on wetlands.

Article 2

l. Each Contracting Party shall designate suitable wetlands within its territory for inclusion in a List of Wetlands of International Importance, hereinafter referred to as "the List" which is maintained by the secretariat established under Article 8. The boundaries of each wetland shall be precisely described and also delimited on a map and they may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands, especially where these have importance as waterfowl habitat.

2. Wetlands should be selected for the List because of their international significance in terms of ecology, botany, zoology, limnology or hydrology. In the first instance wetlands of international importance to waterfowl at any season should be included.

3. The inclusion of a wetland in the List does not prejudice the exclusive sovereign rights of the Contracting Party in whose territory the wetland is situated.

4. Each Contracting Party shall designate at least one wetland to be included in the List when signing this Convention or when depositing its instrument of ratification or accession, as provided in Article 9.

5. Any Contracting Party shall have the right to add to the List further wetlands situated within its territory, to extend the boundaries of those wetlands already included by it in the List, or, because of its urgent national interests, to delete or restrict the boundaries of wetlands already included by it in the List and shall, at the earliest possible time, inform the organization or government responsible for the continuing secretariat duties specified in Article 8 of any such changes.

6. Each Contracting Party shall consider its international responsibilities for the conservation, management and wise use of migratory stocks of waterfowl, both when designating entries for the List and when exercising its right to change entries in the List relating to wetlands within its territory.

Article 3

1. The Contracting Parties shall formulate and implement their planning to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory.

2. Each Contracting Party shall arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference. Information on such changes shall be passed immediately to the organization or government responsible for the continuing secretariat duties specified in Article 8.

Article 4

1. Each Contracting Party shall promote the conservation of wetlands and waterfowl by establishing nature reserves on wetlands, whether they are included in the List or not, and provide adequately for their wardening.

2. Where a Contracting Party in its urgent national interest, deletes or restricts the boundaries of a wetland included in the List, it should as far as possible compensate for any loss of wetland resources,

and in particular it should create additional nature reserves for waterfowl and for the protection, either in the same area or elsewhere, of an adequate portion of the original habitat.

3. The Contracting Parties shall encourage research and the exchange of data and publications regarding wetlands and their flora and fauna.

4. The Contracting Parties shall endeavour through management to increase waterfowl populations on appropriate wetlands.

5. The Contracting Parties shall promote the training of personnel competent in the fields of wetland research, management and wardening.

Article 5

The Contracting Parties shall consult with each other about implementing obligations arising from the Convention especially in the case of a wetland extending over the territories of more than one Contracting Party or where a water system is shared by Contracting Parties.

They shall at the same time endeavour to co-ordinate and support present and future policies and regulations concerning the conservation of wetlands and their flora and fauna.

Article 6

1. The Contracting Parties shall, as the necessity arises, convene Conferences on the Conservation of Wetlands and Waterfowl.

2. These Conferences shall have an advisory character and shall be competent inter alia:

(a) to discuss the implementation of this Convention;

(b) to discuss additions to and changes in the List;

(c) to consider information regarding changes in the ecological character of wetlands included in the List provided in accordance with paragraph 2 of Article 3;

(d) to make general or specific recommendations to the Contracting Parties regarding the conservation, management and wise use of wetlands and their flora and fauna;

(e) to request relevant international bodies to prepare reports and statistics on matters which are essentially international in character affecting wetlands.

3. The Contracting Parties shall ensure that those responsible at all levels for wetlands management shall be informed of, and take into consideration, recommendations of such Conferences concerning the conservation, management and wise use of wetlands and their flora and fauna.

Article 7

1. The representatives of the Contracting Parties at such Conferences should include persons who are experts on wetlands or waterfowl by reasons of knowledge and experience gained in scientific, administrative or other appropriate capacities.

2. Each of the Contracting Parties represented at a Conference shall have one vote, recommendations being adopted by a simple majority of the votes cast, provided that not less than half the Contracting Parties cast votes.

Article 8

1. The International Union for the Conservation of Nature and Natural Resources shall perform the continuing secretariat duties under this Convention until such time as another organization or government is appointed by a majority of two-thirds of all Contracting Parties.

2. The continuing secretariat duties shall be, inter alia:

(a) to assist in the convening and organizing of Conferences specified in Article 6;

(b) to maintain the List of Wetlands of International Importance and to be informed by the Contracting Parties of any additions, extensions, deletions or restrictions concerning wetlands included in the List provided in accordance with paragraph 5 of Article 2;

(c) to be informed by the Contracting Parties of any changes in the ecological character of wetlands included in the List provided in accordance with paragraph 2 of Article 3;

(d) to forward notification of any alterations to the List, or changes in character of wetlands included therein, to all Contracting Parties and to arrange for these matters to be discussed at the next Conference;

(e) to make known to the Contracting Party concerned, the recommendations of the Conferences in respect of such alterations to the List or of changes in the character of wetlands included therein.

Article 9

1. This Convention shall remain open for signature indefinitely.
2. Any member of the United Nations or of one of the Specialized Agencies or of the International Atomic Energy Agency or Party to the Statute of the International Court of Justice may become a party to this Convention by:

(a) signature without reservation as to ratification;

(b) signature subject to ratification followed by ratification;

(c) accession.

3. Ratification or accession shall be effected by the deposit of an instrument of ratification or accession with the Director-General of the United Nations Educational, Scientific and Cultural Organization, (hereinafter referred to as "the Depository").

Article 10

1. This Convention shall enter into force four months after seven States have become Parties to this Convention in accordance with paragraph 2 of Article 9.

