MODULE 1 THE ENVIRONMENT: CONCEPT AND TOPOGRAPHY

UNIT 1 THE ENVIRONMENT

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1.0 Introduction

Since you have gone through the course guide, you would have acquired a general overview of what this unit is about, how it links specifically to the course. This unit will help you acquire basic understanding of what the environment is and its basic components.

Before we do this, let us have a view of what you should learn in this unit, as indicated in the unit objectives below.

2.0 Objectives

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

- Define the term environment
- Differentiate between natural and modified environment
- Mention the components of the environment

3.1 Definitions of the Environment

Barrow (1993) defined the environment as the sum total of the condition within which organisms live; it is the result of interaction between nonliving and living parameters.

The non-living parameter can also be referred to as -ABIOTIC and the living parameter can also be referred to as BIOTIC. Thus the environment may be said to be all external conditions that affect an organism or other specific system during its life time.

Important parameters to be noted in Barrow's definition include:

- Total conditions within which organism lives
- Non-living organism
- Living organism
- Interaction of the organism with the three above mentioned parameters.

Collins dictionary of Environmental Sciences defines the Environment as the combination of external condition that influence the life of individual organism. This external environment includes interrelationships between abiotic and biotic components.

Note that:

- Combination of external conditions
- Interrelationships
- Abiotic, and
- Biotics

Are mentioned in the definition.

Do you notice the similarity between the first and second definition?

Below is a diagrammatic representation of what constitute the environment of an organism.

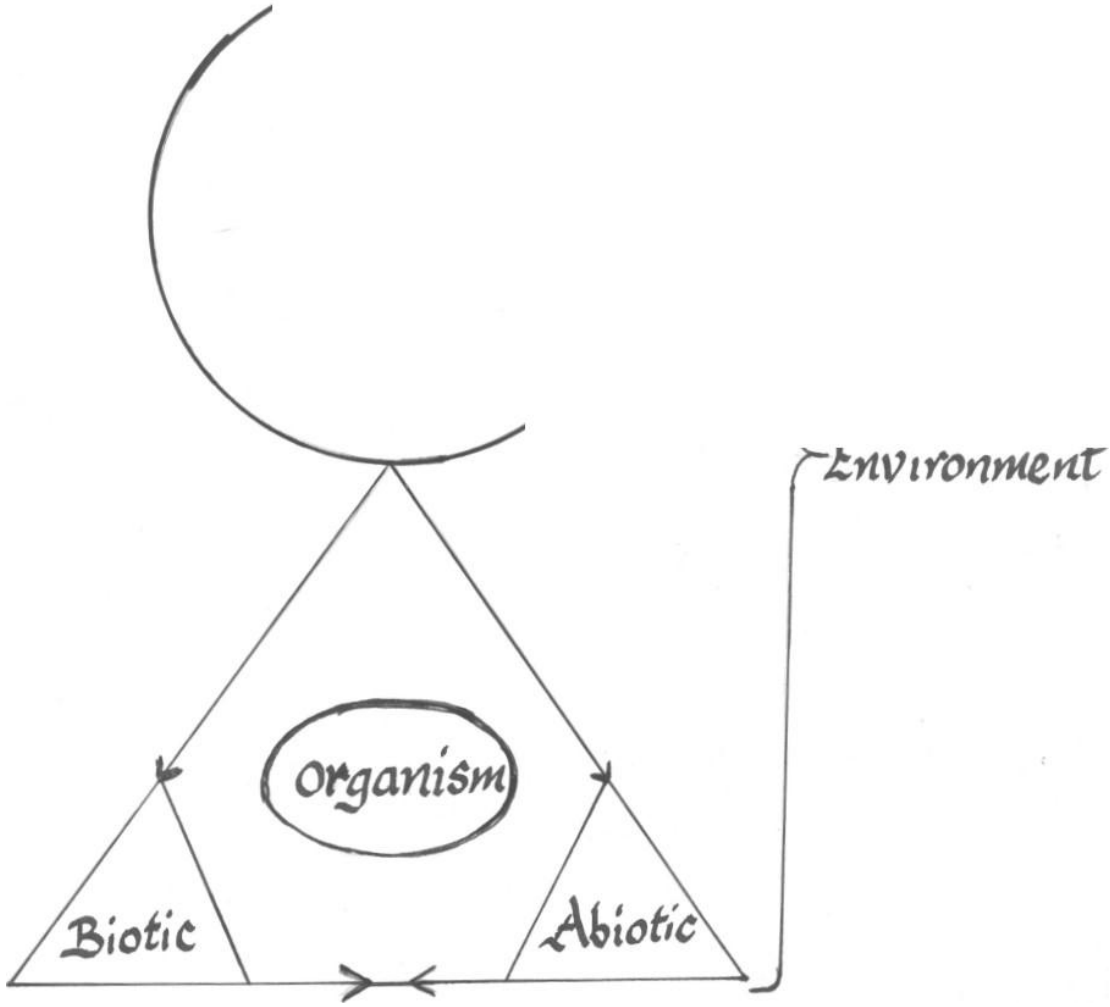

Figure 1.1 The Total External condition

Subsumes:

1. Biotic factors; this includes all living-organisms i.e plants and animals (in a general sense).

2. Abiotic factors: this includes all non-living organisms such as mountains, rain, soil, (these are the physical parameters). Others include pH - acidity or alkalinity and other chemical factors.

3. The interaction between these biotic factors and how they (i.e biotic and abiotic) interact in combination with the organism.

In simple terms, the environment may be said to be all external conditions that affect an organism or other specific systems during its life time (Ahove, 2001).

For instance, the environment in which a fish lives in, is the sea. The sea being its environment has some parameters that influence it including among others, light, temperature, turbidity, types of seas bed-rock, (abiotic).Others include the other aquatic animals present in the sea, plants and the use or abuse of the sea. All these parameters' interaction with one another and with the fish combines to determine what the environment of the fish eventually turns out to be.

The concept of the environment in its totality is as complete as human with far ranging implications and challenges.

3.2 Natural and Modified Environment

Before the 20th century our planet earth or simply the entire environment was in a state of stability where every natural resource was just adequate, functional and untampered with. Human use of environmental resources did not create a significant change on the environment. Ecologists thus describe this condition as being natural and the reverse as being modified.

Natural Environment may be described as a situation or condition where there is insignificant or no human alteration of that environment.

Figure 1.2 Natural Environment

A modified environment may be described as a condition where there has been a significant human alteration of the environment.

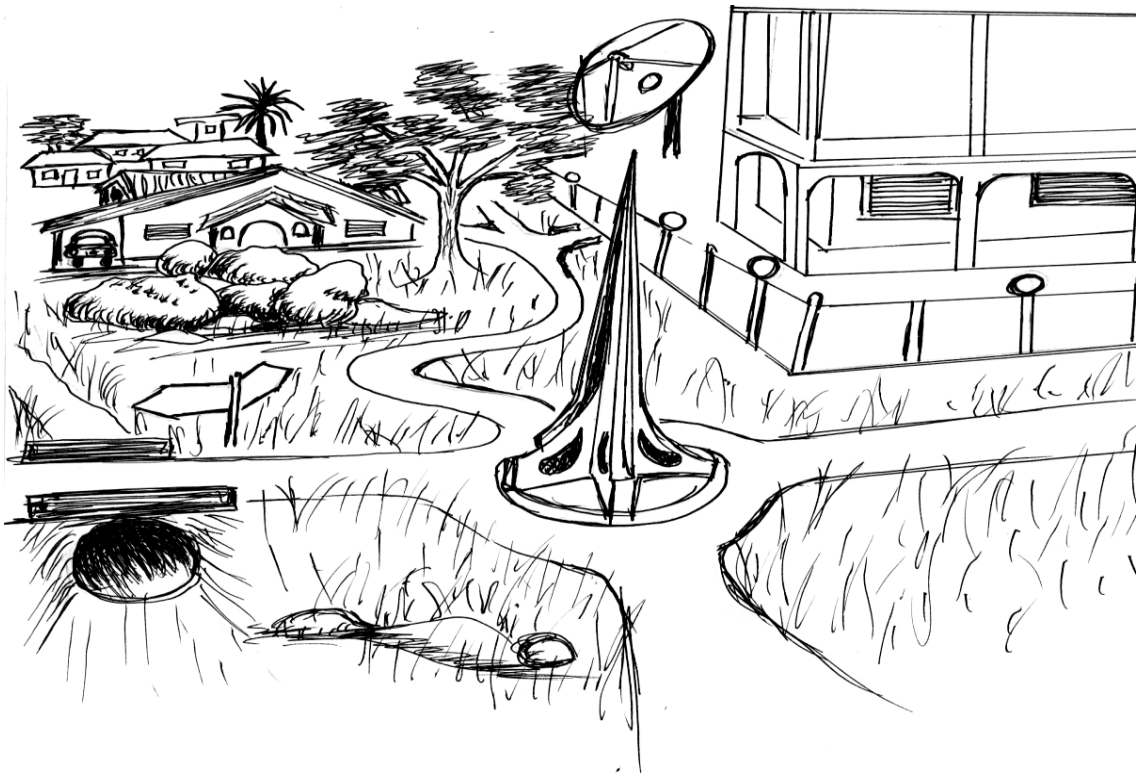

Figure 1.3 A Modified Environment

Exercise 1.1

(a) Identify features in figure 1.2 indicating it to be a natural environment.

