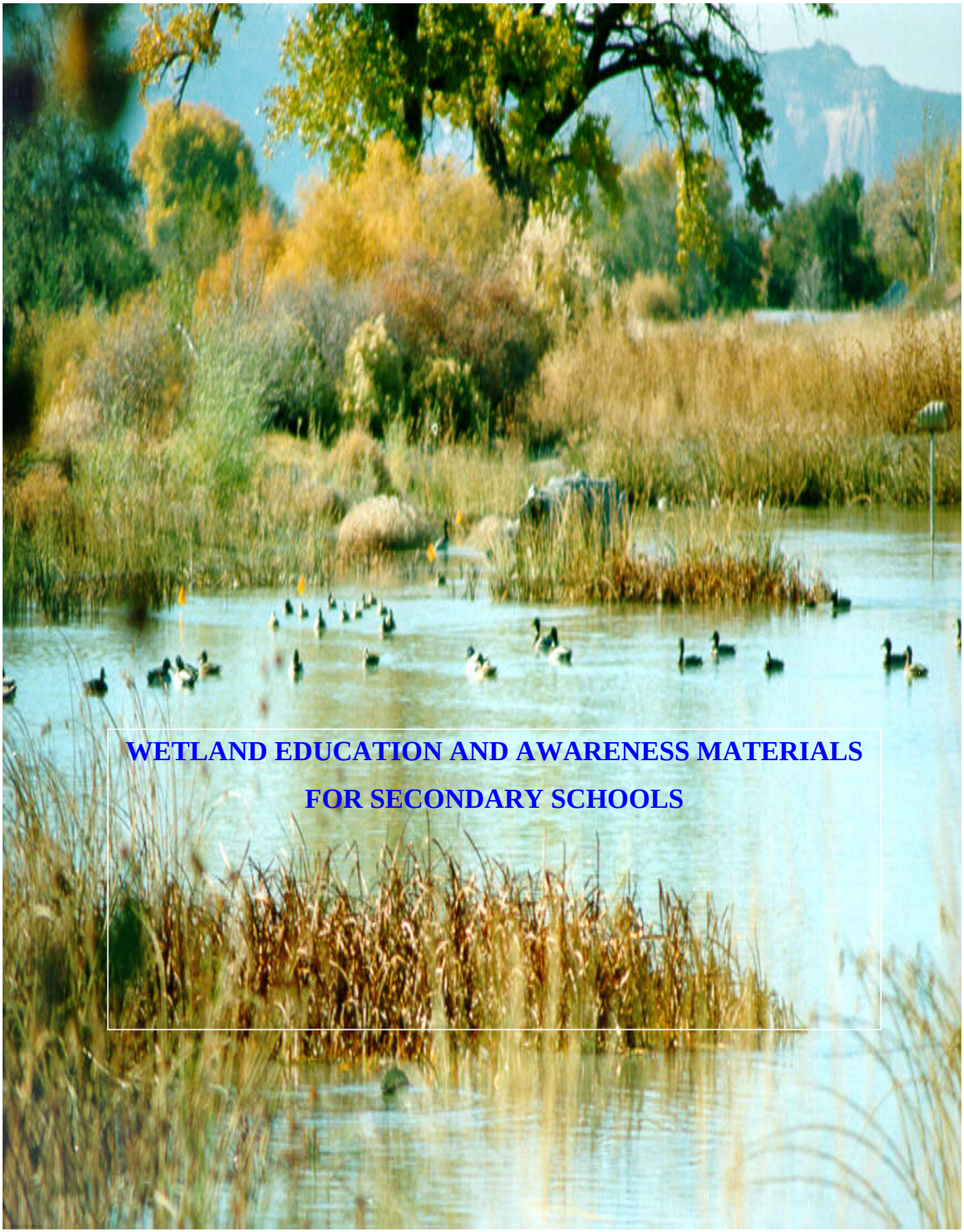

WETLAND EDUCATION AND AWARENESS MATERIALS FOR SECONDARY SCHOOLS

CONTENTS

UNIT 1: WETLANDS AND THEIR USES

INTRODUCTION

Many people in the Nile basin region and in the world at large seem not to understand what wetlands are. Despite their importance, wetlands are among the most impacted and degraded of all ecological systems. This is partly because of their indirect benefits to local communities, such as flood control, water purification, ground water recharge etc. Such benefits are less visible and most people take them for granted or do not know about them and are never appreciated. This module therefore, should make you fully understand what wetlands are and their benefits to man, both direct and indirect, by specifically examining the following;