2. Thereafter this Convention shall enter into force for each Contracting Party four months after the day of its signature without reservation as to ratification, or its deposit of an instrument of ratification or accession.

Article 11

l. This Convention shall continue in force for an indefinite period.

2. Any Contracting Party may denounce this Convention after a period of five years from the date on which it entered into force for that Party by giving written notice thereof to the Depository. Denunciation shall take effect four months after the day on which the Depository receives notice thereof.

Article 12

1. The Depository shall inform all States that have signed and acceded to this Convention as soon as possible of:

(a) signatures to the Convention;
(b) deposits of instruments of ratification of this Convention;
(c) deposits of instruments of accession to this Convention;
(d) the date of entry into force of this Convention;
(e) notifications of denunciation of this Convention.

2. When this Convention has entered into force, the Depository shall have it registered with the Secretariat of the United Nations in accordance with Article 102 of the Charter.

IN WITNESS WHEREOF, the undersigned, being duly authorized to that effect, have signed this Convention.

DONE at Ramsar this 2nd day of February 1971, in a single original in the English, French, German and Russian languages, in any case of divergency the English text prevailing, which shall be deposited with the Depository which shall send true copies thereof to all Contracting Parties.

Appendix II: Contracting parties to the Ramsar convention on Wetlands as at 2008

Country	Entry into force	Number of Ramsar sites	Surface area(Sq/Km)
Albania	29.02.96	3	83,062
Algeria	04.03.84	42	2,959,615
Antigua and Barbuda	02.10.05	1	3,600
Argentina	04.09.92	15	3,992,201
Armenia	06.11.93	2	492,239
Australia	21.12.75	64	7,371,873
Austria	16.04.83	19	122,277
Azerbaijan	21.05.01	2	99,560
Bahamas	07.06.97	1	32,600
Bahrain	27.02.98	2	6,810
Bangladesh	21.09.92	2	611,200
Barbados	12.04.06	1	33
Belarus	25.08.91	8	283,107
Belgium	04.07.86	9	42,938
Belize	22.08.98	2	23,592
Benin	24.05.00	4	1,179,354
Bolivia	27.10.90	8	6,518,073
Bosnia and Herzegovina	01.03.92	2	10,911
Botswana	09.04.97	1	5,537,400
Brazil	24.09.93	8	6,434,086
Bulgaria	24.01.76	10	20,306
Burkina Faso	27.10.90	3	299,200
Burundi	05.10.02	1	1,000
Cambodia	23.10.99	3	54,600
Cameroon	20.07.06	2	600,415
Canada	15.05.81	37	13,066,675
Cape Verde	18.11.05	3	...
Central African Republic	05.04.06	1	101,300
Chad	13.10.90	5	9,879,068
Chile	27.11.81	9	159,154
China	31.07.92	30	2,937,481
Colombia	18.10.98	3	447,888
Comoros	09.06.95	3	16,030
Congo	18.10.98	1	438,960
Costa Rica	27.04.92	11	510,050
Côte d'Ivoire	27.06.96	6	127,344
Croatia	25.06.91	4	86,579
Cuba	12.08.01	6	1,188,411

Cyprus	11.11.01	1	1,585
Czech Republic	01.01.93	12	54,656
Democratic Republic of Congo	18.05.96	2	866,000
Denmark	02.01.78	38	2,078,823
Djibouti	22.03.03	1	3,000
Dominican Republic	15.09.02	1	20,000
Ecuador	07.01.91	12	170,771
Egypt	09.09.88	2	105,700
El Salvador	22.05.99	3	125,769
Equatorial Guinea	02.10.03	3	136,000
Estonia	29.07.94	11	218,344
Fiji	11.08.06	1	615
Finland	21.12.75	49	799,518
France	01.12.86	24	828,803
Gabon	30.04.87	6	1,763,769
Gambia	16.01.97	2	26,304
Georgia	07.06.97	2	34,480
Germany	26.06.76	33	843,109
Ghana	22.06.88	6	178,410
Greece	21.12.75	10	163,501
Guatemala	26.10.90	7	628,592
Guinea	18.03.93	16	6,422,361
Guinea-Bissau	14.05.90	1	39,098
Honduras	23.10.93	6	223,320
Hungary	11.08.79	26	207,176
Iceland	02.04.78	3	58,970
India	01.02.82	25	677,131
Indonesia	08.08.92	3	656,510
Iran, Islamic Republic of	21.12.75	22	1,481,147
Iraq	17.02.08	1	137,700
Ireland	15.03.85	45	66,994
Israel	12.03.97	2	366
Italy	14.04.77	50	59,796
Jamaica	07.02.98	3	37,765
Japan	17.10.80	33	130,293
Jordan	10.05.77	1	7,372
Kazakhstan	02.05.07	1	353,341
Kenya	05.10.90	5	101,849
Kyrgyz Republic	12.03.03	2	639,700
Latvia	25.11.95	6	148,363
Lebanon	16.08.99	4	?1075

