NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE : ESM 328

COURSE TITLE : BIODIVERSITY CONSERVATION

COURSE GUIDE

ESM 328
BIODIVERSITY CONSERVATION

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Published By:
National Open University of Nigeria

First Printed 2010

ISBN: 978-058-860-4

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Introduction

The study of Biodiversity or Biological diversity is majorly concerned with the variety of plant and animal life at the ecosystem, community or species level, and even at the genetic level. Biodiversity is most commonly measured and reported at species level with characteristics such as species richness (number of species), species diversity (types of species) and endemism (uniqueness of species to a certain area) being the most useful elements for comparison.

The rate of biodiversity loss has been accelerating rapidly throughout the industrial era. According to the Global Biodiversity Assessment, species are now becoming extinct at 10,000 times the natural rate. However, extinction is just the final step in a long process of ecosystem degradation, in which a decline in the abundance and distribution of many species is usually accompanied by a rise in the abundance of a few others. Few common species are becoming more common, rare species more rare. This is called the uniformity process.

The loss of biodiversity has been greatest in developed countries, not in tropical areas as one might expect. This is because of the developed world's usual tendency to harness all available grazing areas to the farming of only a few useful species. The overall loss has been incredibly low, though even in the developed world.

Africa has rich and varied biological resources, forming the region's natural wealth on which its social and economic system is based. These resources also have global importance, for the world's climate and for the development of agriculture or industrial activities such as pharmaceutics, tourism or construction, to name but a few of the most important areas. But in the near future, the importance of rainforests as sources of medicine and other benefits is likely to diminish, through the arrival of genetic and nano-technology.

The trend in the loss of biodiversity has two main components:

i. Loss of habitats, or 'ecosystem quantity' resulting from the conversion of natural areas to agricultural or urban use and
ii. Loss of ecosystem quality due to factors such as climate change, pollution, habitat fragmentation and over-exploitation.

What You Will Learn in this Course

This course carries two credits units. This course guide shows you briefly what to expect from reading this course material. Basically, biodiversity has global importance and this makes the study to cut across almost all disciplines. However, this course as it is conceived will expose you to some important aspects of biological diversity. Specifically, the following aspects will consider:

a. Meaning and dimension of biological diversity (Fauna and Flora)
b. Theories of Diversity
c. Biodiversity Statistics
d. Ecological, Economic and Social Values of biological resources
e. Sources of loss and extinction of biodiversity
f. Basic ecological and evolutionary principles/underpinning/efforts to halt the rapid increase in disappearance of both plants and animals
g. Impacts of Pollution on biodiversity
h. Effects of climate change on biodiversity
i. Sociological and economic issues will be treated with emphasis on biological aspects of West Africa region.

Course Aim

The aim of this course is to provide a good understanding of the varieties of life at the ecosystem, community or species level, and even at the genetic level; ecological formation they perform; principal causes of extinction and the best way to conserve biological diversity.

Course Objectives

After going through this course, you should be able to:

i. explain the concept biodiversity
ii. itemise different species of biological diversity
iii. explain the ecological, economic and social values of biological resources
iv. explain factors that are responsible for the loss of biodiversity
v. state basic ecological and evolutionary principles/underpinning/ efforts to halt the rapid increase in disappearance of both plants and animals

Working through this Course

This course has been carefully put together bearing in mind that you might be new to the course. However, efforts have been made to ensure that adequate explanation and illustrations were made to enhance better understanding of the course. You are therefore, advised to spend quality time to study this course and ensure that you attend tutorial sessions where you can ask questions and compare your knowledge with that of your classmates.

Course Materials

You will be provided with the following materials:

i. A course guide
ii. Study units

Moreover, this course comes with a list of recommended text books which are not compulsory for you to buy or read, but are essential to give you more insight to various topics discussed.

Study Units

This course is divided into 10 units. The following are the study units contained in this course.

Module 1

Unit 1	Concept of Biological Diversity
Unit 2	Economic, Ecological and Social Values of Biological Resources
Unit 3	Biodiversity Loss and Extinctions
Unit 4	Biodiversity Conservation Methods
Unit 5	Protocol on Biodiversity Conservation

Module 2

Unit 1	Environmental Pollution and Biodiversity Loss
Unit 2	Climate Change and Biodiversity
Unit 3	Impacts of Climate Change on Biodiversity
Unit 4	Climate Change Mitigation and Biodiversity Conservation
Unit 5	Biodiversity in West Africa (Case Study)

Text Books and References

The following are list of textbooks, journals and website addresses that can be consulted for further reading:

Bendall, Roger. (1996). "Biodiversity: the Follow Up to Rio". *The Globe* 30:4-5.

ENVIS Bulletin (2003). *Himalayan Ecology 11(2).*

FAO (2001). *Global Forest Resources Assessment, FAO, Rome.*

Fakayode, S.O. (2005). *Impact Assessment of Industrial Effluent on Water Quality of the Receiving Alaro River in Ibadan, Nigeria; Baylor University, U.S.A.*

Global Environmental Change (*1995). Human and Policy Implications. Special issue on "People, Land Management and Environmental Change", Vol. 3, No. 4, September.*

Heywood, V.H. (ed.). (1995). *Global Biodiversity Assessment*. United Nations Environment Programme, Cambridge University Press, Cambridge.

Heywood, V.H. (1996). "The Global Biodiversity Assessment". *The Globe*, 30:2-4, April.

Laura Carlsen, (2002). *Indigenous Communities in Latin America: Fighting for Control of Natural Resources in a Globalized Age*, Americas Program, (Silver City, NM: Interhemispheric Resource Center).

Myers, N. (1990). The Biodiversity Challenge: Expanded Hotspot Analysis. The *Environmentalist*, 10: 243-256.

Ohtonen, R., Fritze, H., Penmanen, T., Jumponen, A., Trappe, J. (1999). Ecosystem properties and microbial community changes in primary succession on a glacier forefront. *Oecologia* 119: 239-246.

Onianwa, P. C. (1993). Environmental Pollution Studies in an Underdeveloped Country (I): Heavy Metal Pollution in Ibadan, Nigeria. *International Journal of Environmental Education and Information* 12, 25-34.

Olajire, A. A., and Imeokparia, F. E. (2001). Water Quality Assessment of Osun River: Studies on Inorganic Nutrients. *Environmental Monitoring and Assessment* 69, 17-28.

UNEP (2002). Africa *Environment Outlook: Past, Present and Future perspective*. England, Earthprint Limited.

State of the World's Forests (2001). Food and Agriculture Organisation of the United Nations (FAO) http://www.fao.org/docrep/003/y0900e/y0900e00. htm

http://www.globalissues.org/EnvIssues/Biodiversity/Loss.asp

http://www.wrm.org.uy/bulletin/19/viewpoint.html;

http://www.wrm.org.uy/publicatios/briefings/underlying.html).

Assessment

There are two components of assessment for this course. They are the:

i. Tutor-Marked Assignment (TMA)
ii. End of course examination

Tutor-Marked Assignment

The TMA is the continuous assessment component of your course. It accounts for 30% of the total score. The TMAs will be given to you by your facilitator and you will return it after you have done the assignment.

Final Examination and Grading

The examination concludes the assessment for the course. It constitutes 70% of the whole course. You will be informed of the time for the examination.

Summary

This course intends to provide you with the knowledge of biological diversity, the principal causes of extinction and the best way to conserve biological diversity. At the end of this course, you will be able to answer the following questions:

1. What is biodiversity and how many species are on the Earth
2. Where do most species live?
3. Why are some communities more diverse than others?
4. What are the ecological, economic and social values of biological resources?
5. Explain why biological resources are the backbone of the African economy.
6. Outline the factors that tend a species toward endangerment.
7. State various ways of conserving biological diversity.
8. Discuss why pollution continues to be an increasing problem for the conservation of biological diversity.
9. Examine impact of increased temperatures, sea level rises and altered rainfall regimes on biological diversity.
10. Discuss West African biodiversity under the following headings:

i. Ecological, Economic and Social values of biological resources in Western Africa
ii. Threat to biodiversity in Western Africa
iii. Sustainable management and conservation of biodiversity in Western Africa.

We wish you success in this course and hope that you will apply the knowledge gained to conserve biological resources in your environment.

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First Printed 2010

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MODULE 1

UNIT 1 CONCEPT OF BIOLOGICAL DIVERSITY

CONTENTS

1.0 INTRODUCTION

Global biodiversity is changing at an unprecedented rate as a complex response to several human-induced changes in the global environment. The magnitude of this change is so large and so strongly linked to ecosystem processes and society's use of natural resources that biodiversity change is now considered an important global change in its own right. The definition of biodiversity in this course include all terrestrial and freshwater organisms-including plants, animals, and microbes-at scales ranging from genetic diversity within populations, to species diversity, to community diversity across landscapes. The definition excludes exotic organisms that have been introduced and communities such as agricultural fields that are maintained by regular human intervention. We do not consider marine systems in this study. This unit therefore, defines and considers the dimension of biological diversity (Fauna and Flora).

2.0 OBJECTIVES

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

- define biodiversity
- state the magnitude of species on the earth
- describe the types of species
- explain why some communities are more diverse than the others.

3.0 MAIN CONTENT

3.1 Definition of Biodiversity

Biodiversity or Biological diversity means the variety of plant and animal life at the ecosystem, community or species level, and even at the genetic level. Biodiversity is most commonly measured and reported at species level with characteristics such as species richness (number of species), species diversity (types of species) and endemism (uniqueness of species to a certain area) being the most useful elements for comparison (UNEP, 2002). Species is a group of creatures or plants having common characteristics.

3.2 Magnitude of Species

The Global Biodiversity Assessment completed by 1500 scientists under the auspices of UNEP in 1995 updated what we know or more correctly how little we know, about global biological diversity at the ecosystem, species and genetic levels. The assessment was uncertain of the total number of species on Earth within an order of magnitude. But studies show that between 3 and 30 million species exist on the Earth while only an estimated figure of 1.5 – 1.8 million have been scientifically described.

Birds - 9000 species (3-5 new/year - some new, some splits)
Mammals - 4000 species (20 new/year) - mostly splits
Bacteria - 3000 species known, lots more probably exist
Insects - millions undescribed

More than half of the world species are found in tropical forests. Tropical forests are characterised with - warm, no seasons, adapt into stable niches, moist, 3 or more layers of habitat (ground, shrub, several layers of trees). For examples, 43 ant species are found in Peruvian rain forest; 700 tree species found in 10 ha Indonesia forest while 300 tree species found in 2 ha Peru forest

Ecological community diversity of species is poorly known, as is its relationship to biological diversity, and genetic diversity has been studied for only a small number of species. The effects of human activities on biodiversity have increased so greatly that the rate of species extinctions is rising to hundreds or thousands of times the background level. These losses are driven by increasing demands on species and their habitats, and by the failure of current market systems to value biodiversity adequately.

Since Rio, many countries have improved their understanding of the status and importance of their biodiversity, particularly through biodiversity country studies such as those prepared under the auspices of UNEP/GEF. The United Kingdom identified 1250 species needing monitoring, of which 400 require action plans to ensure their survival. Protective measures for biodiversity, such as legislation to protect species, can prove effective. In the USA, almost 40 per cent of the plants and animals protected under the Endangered Species Act are now stable or improving as a direct result of recovery efforts. Some African countries have joined efforts to protect threatened species through the 1994 Lusaka Agreement, and more highly migratory species are being protected by specialised cooperative agreements among range states under the Bonn Convention.

3.3 Types of Species

Species are of various types and some communities are more diverse than the others while Tropical communities are more diverse than temperate? As **Evolutionary Time theory** argued, Tropics are more ancient (not affected by ice age) thus, species had so more time to develop than the Temperate region. Besides, **Climatic Stability Theory** asserted that in unstable climate, species develop wide range of tolerance, which could make them to adapt to many niches. But in stable climate, few species specialise into niches (the physical, chemical, and biological conditions species needs to live). Among the divert kinds of species are:

i. Native species

This evolved in and for that ecosystem. Fit into the system and provide food or eat food as part of cycle.

ii. Alien species

Migrate into or are brought into system from elsewhere. Some die immediately, because they could not adapt to the new environment. Others out-compete the natives, and eliminate them. *Example*: mammals brought to New Zealand. Many 'LGBs' (little gray birds) acted like mice and rats and squirrels do in our ecosystems. Introduced rats and mice killed most LGBs, including national symbol (kiwi), which is nearly extinct now.

iii. Keystone species

Absolutely essential for particular ecosystem - e.g. plankton for arctic ecosystem; ponderosa for our local forests.

iv. Indicator species

Easily affected by loss of habitat, so serve as early warning.