- Definition of wetlands
- Types of wetlands
- Component parts of a wetland
- Formation of wetlands
- The multiple uses of wetlands
- Examples of wetlands

Learning Outcomes

By the end of this unit, the learners should have improved their ability to:

- Define the term wetland
- Describe the formation of wetlands
- List down correctly the different types of wetlands
- Give examples of wetlands in your country
- Give and explain the various uses of wetlands

- Apply the knowledge learnt to conserve wetlands in their localities and beyond

Wetland Quiz

Instructions: Find out what you already know about wetlands. Attempt this quiz before you read through this module.

Write a **T** for true and **F** for false in the box provided.

Statements	**T for true and F for false**
1. Wetlands are always wet.	☐
2. There are many kinds of wetlands.	☐
3. All wetlands are covered with water or have very wet soil during most of the year.	☐
4. There are thousands of plants and animals that live in wetlands.	☐
5. There are special plants that grow in wetlands. These plants love water.	☐
6. You may find frogs, birds, ducks, snakes, and insects in a wetland.	☐
7. Wetlands provide food resources for humans	☐
8. Wetlands clean the water by collecting dirt and pollution just like a sponge.	☐
9. Wetland degradation can pose severe impacts to the local communities.	☐
10. Wetlands may be referred to as wastelands.	☐

You can now proceed and read this module about wetlands.

Then, attempt this quiz again after you have studied wetlands to see how much you have learned by comparing your scores for the quiz before and after.

WHAT ARE WETLANDS?

Wetlands are areas where water covers the soil or is present either at or near the surface of the soil, all year or for varying periods of time during the year. Water saturation (hydrology) largely determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands may support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes)

Wetlands may also refer to lands where saturation with water 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.

One common feature that most wetlands share is soil that is at least periodically saturated with or covered by water.

An illustration of a wetland

The wetland water may be on a temporary or permanent basis, usually shallow, slow moving or stationary.

Definitions of wetlands vary considerably but the Ramsar convention gives a more universal definition of wetlands as, “areas of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, brackish or salt. Wetlands are dynamic and complex habitats either continuously or periodically flooded by seasonal rains.

While most wetlands are natural sites, artificial water bodies such as fish ponds, reservoirs and artificial lakes are also included under the Ramsar definition in view of their ecological and cultural importance.

Component parts of a wetland

A wetland in its natural state is composed of four features. These include;

- Water
- Soils
- Plants
- Animals

Wetland water

Water is the key element in wetlands i.e no water, no wetland. Water modifies soil types and influences flora and nutrient availability. Wetlands contain water that does not flow at all or flows slowly due to little or no slope. Wetland water comes from all sources including direct rain fall, the hydrological cycle and the rising groundwater.

Wetland soils

Soils are the second vital component of wetlands. The wet characteristic of wetlands has a profound impact on its soils. Wetland soils are waterlogged permanently or seasonally and are often subjected to a fluctuating water table. Water logging creates anaerobic conditions, which in turn result in structural and chemical properties that are very different from dry land soils.

Wetland soils have a high organic matter, which gives them a darkish colour. Wetland soils may also have high clay content. The high organic matter binds wetland soils together. Once lost, the soil falls apart and can easily be carried away by water.

Wetland soils are often wrongly considered to be good for agricultural production because of the water availability and nutrient content in the organic matter. However, their productivity is linked to the water logging. Once the water is drained, the structure and chemical properties alter very quickly. The organic matter breaks down, resulting in an overall breakdown of the soil structure and a quick loss of nutrients.

Wetland flora and fauna

Wetlands are one of the most diverse ecosystems in the world. A wide range of plants and animals live atleast, part of their life cycle in wetlands. However, life in wetlands is not easy, and many plants and animals have evolved special adaptations to survive with soggy soil, fluctuating water and little oxygen. Plants are a vital part of the ecology of the wetland and form the basis for many of its beneficial functions such as; flood control, food and habitat for fauna.