Lesotho	01.11.04	1	434
Liberia	02.11.03	5	95,879
Libyan Arab Jamahiriya	05.08.00	2	83
Liechtenstein	06.12.91	1	101
Lithuania	20.12.93	5	50,451
Luxembourg	15.08.98	2	17,213
Madagascar	25.01.99	6	787,555
Malawi	14.03.97	1	224,800
Malaysia	10.03.95	5	55,355
Mali	25.09.87	1	4,119,500
Malta	30.01.89	2	16
Marshall Islands	13.11.04	1	69,000
Mauritania	22.02.83	3	1,231,100
Mauritius	30.09.01	1	26
Mexico	04.11.86	67	5,317,857
Moldova	20.10.00	3	94,705
Monaco	20.12.97	1	10
Mongolia	08.04.98	11	1,439,530
Montenegro	03.06.06	1	20,000
Morocco	20.10.80	24	272,010
Mozambique	03.12.04	1	688,000
Myanmar	17.03.05	1	256
Namibia	23.12.95	4	629,600
Nepal	17.04.88	4	23,488
Netherlands	23.09.80	49	818,908
New Zealand	13.12.76	6	39,068
Nicaragua	30.11.97	8	405,691
Niger	30.08.87	12	4,317,869
Nigeria	02.02.01	1	58,100
Norway	21.12.75	37	116,369
Pakistan	23.11.76	19	1,343,627
Palau	18.02.03	1	493
Panama	26.11.90	4	159,903
Papua New Guinea	16.07.93	2	594,924
Paraguay	07.10.95	6	785,970
Peru	30.03.92	12	6,780,643
Philippines	08.11.94	4	68,404
Poland	22.03.78	13	145,075
Portugal	24.03.81	17	73,784
Republic of Korea	28.07.97	5	4,550
Romania	21.09.91	4	682,166

Russian Federation	11.02.77	35	10,323,767
Rwanda	01.04.06	1	...
Saint Lucia	19.06.02	2	85
Samoa	06.02.05	1	...
Sao Tome and Principe	21.12.06	1	23
Senegal	11.11.77	4	99,720
Serbia	27.04.92	6	28,025
Seychelles	22.03.05	1	121
Sierra Leone	13.04.00	1	295,000
Slovakia	01.01.93	14	40,697
Slovenia	25.06.91	3	8,205
South Africa	21.12.75	19	543,978
Spain	04.09.82	63	281,768
Sri Lanka	15.10.90	3	8,522
Sudan	07.05.05	2	6,784,600
Suriname	22.11.85	1	12,000
Sweden	21.12.75	51	514,506
Switzerland	16.05.76	11	8,676
Syrian Arab Republic	05.07.98	1	10,000
Tajikistan	18.11.01	5	94,600
Thailand	13.09.98	10	370,600
The FYR of Macedonia	08.09.91	1	18,920
Togo	04.11.95	4	1,210,400
Trinidad & Tobago	21.04.93	3	15,919
Tunisia	24.03.81	20	726,541
Turkey	13.11.94	12	179,482
Uganda	04.07.88	11	354,803
Ukraine	01.12.91	33	744,651
United Arab Emirates	29.12.07	1	620
United Kingdom	05.05.76	166	917,988
United Republic of Tanzania	13.08.00	4	4,868,424
United States of America	18.04.87	22	1,305,860
Uruguay	22.09.84	2	424,904
Uzbekistan	08.02.02	1	31,300
Venezuela	23.11.88	5	263,636
Viet Nam	20.01.89	2	25,759
Zambia	28.12.91	8	4,030,500
former USSR		3	669,200

Appendix III: Criteria for identifying wetlands of international importance.

Criteria for the designation of Wetlands of International Importance

Group A of the criteria Sites containing representative, rare or unique wetland types		**Criterion 1:** A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Group B of the criteria Sites of international importance for conserving biodiversity	Criteria based on species and ecological communities	**Criterion 2:** A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
		Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
		Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
	Specific criteria based on waterbirds	**Criterion 5:** A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
		Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
	Specific criteria based on fish	**Criterion 7:** A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
		Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
	Specific criteria based on other taxa	**Criterion 9:** A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Appendix IV: Articles of the African Eurasian Waterbird Agreemet

ARTICLE I: Scope, Definitions and Interpretation

1. The geographic scope of this Agreement is the area of the migration systems of African-Eurasian waterbirds, as defined in Annex 1 to this Agreement, hereafter referred to as the "Agreement Area".

2. For the purpose of this Agreement:

(a) "Convention" means the Convention on the Conservation of Migratory Species of Wild Animals, 1979;

(b) "Convention Secretariat" means the body established under Article IX of the Convention;

(c) "Waterbirds" means those species of birds that are ecologically dependent on wetlands for at least part of their annual cycle, have a range which lies entirely or partly within the Agreement Area and are listed in Annex 2 to this Agreement;

(d) "Agreement secretariat" means the body established under Article VI, paragraph 7, subparagraph (b), of this Agreement;

(e) "Parties" means, unless the context otherwise indicates, Parties to this Agreement; and

(f) "Parties present and voting" means the Parties present and casting an affirmative or negative vote; those abstaining from voting shall not be counted amongst the Parties present and voting.

In addition, the terms defined in Article I, subparagraphs 1(a) to (k), of the Convention shall have the same meaning, *mutatis mutandis*, in this Agreement.

3. This Agreement is an AGREEMENT within the meaning of Article IV, paragraph 3, of the Convention.

4. The annexes to this Agreement form an integral part thereof. Any reference to the Agreement includes a reference to its annexes.

ARTICLE II: Fundamental Principles

1. Parties shall take co-ordinated measures to maintain migratory waterbird species in a favourable conservation status or to restore them to such a status. To this end, they shall apply within the limits of their national jurisdiction the measures prescribed in Article III, together with the specific actions determined in the Action Plan provided for in Article IV, of this Agreement.

2. In implementing the measures prescribed in paragraph 1 above, Parties should take into account the precautionary principle.

ARTICLE III: General Conservation Measures

1. The Parties shall take measures to conserve migratory waterbirds, giving special attention to endangered species as well as to those with an unfavorable conservation status.