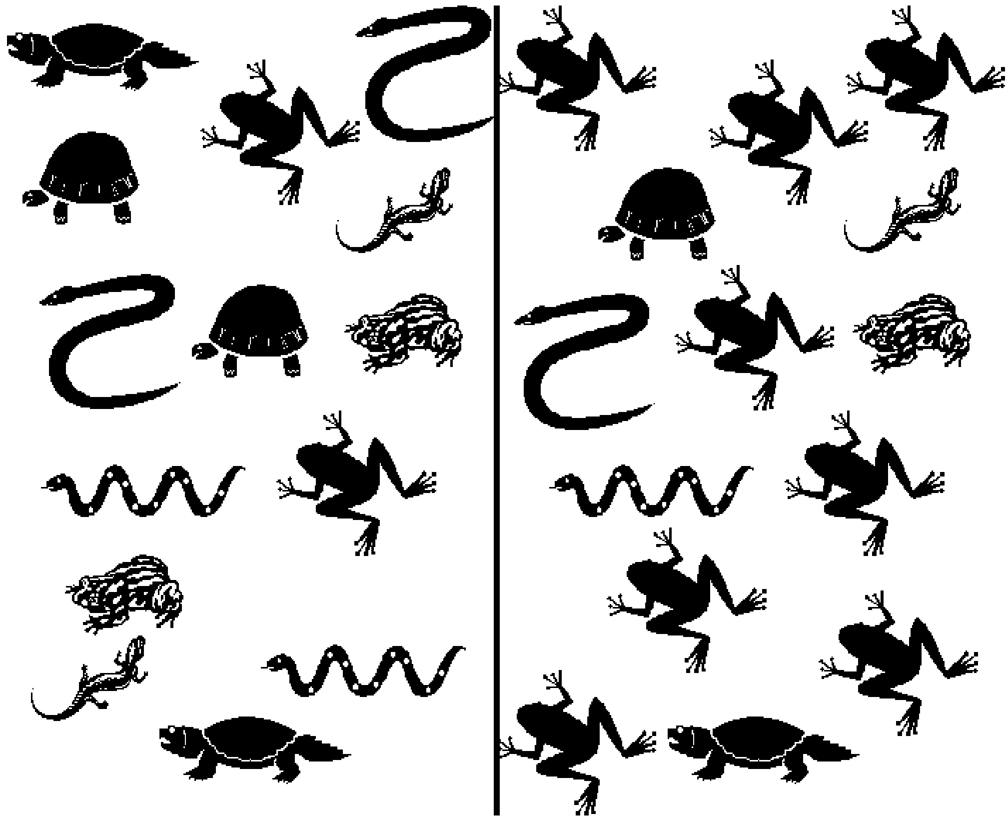

Fig. 1 : Animal Diversity

Fig. 1b: Bird Species

Fig. 2a : **Plant Diversity**

Fig. 2b: Plant Diversity

Fig. 2c: Plant Diversity

Fig. 2d : **Plant Diversity**

4.0 CONCLUSION

The study of biodiversity is essentially hinged on the knowledge of organisms-including plants, animals and microbes-at scales ranging from genetic diversity within populations to species diversity, to community diversity across landscapes.

5.0 SUMMARY

In this unit, we have learnt that:

- biodiversity is the variety of plant and animal life at the ecosystem, community or species level and even at the genetic level
- species on earth numbered between 3 and 30 million
- only 1.5 - 1.8 million of the species have been scientifically described
- species is a group of creatures or plants having common characteristics with different varieties
- some communities are more diverse than the others while tropical communities are more diverse than temperate region
- species are of various kinds.

6.0 TUTOR-MARKED ASSIGNMENT

Differentiate between Biodiversity and Species. Explain why some communities are more diverse than others.

7.0 REFERENCES/FURTHER READING

Heywood, V.H. (ed.). (1995). *Global Biodiversity Assessment*. United Nations Environment Programme. Cambridge: University Press, Cambridge.

Heywood, V.H. (1996). "*The Global Biodiversity Assessment*", The Globe, 30:2-4.

UNEP, (2002). Africa *Environment Outlook: Past, Present and Future Perspective*. England: Earthprint Limited.

UNIT 2 ECONOMIC, ECOLOGICAL AND SOCIAL VALUES OF BIOLOGICAL RESOURCES

CONTENTS

1.0 INTRODUCTION

Biological resources are the backbone of the African economy as well as the life support system for most of African. A variety of resources, both plant and animal are used for food, construction of houses, carts and boats, household utensils, clothing and as raw materials for manufactured goods. Many resources, such as timber and agricultural produce are traded commercially and others are used in traditional crafts such as basket weaving and carving.

In addition, many species with medicinal properties are harvested by local communities and pharmaceutical multinationals alike. These include the African potato (*Hypoxis rooperi*) in Southern Africa, the rosy periwinkle (*Catharanthus roseus*) from Madagascar and Mozambique, and prunus (*Prunus africana*) from Cameroon, Democratic Republic of Congo, Kenya and Madagascar. Other species provide the generic resources for improved agricultural products such as disease or drought resistant crops.

For example, an African species of rice has been used in the development of a high productivity, drought resistant variety and the native Mauritian caffeine-free Coffee species could be used to develop coffee cultivars with low caffeine content.

The richness and diversity of ecosystems in Africa also provide opportunities for tourism which many African countries have successfully exploited. The coral reefs of the Red Sea, Eastern African coast and Western Indian Ocean Islands, for instance, are among the most famous savannas of Eastern and Southern Africa are popular destinations for safari-goers.

2.0 OBJECTIVES

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

- economic and ecological values of biological resources
- environmental benefits of tropical forests resources
- social values of plants and animals.

3.0 MAIN CONTENT

3.1 Economic, Ecological and Social Values of Tropical Forests Resources

All forests have both economic and ecological value, but tropical forests are especially important in global economy. These forests cover less than 6 per cent of the Earth’s land area, but they contain the vast majority of the world's plant and animal genetic resources. The diversity of life is astonishing. The original forests of Puerto Rico, for example, contain more than 500 species of trees in 70 botanical families. By comparison, temperate forests have relatively few. Such diversity is attributed to variations in elevation, climate and soil, and to the lack of frost.

There is also diversity in other life forms: shrubs, herbs, epiphytes, mammals, birds, reptiles, amphibians and insects. One study suggests that tropical rain forests may contain as many as 30 million different kinds of plants and animals, most of which are insects (Figure 2.1).

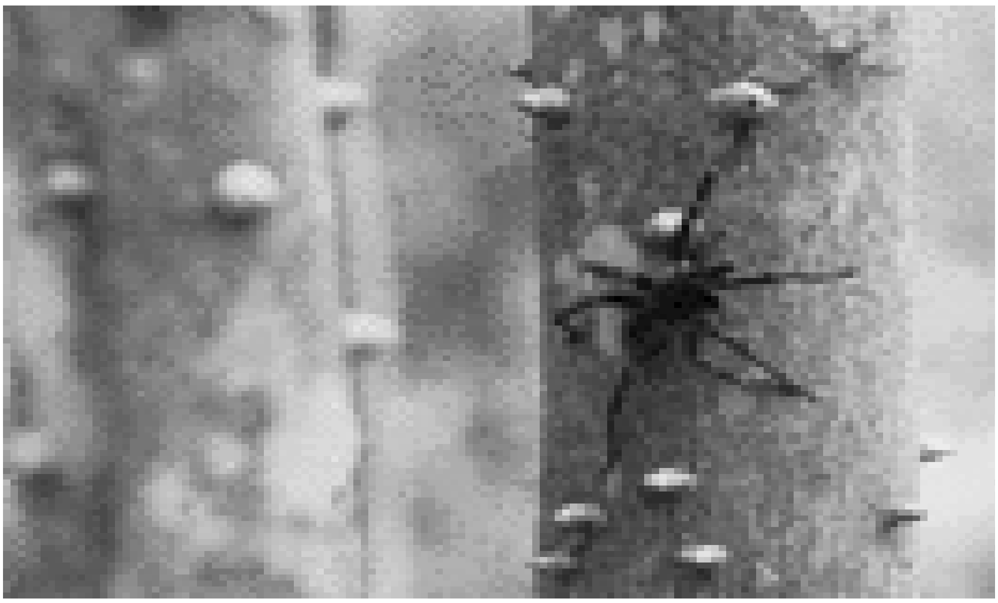

Fig. 2.1: **Example of Tropical Rain Forest Insect**

Tropical forests provide many valuable products including rubber, fruits and nuts, meat, rattan, medicinal herbs, floral greenery, lumber, firewood and charcoal (Figure 2.2). Such forests are used by local people for subsistence hunting and fishing. They provide income and jobs for hundreds of millions of people in small, medium and large industries. Tropical forests are noted for their beautiful woods (Figure 2.3).

Fig. 2.2: Rubber Tree as Source of Income

Fig. 2.3: **Tropical Forest**

Four important commercial woods are mahogany, teak, melina and okoume. Honduras mahogany (*Swietenia macrophylla),* grows in the Americas from Mexico to Bolivia. A strong wood of medium density, mahogany is easy to work, is long lasting, and has good color and grain. It is commonly used for furniture, molding, paneling and trim. Because of its resistance to decay, it is a popular wood used in boats. Teak (*Tectona grandis*) is native to India and Southeast Asia. Its wood has medium density, is strong, polishes well, and has a warm yellow-brown color. Also prized for resistance to insects and rot, teak is commonly used in cabinets, trim, flooring, furniture, and boats. Melina (*Gmelina arborea*) grows naturally from India through Vietnam. Noted for fast growth, melina has light colored wood that is used mainly for pulp and particleboard, matches and carpentry. Okoume (*Aucoumea klaineana*) is native to Gabon and Congo in West Africa (Figure 2.4).

Fig. 2.4: **Example of Tropical Forest Wood**

A large fast-growing tree, the wood has moderately low density, good strength to density ratio, and low shrinkage during drying. It is commonly used (for plywood, paneling, interior furniture parts and light construction (Figure 2.5).

Fig. 2.5: Plywood from Tropical Wood

Tropical forests are home for tribal hunter-gatherers whose way of life has been relatively unchanged for centuries. These people depend on the forests for their livelihood. More than 2.5 million people also live in areas adjacent to tropical forests. They rely on the forests for their water, fuel wood and other resources and on its shrinking land base for their shifting agriculture. For urban dwellers, tropical forests provide water for domestic use and hydroelectric power. Their scenic beauty, educational value and opportunities for outdoor recreation support tourist industries.

Many medicines and drugs come from plants found only in tropical rain forests (Figure 2.6). Some of the best known are quinine, an ancient drug used for malaria; curare, an anesthetic and muscle relaxant used in surgery; and rosy periwinkle, a treatment for Hodgkin's disease and leukemia. Research has identified other potential drugs that may have value as contraceptives or in treating a multitude of maladies such as arthritis, hepatitis, insect bites, fever, coughs and colds (Figure 2.7). Many more may be found. In all, only a few thousand species have been evaluated for their medicinal value.

Fig. 2.6: Medicinal Plants and Products as Source of Income

Fig. 2.7: **Drugs Manufactured from Tropical Medicinal Plants**

In addition, many plants of tropical forests find uses in homes and gardens: ferns and palms, the hardy split-leaf philodendron, marantas, bromeliads and orchids to name just a few.

3.2 Environmental Benefits

Tropical forests resources do more than respond to local climatic conditions, they actually influence the climate. Through transpiration, the enormous number of plants found in rain forests returns huge amounts of water to the atmosphere, increasing humidity and rainfall and cooling the air for kilometres around. In addition, tropical forests replenish the air by utilising carbon dioxide and giving off oxygen. By fixing carbon they help maintain the atmospheric carbon dioxide levels low and counteract the global “greenhouse” effect.

Forests also moderate stream flow. Trees slow the onslaught of tropical downpours, use and store vast quantities of water and help hold the soil in place. When trees are cleared, rainfall runs off more quickly, contributing to floods and erosion.

4.0 CONCLUSION

The knowledge of the values of biological resources is hinged on the benefits man derives from the use of the resources, which are the diverse importance ranging from the used for food, construction of houses, carts and boats, household utensils, clothing and as raw materials for manufactured goods.

5.0 SUMMARY

In this unit, we have learnt that:

- biological resources are the backbone of the African and global economy as well as the life support system for most people
- tropical forests, which cover less than 6 per cent of the earth’s land area and contain the vast majority of the world's plant and animal genetic resources provide varieties of benefits both to Africa and global economy
- tropical forests provide many valuable products including rubber, fruits and nuts, meat, rattan, medicinal herbs, floral greenery, lumber, firewood and charcoal
- such forests are used by local people for subsistence hunting and fishing
- they provide income and jobs for hundreds of millions of people in small, medium and large industries.

- tropical forests are home for tribal hunter-gatherers whose way of life has been relatively unchanged for centuries
- these people depend on the forests for their livelihood
- they provide educational value, and opportunities for outdoor recreation support tourist industries
- many medicines and drugs come from plants found only in tropical rain forests
- they not only influence local climate, they actually influence climate and moderate stream flow.

6.0 TUTOR-MARKED ASSIGNMENT

Highlight various economic, ecological, social and environmental benefits of tropical forests biological resources.

7.0 REFERENCES/FURTHER READING

David Tilman, Johannes Knops, David Wedin, Peter Reich, Mark Ritchie (1997). *"The Influence of Functional Diversity and Composition on Ecosystem Processes*" *Evan Siemann Science, New Series*, Vol. 277, No. 5330. pp. 1300-1302. http://links.jstor.org/sici?sici=0036-.