Wetland fauna includes microbes and animals. Microbes are the smallest in size but play a vital role in nutrient cycling as the main decomposer organisms in the system. Swamp plants are normally unavailable to many animals because of the physical nature of the swamps and because they are very fibrous. These are broken down by mechanical and microbial action, becoming more nutritious and available to smaller animals. It is important to note that organic material from a swamp provides both physical support and food for a major food web outside the swamp. The macro-fauna, although large and often conspicuous, are relatively unimportant in the functioning of wetland ecosystems.

WETLAND FORMATION

Wetlands are formed where water is retained or delayed within catchments. The crucial ingredients for wetland formation are water and a place for it to collect. Rainfall and dew, which

precipitate on the catchments and do not return to the atmosphere by either evaporation or transpiration, flow downhill through the catchments towards its lowest point. This may be in a depression or basin or where the slope along the valley is very slight. A wetland therefore develops where water collects and soil beneath becomes waterlogged and anaerobic.

Wetland vegetation then develops, and as it becomes established, the speed of water flowing through the wetland reduces. This lower speed then results in the sedimentation of suspended silt in the water. This in turn promotes more vegetation growth and further reduction in water speed, and thus the wetland continues to expand slowly sideways across the valley.

TYPES OF WETLANDS

The Ramsar convention recognizes six major types of wetlands. These include;

- **Marine wetlands;** These are coastal wetlands including, rocky shores, and coral reefs.
- **Estuarine wetlands;** These include deltas, tidal marshes, and mangrove swamps.
- **Lacustrine wetlands;** These are wetlands associated with lakes.
- **Riverine wetlands;** These are wetlands along rivers and streams.
- **Palustrine wetlands;** These wetlands include marshes, swamps and bogs.
- **Artificial water bodies;** These include fish ponds, reservoirs and artificial lakes.

IMPORTANCE OF WETLANDS

Wetlands are among the most precious natural resources on Earth, existing as multiple value systems. These highly varied ecosystems are natural areas where water accumulates for atleast part of the year. Driven by the hydrological cycle, water in the wetland is continuously being recycled through the land, sea and atmosphere in a process which ensures the maintenance of ecological functions.

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 communities depend for food, medicine, building material, and dry season grazing.
The functions and services provided by wetlands are many and varied. They may be divided into either natural/ecological or socio-economic functions.

Ecological (natural) uses of wetlands

These are the natural uses of a wetland which seem to be less visible (or hidden) to man and are always not appreciated until a wetland is lost. They may also be referred to as the indirect values of a wetland. They include the following;

- Flood control
- Ground water recharge
- Water filtration
- Habitat for flora and fauna
- Erosion control
- Sediment retention
- Carbon retention
- Climate modification

Flood control

Wetlands play an extremely important role in reducing harmful and costly effects of the flow of storm-water. They slow down the speed of water flow from heavy rains. This reduction in speed lessens the harmful impacts and frequency of flooding during the wet seasons.

Wetlands act as natural sponges that trap and slowly release surface water over time. When water pours into a wetland after a storm, the wetland will flood, but it will do so slowly and over an extended period of time. This ability to store water in periods of heavy rainfall means that wetlands can help prevent flooding.
In areas where wetlands have been drained, heavy rains cause floods that damage crops, livestock, infrastructure and humans drown in the flood waters. Preserving wetlands therefore offers superior flood protection. Many cities in the Nile basin region have faced serious problems

of floods in the recent past due to wetland degradation. For example in Sudan, Uganda, Kenya, Tanzania and Ethiopia, floods have been rampant.

People walk along the Shamba-Jipya Bridge which was destroyed by floods along the Mombasa-Tanzania route in Msambweni, on the Kenyan coast, Nov. 14, 2006.

Groundwater recharge; Wetlands play an important role in replenishing or "recharging" ground water supplies and maintaining ground water levels. By retaining the water for long, the wetland allows the water to infiltrate into the underground aquifer.

Water filtration; Wetlands have the remarkable ability to improve the quality of water by filtering runoff and removing sediment, nutrients, pesticides, metals, municipal sewage and other types of pollutants. This is so, because the speed of the water reduces as it enters the wetland while it filters slowly through the vegetation.

These pollutants that are often dissolved in water are absorbed by wetland plants and microorganisms in the soil. In many cases, this filtration process removes much of the water's nutrient and pollutant load by the time it leaves a wetland, thereby improving the water quality.