2. To this end, the Parties shall:

(a) accord the same strict protection for endangered migratory waterbird species in the Agreement Area as is provided for under Article III, paragraphs 4 and 5, of the Convention;

(b) ensure that any use of migratory waterbirds is based on an assessment of the best available knowledge of their ecology and is sustainable for the species as well as for the ecological systems that support them;

(c) identify sites and habitats for migratory waterbirds occurring within their territory and encourage the protection, management, rehabilitation and restoration of these sites, in liaison with those bodies listed in Article IX, paragraphs (a) and (b) of this Agreement, concerned with habitat conservation;

(d) coordinate their efforts to ensure that a network of suitable habitats is maintained or, where appropriate, re-established throughout the entire range of each migratory waterbird species concerned, in particular where wetlands extend over the area of more than one Party to this Agreement;

(e) investigate problems that are posed or are likely to be posed by human activities and endeavour to implement remedial measures, including habitat rehabilitation and restoration, and compensatory measures for loss of habitat;

(f) cooperate in emergency situations requiring international concerted action and in identifying the species of migratory waterbirds which are the most vulnerable to these situations as well as cooperate in developing appropriate emergency procedures to provide increased protection to these species in such situations and in the preparation of guidelines to assist individual Parties in tackling these situations;

(g) prohibit the deliberate introduction of non-native waterbird species into the environment and take all appropriate measures to prevent the unintentional release of such species if this introduction or release would prejudice the conservation status of wild flora and fauna; when non-native waterbird species have already been introduced, the Parties shall take all appropriate measures to prevent these species from becoming a potential threat to indigenous species;

(h) initiate or support research into the biology and ecology of migratory waterbirds including the harmonization of research and monitoring methods and, where appropriate, the establishment of joint or cooperative research and monitoring programmes;

(i) analyze their training requirements for, *inter alia*, migratory waterbird surveys, monitoring, ringing and wetland management to identify priority topics and areas for training and cooperate in the development and provision of appropriate training programmes;

(j) develop and maintain programmes to raise awareness and understanding of migratory waterbird conservation issues in general and of the particular objectives and provisions of this Agreement;

(k) exchange information and results from research, monitoring, conservation and education programmes; and

(l) cooperate with a view to assisting each other to implement this Agreement, particularly in the areas of research and monitoring.

ARTICLE IV: Action Plan and Conservation Guidelines

1. An Action Plan is appended as Annex 3 to this Agreement. It specifies actions, which the Parties shall undertake in relation to priority species and issues, under the following headings, consistent with the

general conservation measures specified in Article III of this Agreement:

(a) species conservation;

(b) habitat conservation;

(c) management of human activities;

(d) research and monitoring;

(e) education and information; and

(f) implementation.

2. The Action Plan shall be reviewed at each ordinary session of the Meeting of the Parties, taking into account the Conservation Guidelines.

3. Any amendment to the Action Plan shall be adopted by the Meeting of the Parties, taking into consideration the provisions of Article III of this Agreement.

4. The Conservation Guidelines shall be submitted to the Meeting of the Parties for adoption at its first session, and shall be regularly reviewed.

ARTICLE V: Implementation and Financing

1. Each Party shall:

(a) designate the Authority or Authorities to implement this Agreement which shall, *inter alia*, monitor all activities that may have impact on the conservation status of those migratory waterbird species of which the Party is a Range State;

(b) designate a contact point for the other Parties, and communicate without delay its name and address to the Agreement secretariat to be circulated forthwith to the other Parties; and

(c) prepare for each ordinary session of the Meeting of the Parties, beginning with the second session, a report on its implementation of the Agreement with particular reference to the conservation measures it has undertaken. The format of such reports shall be determined by the first session of the Meeting of the Parties and reviewed as may be necessary at any subsequent session of the Meeting of the Parties. Each report shall be submitted to the Agreement secretariat not less than one hundred and twenty days before the ordinary session of the Meeting of the Parties for which it has been prepared, and copies shall be circulated forthwith to the other Parties by the Agreement secretariat.

2. (a) Each Party shall contribute to the budget of the Agreement in accordance with the United Nations scale of assessment. The contributions shall be restricted to a maximum of 25 per cent of the total budget for any Party that is a Range State. No regional economic integration organization shall be required to contribute more than 2.5 per cent of the administrative costs.

(b) Decisions relating to the budget and any changes to the scale of assessment that may be found necessary shall be adopted by the Meeting of the Parties by consensus.

3. The Meeting of the Parties may establish a conservation fund from voluntary contributions of Parties or from any other source for the purpose of financing monitoring, research, training and projects relating to the conservation, including protection and management, of migratory waterbirds.

4. Parties are encouraged to provide training and technical and financial support to other Parties on a multilateral or bilateral basis to assist them in implementing the provisions of this Agreement.

ARTICLE VI: Meeting of the Parties

1. The Meeting of the Parties shall be the decision-making body of this Agreement.

2. The Depositary shall, in consultation with the Convention Secretariat, convene a session of the Meeting of the Parties not later than one year after the date of the entry into force of this Agreement. Thereafter, the Agreement secretariat shall convene, in consultation with the Convention Secretariat, ordinary sessions of the Meeting of the Parties at intervals of not more than three years, unless the

Meeting of the Parties decides otherwise. Where it is possible to do so, such sessions should be held in conjunction with the ordinary meetings of the Conference of the Parties to the Convention.

3. On the written request of at least one third of the Parties, the Agreement secretariat shall convene an extraordinary session of the Meeting of the Parties.