David S. Wilcove, David Rothstein, Jason Dubow, Ali Phillips, Elizabeth Losos (1998). *"Quantifying Threats to Imperiled Species in the United States" BioScience*, Vol. 48, No. 8. pp. 607-615. http://links.jstor.org/sici?sici=0006-.

Ros-Tonen, M.A.F. and Dietz, T. (2005). *African Forests between Nature and Livelihood Resources:* Interdisciplinary Studies in Conservation and Forest Management. Lewiston, NY: The Edwin Mellen Press.

Stoms, D., and J. Estes. (1993). *A Remote Sensing Research Agenda for Mapping and Monitoring Biodiversity*. *International Journal of Remote Sensing*, 14:1839-1860.

Stuart, L. Pimm, Gareth J. Russell, John L. Gittleman, Thomas M. Brooks (1995). *The Future of Biodiversity Science*, New Series, Vol. 269, No. 5222. pp. 347-350. http://links.jstor.org/sici?sici=0036-.

Sunderlin, W.D., Belcher, B., Santoso, L., Angelsen, A., Burgers, P., Nasi and R., Wunder, S. (2005). *'Livelihoods, Forests, and Conservation in Developing Countries:* An Overview', *World Development* (33)9: 1383-1402.

UNEP, (2002). Africa *Environment Outlook: Past, Present and Future Perspective*. England, Earthprint Limited

http://www.fao.org/english/newsroom/focus/2003/wf c3.htm – *Tapping Forests to Reduce Poverty*.

UNIT 3 BIODIVERSITY LOSS AND EXTINCTIONS

CONTENTS

1.0 INTRODUCTION

It is feared that human activity is causing massive extinctions. The previous link, to a new report from *Environment New Service* (August 2, 1999) says that "The current extinction rate is now approaching 1,000 times the background rate and may climb to 10,000 times the background rate during the next century, if present trends continue. At this rate, one-third to two-thirds of all species of plants, animals and other organisms would be lost during the second half of the next century, a loss that would easily equal those of past extinctions." Current extinction rates assume 1% destruction of rain forest per year, which gives extinction rate of 0.2 - 0.3% extinctions/year. This is equivalent to 46,000 species loss per year and 10,000 times the natural rate.

Anecdotal evidence shows that of the Fishes in North America, which is equivalent of 1000 species, 3% have gone into extinction in the last 100 years, many in SW because of loss of riparian corridors, groundwater withdrawals, dam building. Besides, Fish in Malaysia were identified to be 266 species but 122 have left. 20% of the world Birds have gone into extinction in the last 2000 years (many on islands). In Solomon Islands, 13 of 164 birds in the last 100 years have gone into extinction, as well as many in New Zealand. Of the songbirds in US there was 50% loss of population. In 1992, it was estimated that if rainforests are cut at 2%/year, by 2022, 10-22% of the species would go into extinction. In thus unit, you will know the factors (natural and human) that are responsible for the loss and extinction of biological diversity.

2.0 OBJECTIVES

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

- recall the current extinction rate of global biodiversity
- state the anecdotal evidence of biodiversity loss
- identify various human activities causing massive extinctions.

3.0 MAIN CONTENT

Africa’s biodiversity is under threat from four main sources. These are:

1. habitat destruction and fragmentation
2. high demands for biological resources
3. invasion by alien (non-native) species and
4. lack of recognition of indigenous knowledge and property rights.

3.1 Causes of Biodiversity Loss

3.1.1 Habitat Destruction and Fragmentation

As landscapes are “fragmented” by human development the patches become smaller, and can support fewer species and fewer numbers of individual members of species. Smaller patches also suffer more “edge effect”---whereby the habitat near the edge of the patch is compromised (meaning it is less useful to species who need that habitat) because processes from the “matrix” in which the patch is embedded work their way into the patch (e.g. wind, predation, pollution, etc.). This effectively reduces the patch size even further.

Natural habitats in Africa are being degraded or lost owing to a number of ‘proximate’ and ‘ultimate’ (or root) causes. Proximate causes include clearing for alternative land uses (mainly agriculture and human settlements) and over-harvesting of resources (most notably timber in the forest of Central and Western Africa).

More than 211 million hectares of African forest have been lost since 1970, amounting to almost thirty percent (30%) of the original extent. In the same period, the land area under cultivation has increased by 36 million hectares, or 21 per cent (FAOSTAT, 2000).

Other threats to terrestrial habitats include bush fire which is commonly used in agriculture to prepare the soil, but which can get out of control and destroy large areas of forest or woodland. On the other hand, fire (along with grazing) is also considered to be one of the most important factors determining the structure of savanna ecosystems (Gichohi, Gakahu and Mwangi, 1996).

The ultimate causes of habitat loss in Africa are human population growth and the resulting demand for space, food and other resources; widespread poverty; a dependence on natural resources; and economic pressures to increase exports, particularly of agricultural produce, timber and mineral products.

3.1.2 High Demands for Biological Resources

Individual species are under threat from a variety of pressures in addition to loss of their natural habitat. Recent estimates show that a total of 126 recorded animal species have become extinct in Africa, and that there are 2018 threatened animal species across the region. Some 123 plants are recorded as extinct and 1771 are threatened (IUCN, 1997).

The reasons for such high rates of species loss or endangerment include:

- habitat loss
- illegal hunting for food
- medicinal, or commercial use and
- national and international trade.

A recent study found that the bush meat trade in Central and Western Africa is contributing significantly to the decline in populations of gorillas, chimpanzees, elephants, bush pigs and forest antelopes. Bush meat is a traditional supplement to the diets of many African communities, but the increasing human populations and commercial trade are pressurizing these species to the extent of a million tones of bush meat a year (Greenwire, 2001).

Another recent study shows that activities such as logging and mining contribute significantly to improving access to previously remote areas thereby making collection from the wild more profitable. Besides, research reveals that road density is linked to habitat fragmentation, deforestation and intensified bushmeat hunting (Wikie, *et al,* 2000).

An estimated 484 plant species from 112 families are currently threatened with extinction in Nigeria, and animal species such as the Cheetah, the Pygmyape, the Hippopotamus, the Giraffe, the black Rhinoceros and the giant Eland have disappeared (Jaiyeoba, 2002).

Selective harvesting of medicinal plants is also taking its toll on species diversity and abundance. The World Health Organization (WHO) has estimated that eighty per cent (80%) of people in the developing world are reliant on traditional medicines. Eighty-five per cent (85%) of these medicines use plant extracts, so it is estimated that around 3000 million people around the world rely on plants for traditional health treatment. The number is even larger if plant derived commercial drugs are included (Sheldon *et al.*, 1997).

In Africa, eighty percent (80%) of both rural and urban populations depend on medicinal plants for their health needs (and those of their livestock) either because they prefer them for cultural or traditional reasons, because such remedies are effective in treating certain diseases, or because there is lack of affordable alternatives (Baquar, 1995, Ole Lengisugi and Mziray, 1996).

3.1.3 Invasion by Alien (non-native) Species

A further threat to biodiversity comes from invasion by non-native, or alien, species of plants and animals. These are species that have been introduced both accidentally and intentionally, and that are free from their natural predators or other natural limitations to their population growth. They are thus, able to dominate plant and animal communities, either by out-competing native species for space, light or nutrients, or through predation (UNEP, 2002, p.61).

Invasion by alien species reduces biodiversity either through predation, competition or smothering in some cases, alien plants form such dense infestations and produce so many seeds that are dispersed so widely that it is virtually impossible to control them. They also change the dynamics of the natural system and may produce toxic chemicals, inhibiting the growth of native species. In other cases, they threaten native species and functioning of ecosystems through an excessive consumption of resources such as water.

In Southern Africa, pines, eucalyptus and acacias have been introduced for commercial forestry, but have invaded natural habitats where they threaten ecological integrity by using many times more water than native species (Working for water, 2000).

Water hyacinth, a prolific weed, believed to have entered Nigeria through Benin Republic, now covers about 60 km^2 and over 30 km of Nigeria's coastal waterways and constitutes a major threat to marine life (UNEP, 2002: 134). Option to control the introduction and spread of alien species include tightening controls on importation of products of animal or plant origin. However, lack of resources to police borders and entry points, results in continued threats to biodiversity (UNEP, 2002).

Generally, factors that tend a species toward endangerment include:

1. limited range (endemic to limited areas)
2. small population (limited breeding success, and/or genetic degradation due to in-breeding)
3. isolated
4. narrow habitat requirements (habitat specificity) and
5. Non-adaptive behavior.

While the main human causes of species loss are:

1. habitat destruction and fragmentation
2. hunting (for sport and food), including illegal poaching
3. purposeful extermination
4. pollution (e.g., DDT in bird shells reduces reproduction success) and
5. introduction of exotics (may out-compete or prey on endemic species).

4.0 CONCLUSION

The knowledge of biodiversity loss and extinctions is hinged on various human activities causing massive extinctions.

5.0 SUMMARY

In this unit, we have learnt that:

- natural habitats in Africa are being degraded or lost owing to a number of ‘proximate’ and ‘ultimate’ (or root) causes
- proximate causes include clearing for alternative land uses (mainly agriculture and human settlements) and over-harvesting of resources
- the ultimate causes of are human population growth and the resulting demand for space, food and other resources; widespread poverty; a dependence on natural resources; and economic pressures to increase exports, particularly of agricultural produce, timber and mineral products
- individual species are under threat from a variety of pressures in addition to loss of their natural owing to:

a. high demand for bush meat trade as the case of Central and Western Africa

b. logging and mining
c. selective harvesting of medicinal plants.

6.0 TUTOR-MARKED ASSIGNMENT

Critically examine the impacts of proximate and ultimate factors in the loss and extinction of biodiversity.

7.0 REFERENCES/FURTHER READING

Ros-Tonen, M.A.F. and Dietz, T. (2005). *African Forests between Nature and Livelihood Resources:* Interdisciplinary Studies in Conservation and Forest Management. Lewiston, NY: The Edwin Mellen Press.

Stuart L. Pimm, Gareth J. Russell, John L. Gittleman, Thomas M. Brooks (1995). *The Future of Biodiversity Science*, New Series, Vol. 269, No. 5222. pp. 347-350. http://links.jstor.org/sici?sici=0036-

UNEP, (2002). Africa *Environment Outlook: Past, Present and Future Perspective*. England, Earthprint Limited.

UNIT 4 BIODIVERSITY CONSERVATION METHODS

CONTENTS

1.0 INTRODUCTION

There is an emerging realization that a major part of conservation of biological diversity must take place outside of protected areas and involve local communities. The extensive agricultural areas occupied by small farmers contain much biodiversity that is important for sustainable food production. Indigenous agricultural practices have been and continue to be important elements in the maintenance of biodiversity, but these are being displaced and lost. There is a new focus on the interrelationship between agro-diversity conservation and sustainable use and development practices in smallholder agriculture, with emphasis on use of farmers' knowledge and skills as a source of information for sustainable farming. In this unit, we shall consider various ways of conserving biological diversity.

2.0 OBJECTIVES

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

- explain the measures for conserving biological diversity
- state three important elements in the maintenance of biodiversity.

3.0 MAIN CONTENT

The best way to conserve biological diversity is to ensure that development activities are planned so as to minimize any impacts on it. Many past development activities have led to the degradation of land and water resources. This can lead to loss of biological diversity and loss of the opportunity to benefit from its future use. An example is the loss of an aquatic amenity and other uses through eutrophication. Effective planning and rehabilitation can allow resource development to occur in many areas without long-term adverse impacts on biological diversity. Governments, as well as industry, should provide a lead in restoration practices since they have responsibility for much of land and all marine areas. Direct beneficiaries of the use of land and water resources have a responsibility to maintain or restore the biological diversity functions of those resources. Degraded areas should be rehabilitated according to the principles and objectives of ecologically sustainable development. However, there are three general categories of measures for conserving biological diversity of forest. These are:

- protection of natural or near-natural ecosystems
- restoration and rehabilitation of degraded lands and
- *ex-situ* protection of individual species.

By far, the most important of these is protection of ecosystems, which is probably the only way to ensure maximum protection for the full range of biological diversity involved. Under some conditions, measures to restore and rehabilitate degraded lands may conserve biological diversity. These measures range from planting one or few selected species of indigenous trees to mounting complex efforts to replace a range of the pre-existing species of plants and animals. Because abused and degraded lands occupy an ever increasing area of the earth's surface, these measures are becoming increasingly important, both to restore productivity of lands for direct human use and to conserve some biological diversity. The third category of measures (*ex-situ* protection of species), for instance, in zoos, botanical gardens, aquaria, and seed banks, may be the last resort for some species when survival in their natural habitats is no longer possible, but its greatest value is probably in the context of temporary protection with the objective of eventual reintroduction in the wild.