Habitat for flora and fauna

Wetlands provide important habitats to countless bird, fish, and native plant species. In fact, wetlands are some of the most productive ecosystems in the world. They provide a habitat for more aquatic and terrestrial species on an area basis than any other habitat type, making them to be among the most ecologically important ecosystems on earth.

The abundant vegetation and shallow water provide diverse habitats for wildlife species of plants and animals, including fish. Aquatic plant life flourishes in the nutrient-rich wetland environment and energy converted by the plants is passed up the food chain to fish, bird and other wildlife and to humans as well.

Erosion control

The wetland ensures that the flow of water is slowed down. This allows the region down stream of the wetland to receive less erosive force of water runoff that would result in soil and stream bank degradation.

Sediment retention

Materials that are eroded from the surrounding catchment by rainfall and carried into wetlands by surface runoff can be trapped in the filtration and sedimentation processes that occur in wetlands. Sediment retention prevents downstream resources of dams, farmland, rivers and lakes from being silted up. Retention of sediment also helps to cleanse the water. Sediment retention by wetlands generally benefits those down stream. Facilities such as water storage dams and irrigation schemes that would fill with sediment are protected from in-filling and their lifespan increased. However, it may also gradually lead to in-filling of the wetland resulting eventually into dry land conditions.

Carbon retention

Wetlands absorb carbon dioxide from the atmosphere through photosynthesis by wetland plants thus acting as carbon sinks. In carrying out photosynthesis, wetland plants convert atmospheric carbon dioxide into biomass. This retention of carbon dioxide greatly reduces global warming of the atmosphere.

Climate modification

Wetlands modify local and regional climate by evaporating enormous quantities of water into the atmosphere. This process of evaporation reduces air temperature and increases humidity thus providing cool climate. Wetlands therefore act as local “air conditioners”. Dust in the

atmosphere is reduced, and the air quality is improved. The presence of a wetland also helps to trigger rainfall in its catchment.

Socio-economic uses of wetlands;

These are the direct benefits of wetlands to man that seem to be visible and appreciated. Despite these direct benefits, wetlands are still undergoing serious degradation. These uses include the following;

Water supply

Water is the most important product of wetlands. Water is a daily commodity that occurs in all wetlands, permanently or seasonally. Wetlands retain water for long periods thus making it available for local people and domestic animals. The water supplied by wetlands is free and clean. Generally the wetland water is used for, rural and urban domestic use, livestock and industrial use and for irrigation.

Fish production

Wetlands have a great importance and potential in fisheries. Large amounts of fish are present in wetlands which provide valuable protein to local communities. This is especially important for those who would be unable to afford other sources of proteins. The common types of fish found in wetlands include, the catfish, lungfish, and some tilapia. Wetlands also act as breeding and nursery grounds for commercial fish species, including tilapia and the Nile perch. Thus, the fish biomass in the lakes depends upon the existence of fringing wetlands.

A man attends to his fish at the Rufiji wetland Tanzania

Provision of craft and building materials

Wetlands provide a variety of craft and building materials such as reeds, grasses, sedges, papyrus and palm trees that are usually harvested for thatching and mulching or processed into domestic items such as baskets, mats and furniture. Crafts add beauty to the home, reinforce culture and provide employment and income when sold.

Timber, sand and clay are often extracted from wetlands in many areas of the Nile basin region as building materials. Wetland sand and clay are used for bricks, tiles and pottery, while wetland trees are used for doors, roof supports furniture and fences.

Livestock grazing

The parts of wetlands, where the soil is permanently or seasonally moist are often used as grazing areas for livestock especially during the dry season. For example the Sudd wetland in southern Sudan supports large numbers of domestic animals during dry seasons.