4. The United Nations, its Specialized Agencies, the International Atomic Energy Agency, any State not a Party to the Agreement, and the secretariats of international conventions concerned *inter alia* with the conservation, including protection and management, of migratory waterbirds may be represented by observers in sessions of the Meeting of the Parties. Any agency or body technically qualified in such conservation matters or in research on migratory waterbirds may also be represented at sessions of the Meeting of the Parties by observers, unless at least one third of the Parties present object.

5. Only Parties have the right to vote. Each Party shall have one vote, but regional economic integration organizations which are Parties to this Agreement shall, in matters within their competence, exercise their right to vote with a number of votes equal to the number of their Member States which are Parties to the Agreement. A regional economic integration organization shall not exercise its right to vote if its Member States exercise theirs, and *vice versa*.

6. Unless provided otherwise in this Agreement, decisions of the Meeting of the Parties shall be adopted by consensus or, if consensus cannot be achieved, by a two-thirds majority of the Parties present and voting.

7. At its first session, the Meeting of the Parties shall:

(a) adopt its rules of procedure by consensus;

(b) establish an Agreement secretariat within the Convention Secretariat to perform the secretariat functions listed in Article VIII of this Agreement;

(c) establish the Technical Committee provided for in Article VII of this Agreement;

(d) adopt a format for the reports to be prepared according to Article V, paragraph 1, subparagraph (c), of this Agreement; and

(e) adopt criteria to define emergency situations which require urgent conservation measures, and determine the modalities for assigning responsibility for action to be taken.

8. At each of its ordinary sessions, the Meeting of the Parties shall:

(a) consider actual and potential changes in the conservation status of migratory waterbirds and the

habitats important for their survival, as well as the factors which may affect them;

(b) review the progress made and any difficulty encountered in the implementation of this Agreement;

(c) adopt a budget and consider any matters relating to the financial arrangements for this Agreement;

(d) deal with any matter relating to the Agreement secretariat and the membership of the Technical Committee;

(e) adopt a report for communication to the Parties to this Agreement and to the Conference of the Parties of the Convention; and

(f) determine the time and venue of the next session.

9. At any of its sessions, the Meeting of the Parties may:

(a) make recommendations to the Parties as it deems necessary or appropriate;

(b) adopt specific actions to improve the effectiveness of this Agreement and, as the case may be, emergency measures as provided for in Article VII, paragraph 4, of this Agreement;

(c) consider and decide upon proposals to amend this Agreement;

(d) amend the Action Plan in accordance with Article IV, paragraph 3, of this Agreement;

(e) establish such subsidiary bodies as it deems necessary to assist in the implementation of this Agreement, in particular for coordination with bodies established under other international treaties, conventions and agreements with overlapping geographic and taxonomic coverage; and

(f) decide on any other matter relating to the implementation of this Agreement.

ARTICLE VII: Technical Committee

1. The Technical Committee shall comprise:

(a) nine experts representing different regions of the Agreement Area, in accordance with a balanced geographical distribution;

(b) one representative from the International Union for Conservation of Nature and Natural Resources (IUCN), one from the International Waterfowl and Wetlands Research Bureau (IWRB) and one from the International Council for Game and Wildlife Conservation (CIC); and

(c) one expert from each of the following fields: rural economics, game management, and environmental law.

The procedure for the appointment of the experts, the term of their appointment and the procedure for designation of the Chairman of the Technical Committee shall be determined by the Meeting of the Parties. The Chairman may admit a maximum of four observers from specialized international inter-governmental and non-governmental organizations.

2. Unless the Meeting of the Parties decides otherwise, meetings of the Technical Committee shall be convened by the Agreement secretariat in conjunction with each ordinary session of the Meeting of the Parties and at least once between ordinary sessions of the Meeting of the Parties.

3. The Technical Committee shall:

(a) provide scientific and technical advice and information to the Meeting of the Parties and, through the Agreement secretariat, to Parties;

(b) make recommendations to the Meeting of the Parties concerning the Action Plan, implementation of the Agreement and further research to be carried out;

(c) prepare for each ordinary session of the Meeting of the Parties a report on its activities, which shall be submitted to the Agreement secretariat not less than

one hundred and twenty days before the session of the Meeting of the Parties, and copies shall be circulated forthwith by the Agreement secretariat to the Parties; and

(d) carry out any other tasks referred to it by the Meeting of the Parties.

4. Where in the opinion of the Technical Committee there has arisen an emergency which requires the adoption of immediate measures to avoid deterioration of the conservation status of one or more migratory waterbird species, the Technical Committee may request the Agreement secretariat to convene urgently a meeting of the Parties concerned. These Parties shall meet as soon as possible thereafter to establish rapidly a mechanism to give protection to the species identified as being subject to particularly adverse threat. Where a recommendation has been adopted at such a meeting, the Parties concerned shall inform each other and the Agreement secretariat of measures they have taken to implement it, or of the reasons why the recommendation could not be implemented.