Various forms of conservation methods have also been proposed for conserving biological diversity. Among them are:

i. Government initiatives

Ensure that policies and controls are developed and implemented by the governments for the management and conservation of native vegetation on private and public lands, in consultation with landholders and community groups, and for controlling broad-scale clearance. In accordance with the Intergovernmental Agreement on the Environment, review legislation relating to clearing and ensure that criteria for assessing land clearance applications take account of biological diversity conservation, land protection, water management and landscape values.

ii. Incentives and rebates

Undertake cooperative development of a range of measures at all levels of government, including financial incentives, cost reimbursements and rate rebates, to encourage land managers to improve conservation of native vegetation.

iii. Information program

Work through appropriate agencies to develop a native vegetation conservation information program that is targeted at land managers and focuses on the value of retaining native vegetation in-situ while integrating this retention with major land uses.

iv. Voluntary protection

Encourage voluntary management of species remnants and review the effectiveness of all mechanisms for the long-term voluntary protection of native vegetation and wildlife. The landscape ecology principles suggest several management goals, which include:

a. protection of all habitat and maintenance or recreating habitat patches as large as possible---try to improve the habitat in the patch,
b. where possible, maintain or recreate habitat patches in corridors connecting larger patches and
c. remove barriers (roads, developments, etc.) between patches -- or at least make the barriers more "permeable" to species (e.g. design roads so that species can cross them (or go under them) safely.

v. Cooperative programs

Initiate a cooperative program between the State and Local Governments in consultation with industry and community groups to rehabilitate degraded systems of national concern. The program should cover:

a. the development of improved procedures and standards for rehabilitation activities
b. investigation and trial of new mechanisms for increasing the role of the private sector in using rehabilitation to protect biological diversity (for example, in the establishment of native vegetation corridors)
c. increased funding for necessary restoration programs
d. assistance to private landholders in the form of technical support and the provision of appropriate seed stocks and
e. development of a monitoring and reporting program to determine the effectiveness of rehabilitation.

vi. Monitor and manage processes

Through sampling and other techniques, monitor processes and categories of activities that have or are likely to have significant adverse impacts on the conservation of biological diversity. Where a significant adverse effect on biological diversity is determined, regulate or manage the relevant processes and categories of activities.

vii. Strengthen assessment

Ensure that all governments make environmental, including biological diversity, impact assessment procedures an integral part of policy formulation, planning and development activities. Such procedures should take account of significant adverse impacts on biological diversity, especially when assessing the likely impact of proposals in areas considered important for biological diversity. Where undertaken, the environmental impact assessment should, if appropriate, provide for continuing monitoring and the adoption of mitigating measures. Ensure that environmental impact assessment procedures allow for informed and comprehensive public participation.

4.0 CONCLUSION

The best way to conserve biological diversity is to ensure that development activities are planned so as to minimize any impacts on it.

5.0 SUMMARY

In this unit, we have learnt that:

- there are three general categories of measures for conserving biological diversity of forest, which include:

a. protection of natural or near-natural ecosystems
b. restoration and rehabilitation of degraded lands and
c. ex-situ protection of individual species.

- all government arms should make environmental, including biological diversity, impact assessment procedures an integral part of policy formulation, planning and development activities.
- voluntary management of species remnants and review the effectiveness of all mechanisms for the long-term voluntary protection of native vegetation and wildlife should be encouraged.

6.0 TUTOR-MARKED ASSIGNMENT

Discuss various methods of conserving biological diversity

7.0 REFERENCES/FURTHER READING

Global Environmental Change (1995). Human and Policy Implications. Special issue on *People, Land Management and Environmental Change*, Vol. 3, No. 4.

Uitto, Juha I. and Akiko Ono (eds). (1996). *Population, Land Management and Environmental Change*. The United Nations University, Tokyo.

UNEP (2002). *Africa Environment Outlook: Past, Present and Future Perspective*. England, Earthprint Limited

UNIT 5 PROTOCOL ON BIODIVERSITY CONSERVATION

CONTENTS

1.0 INTRODUCTION

In addition to actions necessary to conserve biological diversity directly, there is a need for a range of supporting measures that can minimise the impact of various external factors on biological diversity. In June 1992, the Earth Summit in Rio de Janeiro, Brazil was convened. There was an agreement on a set of "Principles for a global consensus on the management, conservation and sustainable development of all types of forests and marine ecosystem. The conference devoted some chapters of its Agenda to "Combating deforestation" and Pollution of the Sea. The articles of the conference supporting biological diversity conservation are highlighted in this chapter.

2.0 OBJECTIVES

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

- state the aim of the protocol
- describe scope of the protocol
- explain duties of the contracting parties as regards conservation of biodiversity.

3.0 MAIN CONTENT

Recognising that in recent decades there have been significant human induced changes in the biota and **physico**-chemical conditions of the Sea and forest ecosystem; there have been concern on various **threats** to biodiversity, such as eutrophication, over-fishing, pollution and introduction of non-native species. Accepting the importance of control on the Sea and threats to forest ecosystem for the conservation of biodiversity and the maintenance and restoration of ecosystem functions; various articles were signed in the Earth Summit held in Rio de Janeiro, Brazil on June 5, 1992. The Contracting Parties are required to pay particular attention to Combating deforestation" and Pollution of the Sea and Atmosphere.

3.1 Aim of Protocol

The purpose of this Protocol is to maintain ecosystem in the good ecological state and its landscape in the favourable conditions, to protect, to preserve and to sustainably manage the biological and landscape diversity in order to enrich the biological resources.

3.2 Scope of the Protocol

In conjunction with provisions of the Convention on the Protection of marine ecosystem against Pollution and other Protocols to this Convention, the Protocol is intended to serve as a legal instrument for developing, harmonising and enforcing necessary environmental policies, strategies and measures in preserving, protecting and sustainably managing nature, historical, cultural and aesthetic resources and heritage for present and future generations.

3.3 Articles of the Protocol

3.3.1 Definition of Terms

Article 1

1. **Biological diversity** means variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems as defined by Article 2 of the Convention on Biological Diversity.
2. **Landscape** means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors as defined in the Chapter I, the article 1 of European Landscape Convention (October 20, 2000, Florence, Italy).
3. **Landscape Diversity** means the formal expression of the numerous relations existing in a given period between the individual or the society and a topographically defined territory, the appearance of which is the result of the action, over time, of natural and human factors and a combination of both.

3.3.2 Duties of contracting party

The duties of the contracting parties are highlighted in Articles 2-10

Article 2

1. Each Contracting Party shall take all necessary measures to:

i. protect, preserve, improve and manage in a sustainable and environmentally sound way areas of particular biological or landscape value, notably by the establishment of protected areas
ii. ensure that species occurring in the area to which this Protocol applies are maintained at favourable conservation status and habitats close to undisturbed
iii. ensure that species of economic importance, especially living marine resources, are used sustainably
iv. restore and rehabilitate damaged areas of previously high biodiversity and landscape value
v. restore and maintain in good conditions the landscape of high nature, historical, cultural and aesthetic value.

2. The Contracting Parties shall identify and compile inventories of the components of biological and landscape diversity in the area to which this Protocol applies and identify those components important for their conservation and sustainable use within three years of this Protocol coming into force.

3. The contracting parties shall adopt a list of species of economic importance, which may be threatened or important by reason of their role in ecosystem functioning or other significance for the region preferably within three years of this protocol coming into force.

4. The Contracting Parties shall adopt a list of landscapes and habitats of the Black Sea importance that may be destroyed, or important by their nature, cultural or historical value that constitute the natural, historical and cultural heritage or present other significance for the Black Sea region preferably within three years of this Protocol coming into force.

Article 3

5. The Contracting Parties shall act, directly or in co-operation with competent international organisations and in consistency with other Protocols to this Convention, in the conservation and sustainable use of biological and landscape diversity.

6. The Contracting Parties shall produce and commonly agree on the Strategic Action Plan for the marine Biodiversity and Landscape Conservation Protocol within three years of the Protocol coming into force which shall be reviewed every five years

7. On the basis of the Strategic Action Plan for the marine Biodiversity and Landscape Conservation Protocol, the Contracting Parties shall adopt strategies, national plans and/or programmes for the conservation of biological and landscape diversity and the sustainable use of marine and coastal biological and landscape resources and shall integrate them into their national sectoral and intersectoral policies.

8. The Contracting Parties shall take all appropriate measures to regulate an intentional introduction and prevent an accidental introduction of non-indigenous species or genetically modified organisms to the wild flora and fauna and prohibit those that may have harmful impacts on the ecosystems, habitats or species in the area to which this Protocol applies.

9. The Contracting Parties shall endeavour to implement all appropriate measures to eradicate or reduce to a possible level species that have already been introduced when it appears that such species cause or are potentially causing damage to ecosystems, landscapes, habitats or species in the area to which this Protocol applies.

Article 4

1. In implementing this Protocol, the Contracting Parties shall take into account the traditional subsistence and cultural activities of local communities. They may grant exemptions from protection and conservation measures, as necessary, and where appropriate, to meet such needs. No exemption which is allowed for this reason shall:

i. endanger either maintenance of landscapes of high aesthetic value or the ecosystems protected under this Protocol or the biological processes contributing to the maintenance of those ecosystems,

ii. cause a substantial reduction in the number of individuals making up the populations of species of flora and fauna, in particular threatened, migratory or endemic species, destruction of their habitats or landscapes, especially ones of regional importance and

iii. cause an irreversible damage of the landscapes constituting the nature, cultural, historical, or aesthetic heritage of the marine importance.

2. A Contracting Party which grants exemptions from the protection measures shall inform the other Contracting Parties accordingly, within one month period.

Article 5

1. The Contracting Parties shall endeavour to inform the public of the value of protected areas, species and landscapes and shall give appropriate publicity to the establishment of these areas and regulations relating thereto.

2. The Contracting Parties shall also endeavour to promote the participation of all stakeholders including their public in measures that are necessary for the protection of the areas, species and landscapes concerned, including environmental impact assessments.

3. The Contracting Parties shall endeavour to provide information on this Protocol and related matters through appropriate education and public awareness programmes.

Article 6

1. The Contracting Parties shall co-operate in conducting scientific research aimed at protecting and preserving the biological and landscape diversity and shall undertake, where appropriate, joint programmes and projects of scientific research and exchange relevant scientific data and information.

2. The subsidiary bodies of the Commission (the Advisory Group on the Conservation of Biological Diversity and the Advisory Group on the Development of Common Methodology for Integrated Coastal Zone Management) in co-operation with the competent national authorities of the Sea coastal states shall be responsible for scientific activities and monitoring and assessment in the field of the biological and landscape diversity, delegating the co-ordination of their work.

3. The Contracting Parties will invite intergovernmental organisations to co-operate with the Contracting Parties and/or the Commission by preparing and implementing specific programmes and projects, with a view to fulfilling the objectives of the Protocol.

Article 7

1. The Contracting Parties are responsible for the fulfilment of their international obligations concerning the protection and conservation of the biological and landscape diversity.

2. Each Contracting Party shall adopt rules and regulations on the liability for damage caused by natural or juridical persons to the biological and landscape diversity in areas where it exercises, in accordance with international law, its sovereignty, sovereign rights or jurisdiction.

3. The Contracting Parties shall facilitate any legal action or procedure in accordance with their legal systems aiming at prompt and adequate compensation or other relief for damage caused by pollution or human activities to the biological and landscape diversity by natural or juridical persons under their jurisdiction.

4. The Contracting Parties shall co-operate in developing and harmonising their laws, regulations and procedures relating to liability, assessment of and compensation for damage caused by human activities and/or pollution of the marine environment of the Black Sea, in order to ensure the highest degree of deterrence and protection for the biological and landscape diversity as a whole.

Article 8

Each Contracting Party shall provide, in accordance with its capabilities, financial support and incentives of those national/regional activities which are intended to achieve the objectives of this Protocol, in accordance with their national plans, priorities and programs.

Article 9

1. The Commission and its Permanent Secretariat shall promote the implementation of this Protocol, inform the Contracting Parties of its work and make recommendations on measures necessary for achieving the aims of this Protocol.

2. The Commission shall report on the state of the biological and landscape diversity and efficacy of undertaken measures to preserve and manage it to the Meeting of the Contracting Parties on five years basis in a jointly agreed reporting format.

Article 10

1. Nothing in this Protocol nor any act adopted on the basis of this Protocol shall prejudice the rights and the interests of any state in full compliance with the international law, in particular, the nature and extent of marine areas, the delimitation of marine areas between States, with opposite or adjacent coasts, freedom of navigation on the high seas, the right and modalities of passage through straits used for international navigation, as well as the nature and extent of the jurisdiction of the Coastal State, the Flag State and the Port State.

2. No act or activity undertaken on the basis of the Protocol shall constitute grounds for claiming, contending or disputing any claims to national sovereignty, sovereign rights or jurisdiction.

3. Each Contracting Party shall apply the measures provided for in this Protocol without prejudice to the sovereignty, sovereign rights or the jurisdiction of other Contracting Parties or other States. Any measures taken by a Contracting Party to enforce these measures shall be in accordance with international law.

4.0 CONCLUSION

Biological diversity conservation can often be affected by planning and development decisions and actions. These effects sometimes occur as a result of inadequate information or a lack of sensitive application of policies on the part of the public and private sectors. Although environmental impact assessment procedures have been developed in various countries of the world, the application and scope of these procedures vary considerably between jurisdictions. To redress this problem, overseen the development of common principles for environmental impact assessment and developing guidelines and criteria for determining the need for and level of such assessment should be put in place. Assessment of individual projects cannot always anticipate cumulative environmental impacts. Assessment of broader policies and programs that are likely to significantly affect biological diversity, together with bioregional environmental planning with appropriate development controls, can help overcome this problem.