Migratory mammals depend on the Sudd wetland for their dry season grazing. ***(Photo courtesy Sudan's Higher Council for Environment and Natural Resources)***

Recreation and eco-tourism

The diversity of wetland biological communities has a potential for earning tourism income. Some wetlands can be developed for recreation and eco-tourism, especially in national parks. There are many recreational activities that are dependent on wetlands such as hunting, bird watching, boating, and wildlife photography

EXAMPLES OF WETLANDS OF INTERNATIONAL IMPORTANCE

In response to the Ramsar convention on wetlands of international importance, countries in the Nile basin region have gazetted the following sites as wetlands of international importance;

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	,,
KENYA	L. Nakuru	5/June/1990
	L. Naivasha	10/April/1995
	L. Bogaria	27/Aug/2001
	L. Boringo	10/Jan/2002
	L. Elmenteita	5/Sept/2005
TANZANIA	Malagarasi-Muyvozi wetlands	13/april/2000
	L. Natron	4/July/2001
	Rufigi-Mafia-Kulwa marine Ramsar site	29/Oct/2004
D.R. CONGO	Parc.national des virunga	18/Jan/1996
	Parc.national des mangroves	18/Jan/1996
RWANDA	Rugezi-Bulera-Ruhondo	1/Dec/2005
SUDAN	Sudd	5/June/2006
EGYPT	L.Bardawil	9/Sept/1988
	L.Burullus	9/Sept/1988

The Sudd Wetland is one of the largest tropical wetlands in the world.

(Photo courtesy Sudan's Higher Council for Environment and Natural Resources)

UNIT SUMMARY

In this Unit we have;

- Defined the term wetland
- Explained how wetlands are formed
- Given examples of wetlands in the Nile basin region
- Explained their roles, values and uses

Wetlands are extremely valuable to society. Wetlands can decrease flooding, remove pollutants from water, recharge ground water, protect shorelines, provide habitat for wildlife, and serve important recreational and cultural functions. If wetlands are lost, the cost of replacing them can be extremely expensive, if at all possible. It is therefore important to ensure that they are conserved.

STUDY QUESTIONS

- What are wetlands?
- Describe how wetlands are formed.
- In which way can wetlands be source of wealth for your community?
- In the past, wetlands were regarded as wastelands. Why is this inaccurate perception?
- Discuss the likely consequences of wetland degradation to the communities in your country

UNIT ACTIVITY:

In a group, visit any wetland near your school and make observations about the various component parts the wetland contains.

Specifically, look at the wetland flora and fauna

- *Make a list of the various plants and animals that you saw. Of what value are they to man?*
- *Discuss the role of plants in the water filtration process of wetlands.*
- *Write a story about the wetland you visited and things that happen in and to it.*
- *From your interaction with the wetland, create a poem about wetlands and their value to you.*

UNIT 2: WETLANDS AND BIODIVERSITY

INTRODUCTION

In the previous unit, we examined wetlands and their uses. This unit is mainly concerned with the biological diversity of wetland ecosystems. Wetland ecosystems are habitats of biological diversity providing the water and primary productivity upon which countless species of plants and animals depend for survival. In this unit we shall therefore explore the various wetland flora and fauna, and how they are adapted to the wetland ecosystem. We shall also examine Important Bird Areas (IBA's) in the Nile basin region.

Learning Outcomes

By the end of this unit, you should have improved your ability to:

- Define the term biodiversity
- Explain the importance of biodiversity
- Identify the various flora and fauna that inhabit wetlands.
- Describe the adaptations of wetland fauna and flora.
- Identify IBA's in the Nile basin region
- Use the knowledge gained to develop on their own projects that aim at conserving the biological diversity of wetlands.

"Biodiversity is the variety and variability among living organisms and the ecological complexes in which they occur**.** The term encompasses different ecosystems, species, genes, and their relative abundance."

Biodiversity may also refer to the variation of life forms within a given ecosystem, biome or for the entire earth. 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: i.e

Genetic diversity: This is the combination of different genes found within a population of a single species, and the pattern of variation found within different populations of the same species. Genetic adaptations to local conditions result in genetic differences between the populations of the same species.

Species diversity: This is the variety and abundance of different types of organisms which inhabit an area. "Biodiversity hotspots" are excellent examples of species diversity.

Ecosystem diversity: This encompasses the variety of habitats that occur within a region, or the mosaic of patches found within a landscape. Or it may refer to diversity at a higher level of organization, the ecosystem.

THE BIOLOGICAL DIVERSITY OF WETLANDS

Wetland ecosystems are habitats 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 lakes display high levels of diversity and endemism, whereas others support little life.

Unlike terrestrial ecosystems, the richness of freshwater biodiversity is still poorly known. Identification and classification of wetland species is hampered by the fact that many species may spend part of their life cycle in both freshwater and marine ecosystems.

Wetlands are an important 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 glabberrima), 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.