(b) Identify features in figure 1.3, that qualifies it as a modified environment.

3.3 Components of the Environment

Your understanding of geography may help you guess that the Earth from outer space looks blue and not red like mars. This is due to the vast majority of the earth being ocean. As true as this may be, the earth being our environment is made up of four major components. These include:

l. Atmosphere
2. Hydrosphere
3. Lithosphere
4. Biosphere

The Nigerian environment is made up of these components. This therefore underscores the importance of studying each of these components from a general view.

4.0 Conclusion

In this unit you have learned what the environment is and that in defining the environment parameters such as abiotic, biotic and their interactions with the organisms that make up the environment. You have also realized that the environment can be natural or modified. You have also classified four localities or communities within your state as either being a natural or modified environment.

You should at this point be able to define what environment is in your own words. Also you should be able by now to classify any locality you find yourself as either modified or natural.

This unit has also classified the environment into four major groups, and the Nigerian environment is no exception.

5.0 Summary

This unit has focused on the definition of the environment - all external conditions that affect an organism during its lifetime. This environment could be natural or modified and it has four major components - atmosphere, hydrosphere, lithosphere and biosphere. Unit two will build on these four components of the environment.

6.0 Tutor Marked Assignments

l. Using your own works define the term Environment

2 (a) Make a list of TWO EACH of natural and modified environment within your state.

(b) State at least two features EACH to support your classification.

7.0 References and other Resources

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UNIT 2 MAJOR COMPONENTS OF THE ENVIRONMENT

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1.0 Introduction

The previous unit mentioned four components of the environment. Unlike the previous one, this unit will discuss on each of the four major components of the environment. This unit points out the essential features found in each of the "sphere" (component).It is important before we proceed into the discussion to identify what you are expected to have acquired at the end of this unit as articulated in the objectives.

2.0 Objectives

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

- Explain what is meant by Atmosphere
- Identify in detail classification system of the atmosphere
- Explain with detailed diagrams the distribution of water on earth in percentages
- Outline the essential components of the biosphere with examples.

3.1 The Atmosphere

Our existence depends on the atmosphere therefore its composition, extent and significance should be studied. If the earth is likened to a lemon the atmosphere can be compared with the skin of the lemon or an onion with many spherical layers. The atmosphere clings tightly to the Earth by the attraction of gravity. The atmosphere serves to moderate the extremes of heat and cold on the earth (Okebukola, 1997). During the day as the heat penetrates the air and warms the earth, the atmosphere traps this heat so that it escapes more slowly into space, making the night warmer than it would be without this effect.

The atmosphere also protects the earth's inhabitants to some extent from meteorological particles, cosmic rays, and radiation from the sun, stars, atmosphere dust and other harmful gases.

Exercise 2.1
Take a piece of onion and remove gradually three outmost successive layer of its skin. When you carryout this process, what did you notice about:

(a). Increase or decrease in moisture

(b). Texture of the layers

What you witnessed as you remove each successive layer is similar to moving from one layer of the atmosphere to another.

According to Okebukola (1997) scientists have developed a three classification system for the atmosphere on the basis of

l. Varying temperature

2. Electrical characteristics

3. Composition

3.1.1 Varying Temperature

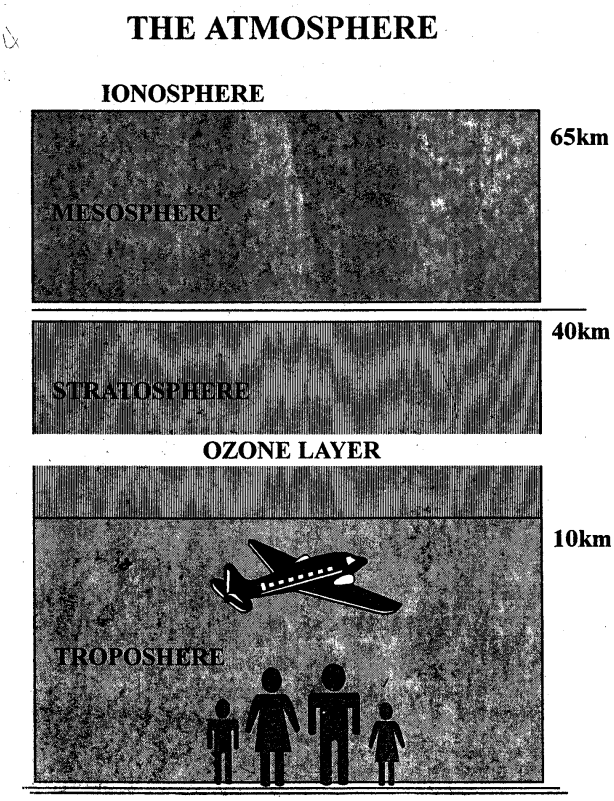
Based on temperature, the atmosphere has about four distinct layers.