5.0 SUMMARY

In this unit, you have learnt that:

- in June 1992, the Earth Summit in Rio de Janeiro, Brazil was convened and was meant to discuss the earth resources and the management, conservation and sustainable development of those earth biological resources
- the Protocol of the convention is intended to serve as a legal instrument for developing, harmonising and enforcing necessary environmental policies, strategies and measures in preserving, protecting and sustainably managing nature, historical, cultural and aesthetic resources and heritage for present and future generations
- the meaning of Biological diversity, Landscape and Landscape Diversity were clearly spelt out in the conference
- Articles which dictated the duties of the contracting countries were clearly articulated and signed by participatory countries.

6.0 TUTOR-MARKED ASSIGNMENT

1. Critically examine the content of Articles 3 and 4
2. Differentiate between Biological diversity, Landscape and Landscape Diversity.

7.0 REFERENCES/FURTHER READING

Conservation International (1999). *Conservation Priority Setting for the Upper Guinea forest Ecosystem, West Africa, Conservation International*, Washington DC.

Conservation International (2002). **ww.conservation.org/**sp/CIWEB/strategy/hotpots/guinean_forest.xml.

Mastrantonio J. L. and Francis J. K. (2003). *A Student Guide to Tropical Forest Conservation* ENVIS Bulletin: Himalayan Ecology 11(2).

Heywood, V.H. (1996). "*The Global Biodiversity Assessment*". The Globe, 30:2-4, April.

http://www.globalissues.org/EnvIssues/Biodiversity/Loss.asp

MODULE 2

UNIT 1 ENVIRONMENTAL POLLUTION AND BIODIVERSITY LOSS

CONTENTS

1.0 INTRODUCTION

Pollution continues to be an increasing problem for the conservation of biological diversity. River systems and near-shore environments are at particular risk. Localised impacts have occurred and their frequency is increasing. A number of river systems suffer from increasing salinity, silt loads, nutrient levels and heavy metal and chemical pollution. Pollution of groundwater has adverse effects on ecosystems in both urban and rural environments. The Environment Protection Agency is developing a National Pollutant Inventory and recommendations for standards and, once reflected in State and Territory control measures, this should help to minimise the impacts of pollution. The use of some agricultural, industrial and urban chemicals continues to cause problems for wildlife, including cumulative effects. Sewage discharge into the sea has a localised impact on biological diversity. In this unit, you will learn ways by which pollution affect biodiversity and measures for ambient air quality and ambient marine, estuarine and freshwater quality.

2.0 OBJECTIVES

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

- identify different types of pollution
- explain the effects of industrial pollution of biodiversity
- state some controlling measures of pollution on biodiversity conservation.

3.0 MAIN CONTENT

Environmental pollution is the unfavourable alteration of our surroundings, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundances of organisms. These changes may affect man directly or through his supplies of water and of agricultural and other biological products, his physical objects or possessions or his opportunities for recreation and appreciation of nature.

Industrial activities generally have varying degrees of social, economic and environmental consequences. These consequences are both positive and negative, the latter being more rampant and widespread than the former. Industrial pollution and environmental degradation due to industrial activities have been a concern of the world in recent times. This is because of the levels of damage caused by the effluents generated by the industrial establishment to both natural and social environment.

Recently in Northern Europe, industrial pollutants in the form of acid rain has eroded structures, injured crops and forests and threatened the lives and habitats of the local wildlife. In 1984, it was reported that 50% of the trees in Germany's Black forest had been destroyed by acid rain. In China, rapid industrial growth has led to a dramatic rise in environmental damage from industrial pollution. Today, nearly 40% of China's mainland is affected by industrial pollution due to industrial emissions; a figure scientists expect will continue to rise. Industrial growth and its associated environmental problem such as soil, plant, and air contamination is fast increasing. Reports of general soil, plants, and water quality contaminations in several cities in Nigeria abound with effect.

3.1 Methods of Waste Management and Disposal

There are various methods of waste management and disposal being applied by industrial establishments, one of these methods is known as the End-of-pipe Approach.

End-Of-Pipe (EOP) Approach

This does not encourage waste reduction, but rather seeks to introduce technology at the production line to prevent waste from becoming pollution. Some modes of EOP include: land filling, land application, containment and extraction technologies.

As the name implies, land filling involves filling the land with waste in thin layers, pollution of surface and ground water is minimised by lining and contouring the fill, compacting and planning the cover, selecting the proper soil and placing waste in a site not subject to flooding or high ground water levels. However, land filling still does have its problems, which include poor litter control, dust, birds, vermin and insects, also noise pollution from the heavy machinery in use.

Containment technologies are used to stop the further spread of migration of contaminants, while extraction technologies, which are also known as the removal of constituents from a site, either vapour or solids through pumping, product recovery, vapour extraction and soil washing. However, these forms of treatment are very expensive and not very reliable.

All these waste management strategies still pose serious threat to biodiversity conservation. For instance, draining or in-filling of wetlands changes hydrological regimes so that they no longer provide suitable habitats for wildlife. Untreated effluents from domestic, commercial and industrial sources have polluted coastal wetlands creating a toxicity risk for flora and fauna.

Waste Minimisation Approach

Another approach to dealing with wastes is Waste Minimisation of Pollution Prevention. In his appeal for the use of waste minimisation as against land-filling techniques, William Reilly (1990) said, “We have learned the inherent limitations of treating and burning wastes. A problem solved in one part of the environment may become a new problem in another part. We must curtail pollution closer to its point of origin so that it is not transformed from place to place”.

Waste minimisation, though not a new concept, due to the fact that it has been practiced in the United States, Europe and the developed world, has only begun to make rounds in the developing world. Studies have further brought to the fore sustainable waste management techniques; waste minimisation has become a key component of national waste management strategies across the world as a result of this. Obviously, if the production of waste is reduced, potential for long term environmental damage is reduced accordingly. Some methods of waste minimisation being practised include the following.

- Waste re-cycling/re-use: though not a form of waste minimisation per se, recycling is accepted as an effective form of waste reduction and is gaining ground in the developing world, such as in South America and India.
- Combustion as Fuel: Combustion of waste as fuel is seen by many as a preferable alternative to landfill, where appropriate, and has received much support, but according to Wallis and Watson (1995), 2 – 5 times the amount of energy renewable by combustion of wastes is recovered by recycling.
- Composting: aerobic microbial process which depends on organic matter to produce a relatively stabilised residue, CO_2 as the main gaseous product.

Much of our native flora and fauna has evolved with fire and relies upon particular fire regimes for continued survival. With settlement, however, the timing, frequency and intensity of these fires have changed.

Although fire is a necessary part of many ecosystems, it can also be damaging. Inappropriate fire regimes - for example, fires of high or low intensity that are either too frequent or insufficiently frequent - can lead to loss of native species, communities and ecosystems. Burning can promote invasion of native vegetation by weeds, sometimes leading to increased fire hazard within a short time, and prescribed fires can escape to become wildfires.

3.2 Impact of Industrial Pollution on Biodiversity

The issue of the impact of industrial establishments on their physical environment has been severally discussed in various academic quarters. As a result of this, scholars have deduced a number of theories and models in order to explain these impacts. Few of these theories that are related to the impacts of industrial pollution in the environment are discussed.

Industrial Pollution is not a new problem to man. It can be traced back to the industrial revolution of the early 19^{th} Century. But even as far back as 14^{th} Century England, the dangers of pollution were already being given centre stage treatment when King Edward II of England (1307 – 1327) tried to abate Britain's 'unbearable smoke' by prohibiting the burning of coal. This was perhaps one of the first government interventions as regards the issue of pollution.

Abduli (1996) defined Industrial pollutants as all wastes arising from industrial operation or desire from the manufacturing process. Now the wastes in themselves do not constitute pollutants, but the mismanagement of these wastes is what leads to industrial pollution. From the review of the literature, most scholars agree that industrial waste in the developing countries are left untreated and are disposed of in an unsafe manner e.g. illegal dumping, open-dumping into lakes and rivers causing biodiversity loss and extinction.

This scenario has been blamed on the rapid unplanned growth of the urban and industrial centres in the developing countries, which creates stress on the natural. Pollution and other forms of degradation, and the continuing spread of urbanisation vis-à-vis industrialisation poses a threat to the sustainability of soil resources, it is generally accepted that most of the soils in the technologically advanced regions of the world are polluted at least to a slight extent. The source of this pollution is the mismanagement of waste disposal services, old industrial sites are generally characterised by being heterogeneous, both with regard to the distribution of pollutants and also to properties of the soil materials that control the behaviour of chemicals (soil pollutants), another source is through the process of land filling, a type of industrial waste management system adopted by most industrial establishments.

Land- filling creates such problems as landfill gas and land fill leachate, and this leachate is what provides the most prominent source of pollution for the soil. The leachate is made up of soluble components of waste and the soluble intermediates and products of waste degradation, which enters the water table and soil as it percolates through the waste body. The amount of leachate generated is dependent on water availability, landfill surface conditions, the state of refuse and the conditions in the surrounding strata.

Chemical pollution from industrial establishments has been estimated by a recent Global Assessment of Soil Degradation (GLASOD) to affect a total of 218×10^6 ha of land in Europe, Asia, Africa and Central America. Some of the major sources of pollution i.e. chemical pollutants from industries are the heavy metals e.g. Copper (Cu), Manganese (Mn),

Nitrogen (N), zinc (Zn), Silver (Ag), Barium (Ba), Mercury (Hg), Lead (Pb), etc., which are hazardous to plants and animal species.
Industries involved in the following activities:

1. Metalliferous Mining e.g. Cd, Cu, N, Pb and Zn
2. Metal Smelting and Metallurgical Industries
3. The electronic industry; making of circuits, solders, batteries in gaseous or solid waste form.

Pollutants here include aerosol particles from the thermal processing of metals and solid wastes, effluents from the treatment of metals with acids.

Other forms of pollutants include hydrocarbons from petroleum comprising a range of saturated alkanes from methane (CH_4), ethane (C_2H_6) and Propane (C_3H_8) etc. As such, leakages from Industrial sites are a major industrial issue as Hydrocarbon solvents are widely used in industry for clearing and de-greasing metals and electrical components. Toxic Organic Micro-pollutants also form a major part of industrial pollutants e.g. insecticides, herbicides, fungicides, etc which pose serious threat to biodiversity.

Between 60,000 to 90,000 chemicals are being used in industry although not all are hazardous, many will cause pollution as a result of leakage during storage, from use in the environment or disposal either directly or of wastes containing them. As at 1990, the total world production of hazardous and special wastes was 338 x 10^6 tonnes according to the Organization for Economic Cooperation and Development (OECD) on the state of the environment in Paris, 1991.

Pollution Control

In advanced countries, environmental monitoring agencies are more effective and environmental laws are strictly followed. General environmental quality monitoring is compulsory and the monitoring of the quality of natural and social environment is done on a regular basis. As a result, any abnormal changes in the environment can easily be detected and appropriate action taken before the outbreak of epidemics or biodiversity loss. The case is quite the opposite in many developing countries. Environmental laws where there are any, are rarely observed.

In Europe, various protocols have been adopted to stem the tide of industrial pollution. The first Sulphur Protocol in Europe produced by the United Nations Economic Commission for Europe (UNECE) in 1985 called for the reduction of sulphur emissions to 70% of 1980 levels by 1993. Other protocols adopted include the Nitrogen Oxides Protocol, the Volatile Organic Compounds Protocol (1991) and the 2^{nd} Sulphur Protocol (1994).

Federal, State and Local Government should develop new pollution prevention and control measures, including market measures and national standards to minimise the impacts of pollution on biological diversity. This will require:

a. reviewing legislation and guidelines to ensure that criteria for minimising significant adverse impacts on the conservation of biological diversity are included as part of the basis for pollution prevention and control measures. Particular attention should be paid to non-point-source pollution, industrial pollution, control of the discharge of sewage, waste minimisation and accident prevention, and the need for a catchments or bioregional approach in implementation,
b. strengthening measures to deal with activities or processes that result in detrimental changes to the physical environment of organisms, such as the potentially damaging discharge of dam water,
c. strengthening the systems of control for the manufacture, importation and use of chemicals where scientific evidence shows that these chemicals adversely affect biological diversity, with a view to minimising their impacts.

4.0 CONCLUSION

The overall assessment of all impacts of industrial establishments on biodiversity loss is unprecedented. Legislation and guidelines to ensure that criteria for minimising significant adverse impacts on the conservation of biological diversity should be put in place as part of the basis for pollution prevention and control measures.

5.0 SUMMARY

In this unit, you have learnt that:

- environmental pollution is the unfavourable alteration of our surroundings, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundances of organisms
- industrial activities generally have varying degrees of social, economic and environmental consequences, which could be both positive and negative

- industrial pollution are in form of waste disposal, land filling, chemical pollution in form of heavy metals, hydrocarbons from petroleum etc
- industrial pollutants in the form of acid rain has eroded structures, injured crops and forests and threatened the lives and habitats of the local wildlife
- industrial growth and its associated environmental problem such as soil, plant, and air contamination is fast increasing and pose serious threat to biological diversity
- various methods of waste management and disposal being applied by industrial establishments still affect flora and fauna
- rapid unplanned growth of the urban and industrial centres in the developing countries, creates stress on the natural environment
- in advanced countries, environmental monitoring agencies are more effective and environmental laws are strictly followed
- the case is quite the opposite in many developing countries and where environmental laws are in place, they are rarely observed
- Federal, State and Local Government should develop new pollution prevention and control measures, including market measures and national standards to minimise the impacts of pollution on biological diversity.