In Africa and the Nile basin region in particular, the biological diversity of wetlands is unevenly distributed, with some habitats being characterised by a richer range of species than others. Wetlands in areas of high rainfall and warm climates such as the Congo basin display richer species diversity than those of drier regions.

Wetland biodiversity is not only assessed by the overall richness in number of species present, but on the uniqueness of wetland in terms of the number of localized species, particularly the endemic ones. Most wetlands in the Nile basin region display both characteristics, i.e richness in number of species and endemism. In this regard, wetland areas of highest endemism and of international significance in the Nile basin region include; the Sudd wetland of southern Sudan, the swamps of Western Tanzania, and Lakes Victoria, kyoga and George in Uganda.

WETLAND FAUNA AND FLORA

Wetlands support a wide variety of plant and animal life, from floating water plants to marsh vegetation, from grazing mammals (eg cattle, goats, sheep) to fish and invertebrates (mainly snails and insects). It's important to note that the biological diversity and biological productivity is great and exceeded only by some tropical rain forests.

Wetlands are one of the most diverse ecosystems in the world. A wide range of plants and animals live at least part of their life cycle in wetlands. However life in wetlands is not easy and many plants and animals have evolved special adaptations to survive with soggy soil, fluctuating water and little oxygen. Once they have developed functional systems and structures to survive they have a definite advantage over non adapted species.

WETLAND PLANTS

Wetlands support a high diversity of plants far in excess of what would be predicted when considering the relative land area they occupy. Each wetland community has a variety of plants which provide shelter and food for many of the animals living there.

Wetland plants are therefore, an integral part of the ecology of the wetland and form the basis for many of its beneficial functions; that is;

- plants are responsible for drainage and water control
- plants provide the physical habitat or shelter for the animal populations
- Plants are a major food resource for the wetland fauna (animals).
- Plants provide food and goods (papyrus as building materials) for humans.
- Plants add oxygen to the water for underwater species

Wetland plants face serious challenges within the wetland ecosystem. These include;

- The soil is often weak or difficult for the roots of the plants to reach.
- Fluctuating water depth
- oxygen levels in the soil are low
- some wetlands are low in nutrients
- Some wetlands are acidic while others have toxic elements in the root zone.

Adaptations of wetland plants to wetland conditions

Wetland plants have developed adaptations to deal with the challenges posed by wetland ecosystems, the biggest of which is probably 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.

If oxygen levels are low in the root zone, there are various strategies a plant can exploit; these are;

- To bring oxygen from the air to the root zone.
- To use another 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.

Summary of adaptations of plants to wetland conditions

Fluctuating water depths

- Plants have developed elongated stems.
- Plants have developed floating leaves or stems
- Plants have developed water retention structures

Oxygen deficiency

- Plants have developed porous stems and roots
- Plants undergo anaerobic respiration
- Plants have developed very fine root mat.
- Plants have developed lateral air roots

Toxic elements in the root zone

- Plants have developed C4 (efficient) metabolism.
- Plants have developed immobilization techniques
- Plants have developed secretion structures

Nutrient deficiency

- Plants have developed C4 (efficient) metabolism
- Plants have developed nutrient retention or withdrawal from mature stems

WETLAND ANIMALS

Wetland fauna includes microbes and animals. Microbes are the smallest in size but play a vital role in nutrients cycling as the main decomposer organisms in the system. Swamp plants are normally unavailable to many animals because of the physical nature of the swamps and because they are very fibrous.

These are broken down by mechanism and microbial action, becoming more nutritious and available to smaller animals. The macro-fauna, although large and often conspicuous are relatively unimportant in the functioning of wetland ecosystems.

Wetlands are also habitats for large mammals. This heavy dependence of large mammals on wetlands is of great economic value to the Nile Basin Countries and Africa in general, since they are the main stay of the tourist industry. These mammals include; elephants, buffalos, antelopes, hippos, zebras and the major predators lions, wild dogs, and hyenas.
The lives of these mammals are often inextricably linked to wetlands, e.g. the Amboseli swamps in Kenya are the only water source for mammals in the surrounding area.

In addition to mammals, wetland ecosystems also inhabit a great number of other animal species, such as birds, fish, reptiles, amphibian, and invertebrates.