5. The Technical Committee may establish such working groups as may be necessary to deal with specific tasks.

ARTICLE VIII: **Agreement Secretariat**

The functions of the Agreement secretariat shall be:

(a) to arrange and service the sessions of the Meeting of the Parties as well as the meetings of the Technical Committee;

(b) to execute the decisions addressed to it by the Meeting of the Parties;

(c) to promote and coordinate activities under the Agreement, including the Action Plan, in accordance with decisions of the Meeting of the Parties;

(d) to liaise with non-Party Range States and to facilitate coordination between the Parties and with international and national organizations, the activities of which are directly or indirectly relevant to the conservation, including protection and management, of migratory waterbirds;

(e) to gather and evaluate information which will further the objectives and implementation of the Agreement and to arrange for appropriate dissemination of such information;

(f) to invite the attention of the Meeting of the Parties to matters pertaining to the objectives of this Agreement;

(g) to circulate copies of the reports of the Authorities referred to in Article V, paragraph 1, subparagraph (a), of this Agreement and of the Technical Committee, along with copies of the reports it must provide pursuant to paragraph (h) of this Article, to each Party not less than sixty days before the commencement of each ordinary session of the Meeting of the Parties;

(h) to prepare, on an annual basis and for each ordinary session of the Meeting of the Parties, reports on the work of the secretariat and on the implementation of the Agreement;

(i) to administer the budget for the Agreement and, if established, its conservation fund;

(j) to provide information for the general public concerning the Agreement and its objectives; and

(k) to perform such other functions as may be entrusted to it under the Agreement or by the Meeting of the Parties.

ARTICLE IX: Relations with International Bodies dealing with Migratory Waterbirds and their Habitats

The Agreement secretariat shall consult:

(a) on a regular basis, the Convention Secretariat and, where appropriate, the bodies responsible for the secretariat functions under Agreements concluded pursuant to Article IV, paragraphs 3 and 4, of the Convention which are relevant to migratory waterbirds, the Convention on Wetlands of International Importance, especially as Waterfowl Habitat, 1971, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973, the African Convention on the Conservation of Nature and Natural Resources, 1968, the Convention on the Conservation of European Wildlife and Natural Habitats, 1979, and the Convention on Biological Diversity, 1992, with a view to the Meeting of the Parties cooperating with the Parties to these conventions on all matters of common interest and, in particular, in the development and implementation of the Action Plan;

(b) the secretariats of other pertinent conventions and international instruments in respect of matters of common interest; and

(c) other organizations competent in the field of conservation, including protection and management, of migratory waterbirds and their habitats, as well as in the fields of research, education and awareness raising.

ARTICLE X: **Amendment of the Agreement**

1. This Agreement may be amended at any ordinary or extraordinary session of the Meeting of the Parties.

2. Proposals for amendment may be made by any Party.

3. The text of any proposed amendment and the reasons for it shall be communicated to the Agreement secretariat not less than one hundred and fifty days before the opening of the session. The Agreement secretariat shall transmit copies forthwith to the Parties. Any comments on the text by the Parties shall be communicated to the Agreement secretariat not less than sixty days before the opening of the session. The Secretariat shall, as soon as possible after the last day for submission of comments, communicate to the Parties all comments submitted by that day.

4. An amendment to the Agreement other than an amendment to its annexes shall be adopted by a two-thirds majority of the Parties present and voting and shall enter into force for those Parties which have accepted it on the thirtieth day after the date on which two thirds of the Parties to the Agreement at the date of the adoption of the amendment have deposited their instruments of acceptance of the amendment with the Depositary. For each Party which deposits an instrument of acceptance after the date on which

two thirds of the Parties have deposited their instruments of acceptance, the amendment shall enter into force on the thirtieth day after the date on which it deposits its instrument of acceptance.

5. Any additional annexes and any amendment to an annex shall be adopted by a two-thirds majority of the Parties present and voting and shall enter into force for all Parties on the ninetieth day after the date of its adoption by the Meeting of the Parties, except for Parties which have entered a reservation in accordance with paragraph 6 of this Article.

6. During the period of ninety days provided for in paragraph 5 of this Article, any Party may by written notification to the Depositary enter a reservation with respect to an additional annex or an amendment to an annex. Such reservation may be withdrawn at any time by written notification to the Depositary, and thereupon the additional annex or the amendment shall enter into force for that Party on the thirtieth day after the date of withdrawal of the reservation.

ARTICLE XI: **Effect of this Agreement on International Conventions and Legislation**

1. The provisions of this Agreement do not affect the rights and obligations of any Party deriving from existing international treaties, conventions or agreements.

2. The provisions of this Agreement shall in no way affect the right of any Party to maintain or adopt stricter measures for the conservation of migratory waterbirds and their habitats.

ARTICLE XII: **Settlement of Disputes**

1. Any dispute which may arise between two or more Parties with respect to the interpretation or application of the provisions of this Agreement shall be subject to negotiation between the Parties involved in the dispute.

2. If the dispute cannot be resolved in accordance with paragraph 1 of this Article, the Parties may, by mutual consent, submit the dispute to arbitration, in particular that of the Permanent Court of Arbitration at The Hague, and the Parties submitting the dispute shall be bound by the arbitral decision.

ARTICLE XIII: **Signature, Ratification, Acceptance, Approval, Accession**

1. This Agreement shall be open for signature by any Range State, whether or not areas under its jurisdiction lie within the Agreement Area, or regional economic integration organization, at least one member of which is a Range State, either by:

(a) signature without reservation in respect of ratification, acceptance or approval; or

(b) signature with reservation in respect of ratification, acceptance or approval, followed by ratification, acceptance or approval.

2. This Agreement shall remain open for signature at The Hague until the date of its entry into force.

3. This Agreement shall be open for accession by any Range State or regional economic integration organization mentioned in paragraph 1 above on and after the date of entry into force of the Agreement.

4. Instruments of ratification, acceptance, approval or accession shall be deposited with the Depositary.

ARTICLE XIV: **Entry into Force**

1. This Agreement shall enter into force on the first day of the third month after at least fourteen Range States or regional economic integration organizations, comprising at least seven from Africa and seven from Eurasia, have signed without reservation in respect of ratification, acceptance or approval, or have deposited their instruments of ratification, acceptance or approval in accordance with Article XIII of this Agreement.