6.0 TUTOR-MARKED ASSIGNMENT

Discuss why biological diversities are still being threatened by environmental pollution in a named developing country in spite of different environmental laws and environmental protection agencies in place.

7.0 REFERENCES/FURTHER READING

Abduli, M.A. (1996). Industrial Waste Management in Tehran, in: *Environmental International,* v. 22 (3): 335-341.

Biney, C., Amuzu, A. T., Calamari, D., Kaba, N., Mbome, I. L., Naeve, H., Ochumba, P. B. O., Osibanjo, O., Radegonde, V., Saad, M.A. H. 1994. Review of Heavy Metals in the African Aquatic Environment. *Ecotoxicology and Environmental Safety* 28, 134-159.

Catlow & Thirlwell (1976). *Environmental Impact Analysis*, Department of Environment Research Report II, London

Fakayode, S. O. and Onianwa, P. C. (2002). *Heavy Metals Contamination of Soil and Bioaccumulation in Guinea Grass*

(Panicum maximum) Around Ikeja Industrial Estate, Lagos, *Nigeria Environmental Geology* 43, 145-150.

Fakayode, S.O. (2005). *Impact Assessment of Industrial Effluent on Water Quality of the Receiving Alaro River in Ibadan, Nigeria*; Baylor University, U.S.A.

Onianwa, P. C. (1993). *Environmental Pollution Studies in an Underdeveloped Country* (I): Heavy Metal Pollution in Ibadan, Nigeria. *International Journal of Environmental Education and Information* 12, 25-34.

Olajire, A. A., and Imeokparia, F. E. (2001). *Water Quality Assessment of Osun River*: Studies on Inorganic Nutrients. *Environmental Monitoring and Assessment* 69, 17-28.

United States Environmental Protection Agency (USEPA) (2000). 2000 *National Water Quality Inventory*. http://www.epa.gov/305b/ 2000report/ (Retrieved August 6, 2003).

United States Geological Survey (USGS) (1995). *Water Used in the United States. U.S. Geological Survey*. http://water.usgs.gov/ watuse/ (Retrieved August 6, 2003).

Westlake (1995). *Landfill Waste Pollution and Control*, Albion Publishing, London

UNIT 2 CLIMATE CHANGE AND BIODIVERSITY

CONTENTS

1.0 INTRODUCTION

Weather is the day-to-day state of the atmosphere, and is a chaotic non-linear dynamical system. On the other hand, *climate* is the average state of weather which is fairly stable and predictable. Climate includes the average temperature, amount of precipitation, days of sunlight, and other variables that might be measured at any given site. However, there are also changes within the Earth’s environment that can affect the climate. Climate changes reflect variations within the Earth’s atmosphere, processes in other parts of the Earth such as oceans and ice caps, and the effects of human activity. The external factors that can shape climate are often called climate forcing and include such processes as variations in solar radiation, the Earth's orbit, and greenhouse gas concentrations. In this unit, the drivers of climate change are considered.

2.0 OBJECTIVES

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

- define climate change
- differentiate between climate change and global warming
- identify and explain the drivers of climate change.

3.0 MAIN CONTENT

3.1 Definition of Climate Change

The term Climate Change is used to refer to changes in the Earth's climate. Generally, this is taken to regard changes in temperature, by monitoring averages, extremes, durations, and geographic coverages. Climate change is the variation in the Earth's global climate or in regional climates over time. It involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years. These changes can be caused by dynamic process on Earth, external forces including variations in sunlight intensity, and more recently by human activities. 'Climate change' is caused by natural forces including, but not limited to, human activities.

3.2 Difference between Climate Change and Global Warming

When scientists talk about the issue of climate change, their concern is about global warming caused by human activities. The terms global warming and climate change are often used interchangeably, but the two phenomena are different. Global warming is the rise in global temperatures due to an increase of heat-trapping carbon emissions in the atmosphere. Climate change, on the other hand, is a more general term that refers to changes in many climatic factors (such as temperature and precipitation) around the world.

These changes are happening at different rates and in different ways. For example, the United States has become wetter over the 20th century, while the Sahel region of central Africa has become drier.

3.3 Factors Driving Climate change

3.3.1 Changes within the Earth’s Environment

There are changes within the Earth's environment that can affect the climate; among them are:

a. Glaciation

Glaciers are recognised as being among the most sensitive indicators of climate change, advancing substantially during climate cooling (e.g., the Little Ice Age) and retreating during climate warming on moderate time scales. Glaciers grow and collapse, both contributing to natural variability and greatly amplifying externally forced changes. For the last century, however, glaciers have been unable to regenerate enough ice during the winters to make up for the ice lost during the summer months.

The most significant climate processes of the last several million years are the glacial and interglacial cycles of the present ice age. Though shaped by orbital variations, the internal responses involving continental ice sheets and 130 m sea-level change certainly played a key role in deciding what climate response would be observed in most regions. Other changes, including Heinrich events, Dansgaard–Oeschger events and the Younger Dryas show the potential for glacial variations to influence climate even in the absence of specific orbital changes.

b. Ocean Variability

On the scale of decades, climate changes can also result from interaction of the atmosphere and oceans. Many climate fluctuations — including not only the El Niño Southern oscillation (the best known) but also the Pacific decadal oscillation, the North Atlantic oscillation, and the Arctic oscillation — owe their existence at least in part to different ways that heat can be stored in the oceans and move between different reservoirs. On longer time scales ocean processes such as thermohaline circulation play a key role in redistributing heat, and can dramatically affect climate.

c. The Memory of Climate

More generally, most forms of internal variability in the climate system can be recognised as a form of hysteresis, meaning that the current state of climate reflects not only the inputs, but also the history of how it got there. For example, a decade of dry conditions may cause lakes to shrink, plains to dry up and deserts to expand. In turn, these conditions may lead to less rainfall in the following years. In short, climate change can be a self-perpetuating process because different aspects of the environment respond at different rates and in different ways to the fluctuations that inevitably occur.

3.3.2 Non-Climate Factors Driving Climate Change

d. Greenhouse Gases

Current studies indicate that radioactive forcing by greenhouse gases is the primary cause of global warming. Greenhouse gases are also important in understanding Earth’s climate history. According to these studies, the greenhouse effect, which is the warming produced as greenhouse gases trap heat, plays a key role in regulating Earth's temperature.

Over the last 600 million years, carbon dioxide concentrations have varied from perhaps >5000 ppm^3 to less than 200 ppm^3, due primarily to the effect of geological processes and biological innovations. It has been argued that variation in greenhouse gas concentrations over tens of millions of years have not been well correlated to climate change, with plate tectonics perhaps playing a more dominant role. More recently CO_2-climate has been correlation to derive a value for the climate sensitivity. There are several examples of rapid changes in the concentrations of greenhouse gases in the Earth's atmosphere that do appear to correlate to strong warming, including the Paleocene–Eocene thermal maximum, the Permian–Triassic extinction event, and the end of the Varangian snowball earth event.

During the modern era, the naturally rising carbon dioxide levels are implicated as the primary cause of global warming since 1950. According to the Intergovernmental Panel on Climate Change (IPCC), (2007), the atmospheric concentration of CO_2 in 2005 was 379 ppm^3 compared to the pre-industrial levels of 280 ppm^3. Thermodynamics and Le Chatelier's principle explain the characteristics of the dynamic equilibrium of a gas in solution such as the vast amount of CO_2 held in solution in the world's oceans moving into and returning from the atmosphere. These principles can be observed as bubbles which rise in a pot of water heated on a stove, or in a glass of cold beer allowed to sit at room temperature; gases dissolved in liquids are released under certain circumstances.

e. Plate Tectonics

On the longest time scales, plate tectonics will reposition continents, shape oceans, build and tear down mountains and generally serve to define the stage upon which climate exists. More recently, plate motions have been implicated in the intensification of the present ice age when, approximately 3 million years ago, the North and South American plates collided to form the Isthmus of Panama and shut off direct mixing between the Atlantic and Pacific Oceans.

f. Solar Variation

The sun is the ultimate source of essentially all heat in the climate system. The energy output of the sun, which is converted to heat at the Earth's surface, is an integral part of shaping the Earth’s climate. On the longest time scales, the sun itself is getting brighter with higher energy output, as it continues its main sequence, this slow change or evolution affects the Earth's atmosphere. It is thought that, early in Earth's history, the sun was too cold to support liquid water at the Earth’s surface, leading to what is known as the Faint young sun paradox.

On more modern time scales, there are also a variety of forms of solar variation, including the 11-year solar cycle and longer-term modulations. However, the 11-year sunspot cycle does not manifest itself clearly in the climatological data. Solar intensity variations are considered to have been influential in triggering the Little Ice Age, and for some of the warming observed from 1900 to 1950. The cyclical nature of the sun's energy output is not yet fully understood, it differs from the very slow change that is happening within the sun as it ages and evolves.

g. Orbital Variations

In their effect on climate, orbital variations are in some sense an extension of solar variability, because slight variations in the Earth's orbit lead to changes in the distribution and abundance of sunlight reaching the Earth's surface. Such orbital variations, known as Milankovitch cycles, are a highly predictable consequence of basic physics due to the mutual interactions of the Earth, its moon, and the other planets. These variations are considered the driving factors underlying the glacial and interglacial cycles of the present ice age. Subtler variations are also present, such as the repeated advance and retreat of the Sahara desert in response to orbital precession.

h. Volcanism

A single eruption of the kind that occurs several times per century can affect climate, causing cooling for a period of a few years. For example, the eruption of Mount Pinatubo in 1991 affected climate substantially. Huge eruptions, known as large igneous provinces, occur only a few times every hundred million years, but can reshape climate for millions of years and cause mass extinctions. Initially, scientists thought that the dust emitted into the atmosphere from large volcanic eruptions was responsible for the cooling by partially blocking the transmission of solar radiation to the Earth's surface. However, measurements indicate that most of the dust thrown in the atmosphere returns to the Earth's surface within six months.

Volcanoes are also part of the extended carbon cycle. Over very long (geological) time periods, they release carbon dioxide from the earth's interior, counteracting the uptake by sedimentary rocks and other geological carbon dioxide sinks. However, this contribution is insignificant compared to the current anthropogenic emissions. The US Geological Survey estimates that human activities generate more than 130 times the amount of carbon dioxide emitted by volcanoes.[2]

3.3.3 Human Influences on Climate Change

Anthropogenic factors are human activities that change the environment and influence climate. In some cases the chain of causality is direct and unambiguous (e.g., by the effects of irrigation on temperature and humidity), while in others it is less clear. Various hypotheses for human-induced climate change have been debated for many years. In the late 1800s, the "rain follows the plow" idea had many adherents in the western United States.

The biggest factor of present concern is the increase in CO_2 levels due to emissions from fossil fuel combustion, followed by aerosols (particulate matter in the atmosphere), which exert a cooling effect, and cement manufacture. Other factors, including land use, ozone depletion, animal agriculture and deforestation, also affect climate.

i. Fossil Fuels

Carbon dioxide variations over the last 400,000 years show a rise since the industrial revolution. Beginning with the industrial revolution in the 1850s and accelerating ever since, the human consumption of fossil fuels has elevated CO_2 levels from a concentration of ~280 ppm to more than 380 ppm today. These increases are projected to reach more than 560 ppm before the end of the 21st century. It is known that carbon dioxide levels are substantially higher now than at any time in the last 750,000 years.[4] Along with rising methane levels, these changes are anticipated to cause an increase of 1.4–5.6 °C between 1990 and 2100. (see global warming).

j. Aerosols

Anthropogenic aerosols, particularly sulphate aerosols from fossil fuel combustion, exert a cooling influence. This, together with natural variability, is believed to account for the relative "plateau" in the graph of 20th-century temperatures in the middle of the century.

k. Cement Manufacture

Cement manufacturing is the third largest cause of man-made carbon dioxide emissions. Carbon dioxide is produced when calcium carbonate ($CaCO_3$) is heated to produce the cement ingredient calcium oxide (CaO, also called *quicklime*). While fossil fuel combustion and deforestation each produce significantly more carbon dioxide (CO_2), cement-making is responsible for approximately 2.5% of total worldwide emissions from industrial sources (energy plus manufacturing sectors).

l. Land Use

Prior to widespread fossil fuel use, humanity's largest effect on local climate is likely to have resulted from land use. Irrigation, deforestation, and agriculture fundamentally change the environment. For example, they change the amount of water going into and out of a given location. They also may change the local albedo by influencing the ground cover and altering the amount of sunlight that is absorbed. For example, there is evidence to suggest that the climate of Greece and other Mediterranean countries was permanently changed by widespread deforestation between 700 BC and 1 AD (the wood being used for shipbuilding, construction and fuel), with the result that the modern climate in the region is significantly hotter and drier, and the species of trees that were used for shipbuilding in the ancient world can no longer be found in the area.