Adaptations of wetland animals to wetland conditions

Just as wetland vegetation is unique to wetlands, so the fauna has adapted to the special conditions of wetlands. To exploit wetland habitats, animals have evolved unique adaptations to live more competitively. These adaptations include; `
Respiration; Some insects, fish, and amphibian larvae, utilize dissolved oxygen in the water where it is available. The insects absorb oxygen through the thin cuticles; fish and amphibians use gills; mosquito larvae use tinny tubes pocking out of the water for breathing; lung fish have lung-like apparatus with which they 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. Swimmers such as fish and otter also have muscular, slim and smooth bodies enabling them to cut 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 avoids 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. Lung fish also aestivate during dry season to conserve energy until water levels rise.

Summary of adaptations of wetland animals to wetland conditions

Breathing

- Fish, amphibians and insects breathe through gills
- Lung fish uses lung like structure to supplement gill filaments

Mobility

- Some animals have long hooves for easy movement
- Some have webbed and elongated toes eg birds.
- Developed water proof bodies
- Have muscular and streamlined smooth bodies for swimming

Feeding

- Adapted to feeding a various water levels e.g. sitatunga
- Have well developed feet and beak for feeding at different depth in the mud or water.

ASSESSING BIODIVERSITY

In order to recognize biodiversity loss, and set conservation priorities efficiently, it is necessary to accurately assess biodiversity. There are two main methods, each with advantages and disadvantages.

Full Biodiversity Assessment

A full assessment of the biodiversity of a given area requires identifying every individual species, from the smallest worm to the largest tree. Besides the compilation of a species list, it is also necessary to note the sizes and abundances of each organism in order to build up accurate pictures of the population. In most cases some ecological notes are also made, particularly with regard to sessile organisms, so that further inferences can be made. This is a very comprehensive study, although time consuming.

Spot check Analysis

A spot check analysis will identify most of the species in an area, particularly those that dominate or are particularly common. This allows us to create a fairly accurate assessment of an area's biodiversity, without the time required to search out the less common and more elusive species.

Unfortunately biodiversity assessment is affected by an ever changing ecosystem. It is therefore important to carry out repeated assessments to get much better idea of conservation status.

Biodiversity can also be assessed through the "ecosystem approach" which is the primary framework for the implementation of the Convention on Biodiversity. This approach requires that, in the assessment of biodiversity all the components of biodiversity to be considered. The ecosystem approach is described as a strategy for management of land, water and living resources that promotes conservation and sustainable use in an equitable way). It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment, and among ecosystems.

It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

The assessment of biodiversity should include identification and monitoring of ecosystems and habitats as well as identification, monitoring and assessment of species. In order to accelerate environmental research without having to wait for results from traditional taxonomy, which is perceived to be slow to deliver because it is based on monographic treatments, new methodologies have been developed for assessing biodiversity. These include inventories, surveys, rapid biodiversity assessment, monitoring, and the use of indicator species.

Identification, monitoring and assessment of species

The major problem with species is that there are a very large number of them, a high proportion of which, particularly invertebrates, are not described. Moreover, the identification of described species often requires a high level of expertise. Identifying all species in even a limited area is thus a very hectic task and generally impracticable.

Identifying and monitoring ecosystems and habitats

The classification of the natural environment is far more problematic than the classification of organisms: In fact the natural environment is highly variable and can not be divided into a series of discrete, discontinuous units.

Ecosystem structure variables are most promising indicators of biodiversity because they can offer a lot of information on the state of ecosystems over large areas for relatively low effort. Many aspects of quality can be captured by identifying key-ecosystem structure variables which can indicate if the ecosystem is functioning correctly or not. For example, a crude measure of quality might be the total number of well-specified habitat types observed within a sample area(s) relative to the postulated baseline number.

UNIT ACTIVITY 1

Several environmental factors affect an organism's survival in a wetland. Each species living in a wetland has developed special adaptations for its survival.

The ability to stay under water for extended periods of time, whether to get food or avoid becoming food, is essential to the survival of many wetland animals. Staying under water can have severe drawbacks, like drowning unless an organism is specially adapted to the conditions. Many wetland organisms have gills that filter oxygen from water, but many others do not.

- *How then do these other wetland animals that do not have gills obtain oxygen from water?*
- *What special adaptations do they have to survive in the wetland conditions?*
- *Are wetland plants also adapted to survive in the same wetland conditions?*