2. For any Range State or regional economic integration organization which has:

(a) signed without reservation in respect of ratification, acceptance, or approval;

(b) ratified, accepted, or approved; or

(c) acceded to

this Agreement after the date on which the number of Range States and regional economic integration organizations necessary to enable entry into force have signed it without reservation or have ratified, accepted or approved it, this Agreement shall enter into force on the first day of the third month following the signature without reservation, or deposit, by that State or organization, of its instrument of ratification, acceptance, approval or accession.

ARTICLE XV: **Reservations**

The provisions of this Agreement shall not be subject to general reservations. However, a specific reservation may be entered by any State or regional economic integration organization on signature without reservation in respect of ratification, acceptance or approval or, as the case may be, on depositing its instrument of ratification, acceptance, approval or accession in respect of any species covered by the Agreement or any specific provision of the Action Plan. Such a reservation may be withdrawn at any time by the State or regional economic integration organization which had entered it, by notification

in writing to the Depositary; such a State or organization shall not be bound by the provisions which are the object of the reservation until thirty days after the date on which the reservation has been withdrawn.

ARTICLE XVI: **Denunciation**

Any Party may denounce this Agreement by written notification to the Depositary at any time. The denunciation shall take effect twelve months after the date on which the Depositary has received the notification.

ARTICLE XVII: **Depositary**

1. The original of this Agreement, in the Arabic, English, French and Russian languages, each version being equally authentic, shall be deposited with the Government of the Kingdom of the Netherlands which shall be the Depositary. The Depositary shall transmit certified copies of these versions to all States and regional economic integration organizations referred to in Article XIII, paragraph 1, of this Agreement, and to the Agreement secretariat after it has been established.

2. As soon as this Agreement enters into force, a certified copy thereof shall be transmitted by the Depositary to the Secretariat of the United Nations for registration and publication in accordance with

Article 102 of the Charter of the United Nations.

3. The Depositary shall inform all States and regional economic integration organizations that have signed or acceded to the Agreement, and the Agreement secretariat, of:

(a) Any signature;

(b) Any deposit of instruments of ratification, acceptance, approval or accession;

(c) The date of entry into force of this Agreement and of any additional annex as well as of any amendment to the Agreement or to its annexes;

(d) Any reservation with respect to an additional annex or to an amendment to an annex;

(e) Any notification of withdrawal of a reservation; and

(f) Any notification of denunciation of the Agreement.

The Depositary shall transmit to all States and regional economic integration organizations that have signed or acceded to this Agreement, and to the Agreement secretariat, the text of any reservation, of any additional annex and of any amendment to the Agreement or to its annexes.

Appendix V: Important websites

1. http://www.kenya-wildlife-service.org/wetlands.htm
2. http://www.wes.army.mil/el/vrtc/wrp/tnotes/wgev2-1.pdf
3. http://www.on.ec.gc.ca/wildlife/factsheets/fs_wetlands-e.html (section 2.3)
4. http://www.unep.org/unep/products/eeu/ecoserie/ecos14/ecos141.htm
5. http://www.on.ec.gc.ca/wildlife/docs/glwcap1997-2000-e.html
6. http://www.ramsar.org/key_rec_7.01e.htm
7. http://ces.iisc.ernet.in/energy/water/recom.html
8 http://www.unep.org/unep/products/eeu/ecoserie/ecos14/ecos141.htm
9. http://www.wes.army.mil/el/vrtc/wrp/tnotes/wgev2-1.pdf
10. http://www.ugandawetlands.org.com
11. http://www.eoearth.org/article/Eastern_Africa_and_freshwater_resources
12. http://www.epa.gov/owow/wetlands
13. http://www.epa.gov/owow/wetlands/awm
14. http://www.ramsar.org/mtg/mtg_reg_europe2001_5paulsen_e.doc
15. http://www.wetland.org/education_writeon_challenge.htm
16. http://www.ag.iastate.edu/centers/iawetlands/Journal.html
17. http://www.myhero.com/myhero/hero.asp?hero=Wetland_Conservation
18. http://www.uwa.co.ug

GLOSSARY

Aquatic ecosystem - Communities of organisms that are dependent on each other and on their environment live in aquatic ecosystems.

Biotop - Is an area of uniform environmental conditions providing a living place for a specific assemblage of plants and animals.

Biodiversity -

Biodiversity hotspot - is a biogeographic region with a significant reservoir of biodiversity that is threatened with destruction.

Constructed wetlands - are wetlands intentionally created from non-wetland sites for the sole purpose of wastewater or stormwater treatment" (Hammer 1997).

Creation -Wetland creation is "the construction of wetlands where they did not exist before and can involve engineering of hydrology and soils" (Mitsch and Gosselink 1993).

Ecological succession
The gradual and orderly process of change in an ecosystem brought about by the progressive replacement of one community by another until a stable climax is established. It is also referred to as the gradual process incurred by the change in the number of individuals of each species of a community and by establishment of new species populations that may gradually replace the original inhabitants.

Enhancement - "is improving the structure or function of an already existing wetland" (Middleton 1999). "In the context of restoration ecology, enhancement is any improvement of a structural or functional attribute" (National Research Council 1992).

Ecosystem - is a natural consisting of plants, animals and micro organisms (biotic factor) in an area functioning together with the non living things.

Ecosystem services -

Goals are general statements about desired project outcomes - stating goals allows all stakeholders to understand, in general terms, the desired direction of a project. Projects may have more than one goal, reflecting the multiple functions that individual wetlands perform.