A controversial hypothesis by William Ruddiman called the early anthropocene hypothesis suggests that the rise of agriculture and the accompanying deforestation led to the increases in carbon dioxide and methane during the period 5000–8000 years ago. These increases, which reversed previous declines, may have been responsible for delaying the onset of the next glacial period, according to Ruddimann's overdue-glaciation hypothesis.

In modern times, Jet Propulsion Laboratory study found that the average temperature of California has risen about 2 degrees over the past 50 years, with a much higher increase in urban areas. The change was attributed mostly to extensive human development of the landscape.

m. Livestock

According to a 2006 United Nations report, Livestock's Long Shadow, livestock is responsible for 18% of the world’s greenhouse gas emissions as measured in CO_2 equivalents. This, however, includes land usage change, meaning deforestation in order to create grazing land. In the Amazon Rainforest, 70% of deforestation is to make way for grazing land, so this is the major factor in the 2006 UN FAO report, which was the first agricultural report to include land usage change into the radiative forcing of livestock. In addition to CO_2 emissions, livestock produces 65% of human-induced nitrous oxide (which has 296 times the global warming potential of CO_2) and 37% of human-induced methane (which has 23 times the global warming potential of CO_2).

4.0 CONCLUSION

Ecosystems could be affected by a change in temperature. It has been predicted that an increase in temperature would affect species composition. Scientists also believe that up to two thirds of the world's forests would undergo major changes. Scientists believe that deserts would become hotter, and desertification would extend and become harder to reverse.

5.0 SUMMARY

In this unit, you have learnt that:

- climate change is the variation in the Earth's global climate or in regional climates over time
- global warming is the rise in global temperatures due to an increase of heat-trapping carbon emissions in the atmosphere
- drivers of climate change are in categories which include:

a. Changes within the Earth's environment (Glaciation, Ocean variability, memory of climate)
b. Non-climate factors driving climate change (Greenhouse gases, Plate tectonics, solar variation, Orbital variations, Volcanism)
c. Human influences on climate change (Fossil fuels, Cement manufacture, Land use, Livestock).

6.0 TUTOR-MARKED ASSIGNMENT

Discuss physical and human factors driving climate change.

7.0 REFERENCES/FURTHER READING

Emanuel, K. A. (2005). *Increasing Destructiveness of Tropical Cyclones over the Past 30 Years.*, *Nature*, 436; 686-688 ftp://texmex.mit.edu/pub/emanuel/PAPERS/NATURE03906.pdf PDF.

IPCC. (2007). *Climate change 2007: the Physical Science Basis (Summary for Policy Makers)*, IPCC.

Miller, C. and Edwards, P. N. (ed.) (2001). *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, MIT Press

Ruddiman, W. F. (2003). *The Anthropogenic Greenhouse era began Thousands of Years Ago*, *Climate Change* 61 (3): 261-293.

Ruddiman, W. F. (2005). *Plows, Plagues and Petroleum: How Humans Took Control of Climate*, Princeton University Press.

Ruddiman, W. F., Vavrus, S. J. and Kutzbach, J. E. (2005). *A Test of the Overdue-Glaciation Hypothesis*, *Quaternary Science Review*, 24:11.

Schmidt, G. A., Shindel, D. T. and Harder, S. (2004). *A note of the Relationship between Ice Core Methane Concentrations and Insolation* GRL v31 L23206.

U.S. *Environmental Protection Agency [1]* "http://www.sourcewatch.org/index.php?title=Climate_change"

UNIT 3 IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY

CONTENTS

1.0 INTRODUCTION

Climate change is one of the most critical global challenges of our time. Recent events have emphatically demonstrated our growing vulnerability to climate change. Climate change impacts range from affecting agriculture to further endangering food security, sea-level rise and the accelerated erosion of coastal zones, increasing intensity of natural and biological resources. In this unit, the impact of climate change on the performance or the life cycle of the species is considered.

2.0 OBJECTIVES

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

- explain the influence of climate change on biodiversity.

3.0 MAIN CONTENT

Due to past and present emissions, climate change is unavoidable. According to the UNFCC, the climate does not respond immediately to external changes, but after 150 years of industrialisation, global warming has momentum, and it will continue to affect the earth's natural systems for hundreds of years even if greenhouse gas emissions are reduced and atmospheric levels stop rising. Even the minimum predicted shifts in climate for the 21st century are likely to be significant and disruptive. Scientific understanding and computer models have improved recently and many projections can now be made with greater certainty. Predictions of future climate impacts show that the consequences could vary from disruptive to catastrophic. Current climate models predict a global temperature increase of 1.4-5.8°C by 2100 if nothing is done to reduce emissions. The minimum warming forecast for the next 100 years is more than twice the 0.6°C increase that has occurred since 1900 and that earlier increase is already having marked consequences.

3.1 Climate Change and Biodiversity

The life cycles of many wild plants and animals are closely linked to the passing of the seasons, climatic changes can lead to interdependent pairs of species (e.g. a wild flower and its pollinating insect) losing synchronization, if, for example, one has a cycle dependent on day length and the other on temperature or precipitation. In principle, at least, this could lead to extinctions or changes in the distribution and abundance of species.

One phenomenon is the movement of species northwards in Europe. A recent study by Butterfly Conservation in the UK has shown that relatively common species with a southerly distribution have moved north, whilst scarce upland species have become rarer and lost territory towards the south. This picture has been mirrored across several invertebrate groups.

Drier summers could lead to more periods of drought, potentially affecting many species of animal and plant. For example, in the UK during the drought year of 2006 significant numbers of trees died or showed dieback on light sandy soils. In Australia, since the early 90s, tens of thousands of flying foxes (Pteropus) have died as a direct result of extreme heat. Wetter, milder winters might affect temperate mammals or insects by preventing them hibernating or entering torpor during periods when food is scarce.

One predicted change is the ascendancy of 'weedy' or opportunistic species at the expense of scarcer species with narrower or more specialized ecological requirements. One example could be the expanses of bluebell seen in many types of woodland in the UK. These have an early growing and flowering season before competing weeds can develop and the tree canopy closes. Milder winters can allow weeds to overwinter as adult plants or germinate sooner, whilst trees leaf earlier, reducing the length of the window for bluebells to complete their life cycle.

Organisations such as Wildlife Trust, World Wide Fund for Nature, Birdlife International and the Audubon Society are actively monitoring and research the effects of climate change on biodiversity and advance policies in areas such as landscape scale conservation to promote adaptation to climate change.

Changes in climate over the last few decades of the 20th century have already affected biodiversity. The observed changes in the climate system (e.g., increased atmospheric concentrations of carbon dioxide, increased land and ocean temperatures, changes in precipitation and sea level rise), particularly the warmer regional temperatures, have affected the timing of reproduction of animals and plants and/or migration of animals, the length of the growing season, species distributions and population sizes, and the frequency of pest and disease outbreaks. Projected changes in climate during the 21st century occur faster than in at least the past 10,000 years and combined with land use change and exotic/ alien species spread, are likely to limit both the capability of species to migrate and the ability of species to persist in fragmented habitats.

There is a growing body of evidence showing that increases in atmospheric concentrations of 'greenhouse' gases will enhance the greenhouse effect, resulting on average in additional warming of the earth's surface. This is likely to lead to climatic changes, including increased temperatures, sea level rises and altered rainfall regimes. The extent, pattern and timing of such changes remain uncertain. However, sea level rises would have a direct effect on coastal and estuarine ecosystems and freshwater lagoons near the coast, many of which are important breeding grounds for birds. In alpine ecosystems relatively small temperature changes may result in extensive loss of habitat and consequently extinction of some alpine species. Scientists have observed climate-induced changes in at least 420 physical processes and biological species or communities. In the Alps, some plant species have been migrating upward by one to four metres per decade, and some plants previously found only on mountaintops have disappeared. The ability of species and ecosystems to adapt to climate changes is affected by the rate of change and possible increases in the frequency of extreme climatic events. Pollution and the fragmentation of many natural habitats place further stresses on biological diversity and ecosystem function. Integrated conservation and sympathetic management of large areas of the environment, within a bioregional context, have the greatest potential to mitigate the possible effects of climate change on biological diversity.

In the National Greenhouse Response Strategy, governments have emphasised the need to adopt land uses and management measures designed to conserve carbon sinks and increase the amount of vegetation in forests and elsewhere. They have also stated in the Strategy that they will seek to provide corridor systems that link reserves and refuges with a relatively large range of altitudinal and other geographical variation, to take into account possible impacts of climate change.

4.0 CONCLUSION

Human activities that contribute to climate change include in particular the burning of fossil fuels, agriculture and land-use changes like deforestation. These cause emissions of carbon dioxide (CO_2), the main gas responsible for climate change, as well as of other 'greenhouse' gases. To bring climate change to a halt, global greenhouse gas emissions must be reduced significantly.

5.0 SUMMARY

In this unit, you have learnt that:

- due to past and present emissions, climate change is unavoidable
- the observed changes in the climate system particularly the warmer regional temperatures, have affected the timing of reproduction of animals and plants
- the observed changes in the climate system have affected migration of animals
- the observed changes in the climate system have affected the length of the growing season, species distributions and population sizes, and the frequency of pest and disease outbreaks
- the ability of species and ecosystems to adapt to climate changes is affected by the rate of change and possible increases in the frequency of extreme climatic events
- pollution and the fragmentation of many natural habitats place further stresses on biological diversity and ecosystem function.

6.0 TUTOR-MARKED ASSIGNMENT

Changes in climate over the last few decades of the 20th century have affected biodiversity - Discuss

7.0 REFERENCES/FURTHER READING

IPCC. (2007). *Climate Change: the Physical Science Basis (Summary for Policy Makers)*, IPCC.

Miller, C. and Edwards, P. N. (ed.) (2001). *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, MIT Press.

UNIT 4 CLIMATE CHANGE MITIGATION AND BIODIVERSITY CONSERVATION

CONTENTS

1.0 INTRODUCTION

There are significant opportunities for mitigating climate change, and for adapting to climate change, while enhancing the conservation of biodiversity. Carbon mitigation and adaptation options that take into account environmental (including biodiversity), social and economic considerations, offer the greatest potential for positive synergistic impacts.

2.0 OBJECTIVES

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

- identify different mitigation methods of climate change on biodiversity
- explain the methods of mitigation
- assess the effects of the methods on biodiversity conservation
- explain the significance of climate change mitigation for biodiversity conservation.

3.0 MAIN CONTENT

3.1 Definition of Mitigation and Adaptation

Mitigation involves reducing the greenhouse gas emissions from energy and biological sources or enhancing the sinks of greenhouse gases. **Adaptation** is comprised of activities that reduce a system's (human and natural) vulnerability to climate change.

3.2 Methods of Climate Change Mitigation for Biodiversity

Land-use change and forestry activities can play an important role in reducing net greenhouse gas emissions to the atmosphere. Biological mitigation of greenhouse gases through land use change and forestry (LUCF) activities can occur by three strategies:

1. conservation of existing carbon pools, i.e., avoiding deforestation
2. sequestration by increasing the size of carbon pools, e.g., through afforestation and reforestation, and
3. substitution of fossil fuel energy by use of modern biomass.

The estimated upper limit of the global potential of biological mitigation options (a and b) through afforestation, reforestation, avoided deforestation, and agriculture, grazing land, and forest management is on the order of 100 Gt C (cumulative) by the year 2050, equivalent to about 10– 20% of projected fossil-fuel emissions during that period, although there are substantial uncertainties associated with this estimate.

3.3 Effects of Climate Change Mitigation Strategies on Biodiversity

Afforestation and reforestation can have positive, neutral or negative impacts on biodiversity depending on the ecosystem being replaced, management options applied, and the spatial and temporal scales. The value of a planted forest to biodiversity will depend to a large degree on what was previously on the site and also on the landscape context in which it occurs. The reforestation of degraded lands will often produce the greatest benefits to biodiversity but can also provide the greatest challenges to forest management. Afforestation and reforestation activities that pay attention to species selection and site location, can promote the return, survival and expansion of native plant and animal populations. In contrast, clearing native forests and replacing them with a monoculture forest of exotics would clearly have a negative effect on biodiversity. Afforestation of other natural grasslands and other native habitat types would also entail significant loss of biodiversity.

Short rotation plantations will not sequester and maintain carbon as much as long rotation plantations in which vegetation and soil carbon is allowed to accumulate. Loss of soil carbon occurs for several years following harvesting and replanting due to the exposure of soil, increased leaching and runoff and reduced inputs from litter. Short rotation forests, with their simpler structure, foster lower species richness than longer-lived forests. However, products from short rotation plantations may alleviate the pressure to harvest or deforest longer-lived or primary forests.

Plantations of native tree species will support more biodiversity than exotic species and plantations of mixed tree species will usually support more biodiversity than monocultures. Plantations of exotic species support only some of the local biodiversity but may contribute to biodiversity conservation if appropriately situated in the landscape. Planting of invasive exotic species, however, could have major and widespread negative consequences for biodiversity. Tree plantations may be designed to allow for the colonization and establishment of diverse under storey plant communities by providing shade and by ameliorating microclimates. Involvement of local and indigenous communities in the design and the benefits to be achieved from a plantation may contribute to local support for a project and hence contribute to its longevity. Plantations may contribute to the dispersal capability of some species among habitat patches on a formerly fragmented landscape. Even plantations of a single species can confer some benefits to local biodiversity, especially if they incorporate features such as allowing canopy gaps, retaining some dead wood components, and providing landscape connectivity.

Slowing deforestation and forest degradation can provide substantial biodiversity benefits in addition to mitigating greenhouse gas emissions and preserving ecological services. In temperate regions, deforestation mainly occurred, when it did, several decades to centuries ago. In recent decades, deforestation has been most prevalent in the tropics. Since the remaining primary tropical forests are estimated to contain 50–70 percent of all terrestrial plant and animal species, they are of great importance in the conservation of biodiversity. Tropical deforestation and degradation of all types of forests remain major causes of global biodiversity loss. Any project that slows deforestation or forest degradation will help to conserve biodiversity. Projects in threatened/vulnerable forests that are unusually species-rich, globally rare, or unique to that region can provide the greatest immediate biodiversity benefits. Projects that protect forests from land conversion or degradation in key watersheds have potential to substantially slow soil erosion, protect water resources, and conserve biodiversity.

Most of the world's forests are managed, hence improved management can enhance carbon uptake or minimize carbon losses and conserve biodiversity. Humans manage most forests for conservation purposes and to produce goods and services. Forest ecosystems are extremely varied and the positive or negative impact of any forest management operation will differ according to soil, climate and site history, including disturbance regimes (such as fire). Because forests are enormous repositories of terrestrial biodiversity at all levels of organization (genetic, species, population, and ecosystem), improved management activities have the potential to positively affect biodiversity. Forestry practices that enhance biodiversity in managed stands and have a positive influence on carbon retention within forests include: increasing rotation length, low intensity harvesting, leaving woody debris, post-harvest silviculture to restore the local forest types, paying attention to landscape structure and harvesting that emulates natural disturbance regimes. Management that maintains natural fire regime will usually maintain biodiversity and carbon storage.

Revegetation activities that increase plant cover on eroded, severely degraded, or otherwise disturbed lands have a high potential to increase sequestration and enhance biodiversity. Sequestration rates will depend on various factors. Soils of eroded or degraded sites generally have low carbon levels and therefore a high potential to accumulate carbon, however, revegetation of these types of such sites will pose technical challenges. An important consideration is to match the plant species to the site conditions and to consider which key ecological functions need to be restored. Biodiversity can be improved if revegetation aids recruitment of native species over time or if it prevents further degradation and protects neighboring ecosystems. In certain instances, where native species may now be impossible to grow on some degraded sites, the use of exotic species and fertilizers may provide the best (and only) opportunity for re-establishing vegetation. However, care should be exercised to avoid situations where exotics that have invasive characteristics end up colonizing neighboring native habitats.

Bio-energy plantations provide the potential to substitute fossil fuel energy with biomass fuels but may have adverse impacts on biodiversity if they replace ecosystems with higher biodiversity. However, bio-energy plantations on degraded lands or abandoned agricultural sites could benefit biodiversity.

4.0 CONCLUSION

Since the remaining primary tropical forests are estimated to contain 50–70 percent of all terrestrial plant and animal species, they are of great importance in the conservation of biodiversity. Tropical deforestation and degradation of all types of forests remain major causes of global biodiversity loss. Any project that slows deforestation or forest degradation will help to conserve biodiversity.

5.0 SUMMARY

In this unit, you have learnt that:

- Mitigation involves reducing the greenhouse gas emissions from energy and biological sources or enhancing the sinks of greenhouse gases
- Biological mitigation of greenhouse gases through land use change and forestry activities can occur in three ways
- Afforestation and reforestation can have positive, neutral or negative impacts on biodiversity depending on the ecosystem being replaced, management options applied, and the spatial and temporal scales
- Afforestation and reforestation activities that pay attention to species selection and site location, can promote the return, survival and expansion of native plant and animal populations
- The reforestation of degraded lands will often produce the greatest benefits to biodiversity but can also provide the greatest challenges to forest management
- Clearing native forests and replacing them with a monoculture forest of exotics would have a negative effect on biodiversity
- Plantations of native tree species will support more biodiversity than exotic species
- Plantations of mixed tree species will usually support more biodiversity than monocultures
- Slowing deforestation and forest degradation can provide substantial biodiversity benefits in addition to mitigating greenhouse gas emissions and preserving ecological services
- Managed forests can enhance carbon uptake or minimize carbon losses and conserve biodiversity
- Revegetation activities that increase plant cover on eroded, severely degraded, or otherwise disturbed lands have a high potential to increase sequestration and enhance biodiversity
- Bio-energy plantations provide the potential to substitute fossil fuel energy with biomass fuels but may have adverse impacts on biodiversity if they replace ecosystems with higher biodiversity.

6.0 TUTOR-MARKED ASSIGNMENT

Critically examine the impacts of climate change mitigation on biodiversity conservation.

7.0 REFERENCES/FURTHER READING

IPCC. (2007) *Climate Change 2007: the Physical Science Basis (Summary for Policy Makers)*, IPCC.

Miller, C. and Edwards, P. N. (ed.) (2001). *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, MIT Press.

Ruddiman, W. F. (2003). *The Anthropogenic Greenhouse Era began Thousands of Years Ago*, *Climate Change* 61 (3): 261-293.

U.S. *Environmental Protection Agency [1]* "http://www.sourcewatch.org/index.php?title=Climate_change.

UNEP (2002). Africa *Environment Outlook: Past, Present and Future Perspective*. England, Earthprint Limited.

UNIT 5 BIODIVERSITY IN WEST AFRICA (A CASE STUDY)

CONTENTS

1.0 INTRODUCTION

Habitat diversity in Western Africa ranges from semi-desert and savanna to tropical forests, mangroves, freshwater, lakes and rivers, and inland and coastal wetlands. The upper Guinea forest, which extends from western Ghana through Cote d'Ivoire, Liberia and Guinea to Southern Sierra Leone, is a biologically unique system that is considered one of the world's priority conservation areas because of its high endemism. Nearly 2,000 plants and more than 41 mammals are endemic to the ecosystem. Species diversity is also high, with more than 20,000 butterfly and moth species, 15 species of even toed ungulates and 11 species of primates. In this unit, the biologically diverse communities of Western Africa are considered.

2.0 OBJECTIVES

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

- explain different types of habitat diversity in West Africa
- state three biological resources in W/A
- describe threat to W/A biodiversity
- list measures towards the sustainable management and conservation of biodiversity in W/A.

3.0 MAIN CONTENT

The richness of Western Africa's biological resources has constituted the basis of survival of the sub-region's indigenous societies. The local human populations have developed knowledge systems and practiced traditions which have protected and conserved plants, animals, water resources and other components of their life support systems. **In Ghana, sacred groves** protect biodiversity in three different ways:

1. by protecting particular ecosystems or habitats,
2. by protecting particular animal or plant species and
3. by regulating the exploitation of natural resources.

Many plants species are also used in Ghana in traditional herbal medicines and the Kakum National Park in Ghana, with its canopy walkway, attracts thousands of visitors a year, helping to boost the economy as well as awareness of environmental issues.

3.1 Threat to Biodiversity in Western Africa

Since the beginning of the last century, biological resources in Western Africa have been rapidly degraded and lost through practices such as large scale clearing and burning of forest, overharvesting of plants and animals, indiscriminate use of persistent chemical pesticides, draining and filling of wetlands, destructive fishing practices, air pollution, and the conversion of protected lands to agricultural and urban development. These activities are the results of uncontrolled population growth and increasing poverty, as well as of economic policies and priorities.

For example, economic pressures led to concessions being granted to foreign logging companies to exploit Western **tropical forests** and prices of cash crops especially in the 1980s, resulted in clearing of large areas of natural habitat for agriculture. Benin, Cote d'Ivoire, Liberia, Mauritania, Niger, Nigeria, Sierra Leone and Togo all have rates of deforestation of more than 2 percent per year. Remnants of forest vegetation are presently found in protected areas in coastal countries. The Upper Guinea forest extends over approximately 420,000 sq km, but estimates of existing forests suggest a loss of nearly 80 percent of the original extent. The remaining forest is highly fragmented and spread across national borders. The forest fragments that remain are under severe threat, mainly arising from slash and burn agriculture, which accounts for much of the sub-region's subsistence food production.

Savannas are the dominant ecosystems in Western Africa, after tropical forests. Like the forests, they also support extremely biologically diverse communities of animals and plants but persistent exploitation for food, fuelwood and other resources from the savanna has resulted in their widespread degradation. For instance, the rich and extensive savanna vegetation found in the northern portions of the sub-region has been severely degraded, with resultant loss of vegetation cover, fertile top soil and wild faunal species.

Another major biodiversity issue in Western Africa is the loss and degradation of **wetlands**. Coastal and inland wetlands in W/A have been regarded as wastelands constituting habitats for pests and thus, representing a threat to public health. As a result of this perception, wetlands in W/A have been under constant threat from development activities, especially agriculture and construction of harbours. Draining or in-filling of wetlands changes hydrological regimes so that they no longer provide suitable habitats for wildlife. Untreated effluents from domestic, commercial and industrial sources in nearby settlements have polluted coastal wetlands creating a toxicity risk for flora and fauna.

Habitat loss is not the only threat to wildlife in W/A. The demand for bush meat is driving high rates of poaching and an international trade in endangered species and wildlife products is also flourishing. A series of surveys of endangered primates in the forest reserves of Eastern Cote D'Ivoire and southern Ghana from 1993 to 1999 document the first recorded extinction of a widely recognized primate taxon.

Rural people in W/A depend heavily on medicinal plants for their health needs. However, as a result of extensive agricultural practices and annual bush fires, many medicinal plants have been lost at a time when conscious efforts are being made in many countries to promote herbal and traditional medicine. Other species are threatened by a few invasive species of animals and plants.

3.2 Sustainable Management and Conservation of Biodiversity in W/A

The countries of W/A have responded to the problems of habitat loss by placing natural areas under protection. However, the number and size of protected areas varies from one country to another. Burkina Faso and Senegal have over 10 % of their lands area under national protection, whereas in Guinea and Guinea Bissau this was less than 1%, although they do have marine protected areas.

International efforts to conserve natural habitats have been very successful as a result of ratification of the Rasmsar convention, and the convention on Biological Diversity. There are 15 Biosphere reserves in the sub-region, 10 World Heritage Sites and 37 Ramsar sites.

Nearly all countries within the sub-region are signatories to the Convention and Biological Diversity and the Ramsar Convention, and many have drawn up programmes and projects under these agreements. Capacity development activities are also underway, under the aegis of new institutions created to coordinate and implement them. Most notable in the area has been GEF support for biological programmes and projects in the recipient of GEF biodiversity funding by mid 1998, with emphasis on coastal, marine and freshwater ecosystems.

4.0 CONCLUSION

The range of climatic conditions and geomorphology found in Africa has created a wide diversity of habitats, which various species of flora and fauna have evolved to exploit. As a result, the region is exceedingly well endowed with diverse biological resources. African countries and sub-regional grouping must cooperate in devising policies, programmes and projects that harmonise biodiversity management and conservation throughout ecologically determined regions

5.0 SUMMARY

In this unit, you have learnt that:

- The range of climatic conditions and geomorphology found in Africa has created a wide diversity of habitats
- Habitat diversity in Western Africa ranges from semi-desert and savanna to tropical forests, mangroves, freshwater, lakes and rivers, inland and coastal wetlands
- The local human populations have developed knowledge systems and practiced traditions which have protected and conserved plants, animals, water resources and other components of their life support systems
- Biological resources in Western Africa have been rapidly degraded and lost through practices such as, large scale clearing and burning of forest, overharvesting of plants and animals, indiscriminate use of persistent chemical pesticides, draining and filling of wetlands, destructive fishing practices, air pollution, and the conversion of protected lands to agricultural and urban development
- These activities are the results of uncontrolled population growth and increasing poverty, as well as of economic policies and priorities
- The countries of W/A have responded to the problems of habitat loss by placing natural areas under protection.

6.0 TUTOR-MARKED ASSIGNMENT

Discuss West African biodiversity under the following headings:

a. Ecological, Economic and Social values of biological resources in Western Africa,
b. Threat to biodiversity in Western Africa,
c. Sustainable management and conservation of biodiversity in Western Africa.

7.0 REFERENCES/FURTHER READING

Conservation International (1999). *Conservation Priority Setting for the Upper Guinea forest Ecosystem, West Africa, Conservation International*, Washington DC.

Conservation International (2002). www.conservation.org/sp/CIWEB/strategy/hotpots/guinean_forest.xml

FAO (2001). *Global Forest Resources Assessment*, FAO, Rome

Myers, N. (1990). The Biodiversity Challenge: Expanded Hotspot Analysis. The *Environmentalist*, 10: 243-256.

UNEP, (2002). Africa *Environment Outlook: Past, Present and Future perspective*. England, Earthprint Limited

World Bank (2001a). *African Development Indicators 2001*. The World Bank Washington DC.