Ground water
Water beneath the earth's surface, often between saturated soil and rocks. This water supplies wells and springs from which millions of people depend especially in rural areas. Ground water also refers to water that occurs below the surface of the Earth, where it occupies spaces in soils or rock layers.

Hydrology
The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hydrological cycle
Hydrological cycle is the succession of water movement from the atmosphere to the earth and return to the atmosphere through various stages such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration

Mitigation - Mitigation is the actual restoration, creation, or enhancement of wetlands to compensate for permitted wetland losses" (Lewis 1990). "Wetland mitigation is the replacing of wetland areas destroyed or impacted by proposed land disturbances with artificially created wetland areas" (National Research Council 1992). " Mitigation is actions taken to avoid, reduce, or compensate for the effects of

environmental damage.

Objectives are specific statements about desired project outcomes - projects typically have more than one objective, reflecting the multiple functions that individual wetlands perform.

Pathogens
Microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in humans, animals and plants. Also refered to as a disease causing organism or an infectious agent that causes illness to its host.

Performance standards (sometimes called success criteria) are observable or measurable attributes that can be used to determine if a project meets its intended multiple objectives - each objective will have one or more associated performance standards.

Precipitation
Rain, snow, or hails, all of which are formed by condensation of moisture in the atmosphere and fall to the ground/earth's surface.

Reclamation - Ecological restoration as reclamation is any deliberate attempt to return a damaged ecosystem to some kind of productive use or socially acceptable condition short of restoration" (Jordan et al. 1988). "Reclamation is an alteration in an ecosystem that creates another type of ecosystem of value to humans" (Middleton 1999).

Reforestation- In reforestation specific components (e.g., trees) are restored such that structural replication of the previous ecosystem is achieved; with an implicit assumption the restoration will succeed reforestation" (Wilson et al. in press).

Rehabilitation - Rehabilitation can be used as an umbrella term that includes both 'restoration' and 'creation' (Streever 1999). Rehabilitation is used primarily to indicate improvements of a visual nature to a natural resource; putting back into good condition or working order" (National Research Council 1992).

Restoration – "Restoration is the return of a system to some previous condition" (Streever 1999). Restoration requires recreating both the structural and functional attributes of a damaged ecosystem (Cairns 1991).

"Restored wetlands are areas that previously supported a natural wetland ecosystem but were modified or changed, eliminating typical flora and fauna and used for other purposes but then subsequently altered to return poorly drained soils and wetland flora and fauna to enhance life support, flood control, recreational, educational, or other functional values" (Hammer 1997).

"The ultimate goal of ecological restoration is perhaps the achieving of a status something very close to the ecosystem's original conditions" (Hamilton 1990).

"Wetland restoration is the rehabilitation of wetlands that may be degraded or hydrologically altered and often involves reestablishing the vegetation" Mitsch and Gosselink 1993).

Riparian Reforestation- "is the replanting of the banks and floodplains of a stream with native forest and shrub species to stabilize erodible soil, improve both surface and ground water quality, increase stream shading, and enhance wildlife habitat" (National Research Council 1992).

Self-design is "the idea that over time a restored wetland will organize itself around and eventually alter its engineered components…it is the environmental conditions there that determine the vegetative outcome" (Middleton 1999).

Sewage
Water-carried wastes, in either solution or suspension, that flows away from a community, home, industry

or any other institution. Also known as, wastewater characterized by distinct physical condition, chemical constituents, and bacteriological organisms. Depending on its origin, wastewater can be classified as sanitary, commercial, industrial, or surface runoff.

Wetland degradation
A process by which the vital and valuable functions of a wetland are reduced or completely destroyed.

Wetland encroachment
The act or process of converting or changing a wetland to some other use e.g. building a house/industry or gardening. During the encroachment process, a small area of the wetland is taken and then increased little by little.

Water table
Surface of a body of underground water below which the soil or rocks are permanently saturated with water.

The water table fluctuates both with the seasons and from year to year because it is affected by climatic variations and by the amount of water used by vegetation, evaporation from land, water and plant surface. It also is affected by withdrawing excessive amounts of water from wells, streams and springs.

Watershed
It describes an area of land that drains down slope to the lowest point. In a watershed water moves through a network of drainage pathways, both underground and on the surface. Generally, these pathways include streams and rivers, which become progressively larger as the water moves downstream.

Wetland Catchment area
The entire geographical area drained by a wetland and its streams or river system; an area characterized by all surface water runoff being conveyed to the wetland system.

Water pollution
A change in the chemical, physical and biological quality or characteristics of water that is harmful to its existing, intended, or potential uses. (For example, drinking, cooking swimming, the consumption of fish, and the health of aquatic organisms)

The term "water pollution" generally refers to human-induced changes to water quality. Thus, the discharge of potentially toxic wastes and chemicals or the release of wastewater into a nearby water body is considered as water pollution.

Waterborne diseases
Diseases caused by pathogenice microorganisms which are directly transmitted when contaminated drinking water is consumed. Contaminated drinking water, used in the preparation of food, can be the source of foodborne disease through consumption of the same microorganisms. A waterborne disease can be caused by protozoa, viruses, bacteria, and intestinal parasites. (Examples include; Diarrhoea, Dysentry, Cholera, Trachoma, Typhoid e.t.c)

Water Quality
Water Quality is a term used to describe the biological, chemical and physical characteristics of water and its general composition. These attributes affect water's ability to sustain life and its suitability for human consumption.

Wetland economic value
The total economic value of a given wetland includes direct values, indirect values, option values, heritage values and existence values

SPECIAL ACKNOWLEDGEMENT TO

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