Troposphere: This is the first layer, which extends from above the earth's surface up to l0kms. It is characterized by a fall in temperature as altitude increases. Winds in this layer usually move in a vertical direction. Airplane travels within this region.

Stratosphere: This layer extends up to about 40km above the earth. It has increasing temperature with increasing altitude and also characterized by jet streams that move mostly in a horizontal motion. The outstanding feature of this layer is the concentration of an isotope of oxygen called **Ozone.**

Mesosphere: This layer extends up to 65km above the earth and is characterized by a rapid rise in temperature with increasing altitude.

Exosphere: The exosphere forms the highest layer of the atmosphere and extends beyond the atmosphere. Here, the air density is very low, that the idea of temperature loses its customary meaning. Ultraviolet rays fill the exosphere and faint glows called zodiacal light that are due to sunlight reflected from particles of meteoric dust originate in this layer.



Source: Okebukola (1997)

3.1.2 Electrical Characteristics

Scientists classified the atmosphere into two layers based on their electrical properties. The first layer is a neutral region, which extends to 60km above the earth's surface.

The second region is electrically charged with ions called ionosphere.The name ionosphere was derived from ions and sphere. The ionosphere may also be further divided into what we may call sub-regions depending on the degree or concentration of ions in the region. The scope of this unit will not however discuss on this.

3.1.3 Composition

The atmosphere can be classified into two regions based on its composition. First is the lower region and the second the upper region.

The lower region is of more importance to you and I. Before reading further, I want you to guess why this region should be of more concern to us? Well, perhaps, you guess right, it is very important to us because this region, which extends to 100km above the earth surface, has a higher concentration of oxygen essential for our survival.

Turbulence causes a continuous mixing of the constituent elements of the atmosphere so that the composition is relatively uniform. This relative uniformity in the composition of the air at this region gave rise to the nomenclature homosphere to the region.

The air at the hemisphere is made of several gases both natural and artificially occurring.

The upper region extends from 100km above the earth and beyond. Within this region elements such as oxygen and nitrogen are in lower concentration. However elements such as helium and hydrogen are in higher concentration. You may begin to wonder, why?

Exercise 2.2

You need a good general chemistry textbook to carry out this exercise.
Take a look at the periodic table showing all the elements.

(a) Identify and write the mass of each of these elements:
   (i) Nitrogen
   (ii) Oxygen
   (iii) Helium
   (iv) Hydrogen

(b) From your findings which two elements are lighter and which are avier.

The answer from your findings is an indication of why we find, and as earlier mentioned elements such as helium and hydrogen in higher concentration at the upper region and elements or gases such as nitrogen and oxygen concentrating at the lower region.

In brief, concentrations of heavier elements decrease with increasing altitude.This upper layer is referred to as heterosphere because various constituents tend to separate out at this region.

3.2 Hydrosphere

The hydrosphere is another sphere in the natural environment comprising of the waters of the earth. These waters include lakes, rivers, glaciers and frozen ice caps, waterfalls, streams, wetlands, seas and oceans plus few others. Water is essential for life ans is a vital natural resource and a solvent for the mineral nutrients, which are only available to plants in solution.

Over 70% of the earth surface are made up of water, which is about 360 million square kilometers. All landmass of the earth will fit into the Pacific Ocean comfortably with eNTIgh space (UNESCO - SOURCESM 1998).

97% of this total volume of water are in the oceans (this is salty water) and
3% is fresh water. 2.997% of the fresh water are locked up in ice caps or glaciers or buried so deep that it costs so much to extract. Only 0.003% of the earth's total volume of water is easily assessable to us.

Below is an annotated diagram showing the distribution of water in the hydrosphere.

Exercise 2.3

Study the Figure 2.3 in detail and follow the instructions below:

(i) Draw a two column table with source of water on the left and percentage volume on the right.

E.g Table 1

Source of Water	Percentage Volume
Oceans	97.41

(ii) Using the example show the distribution of water in the hydrosphere.

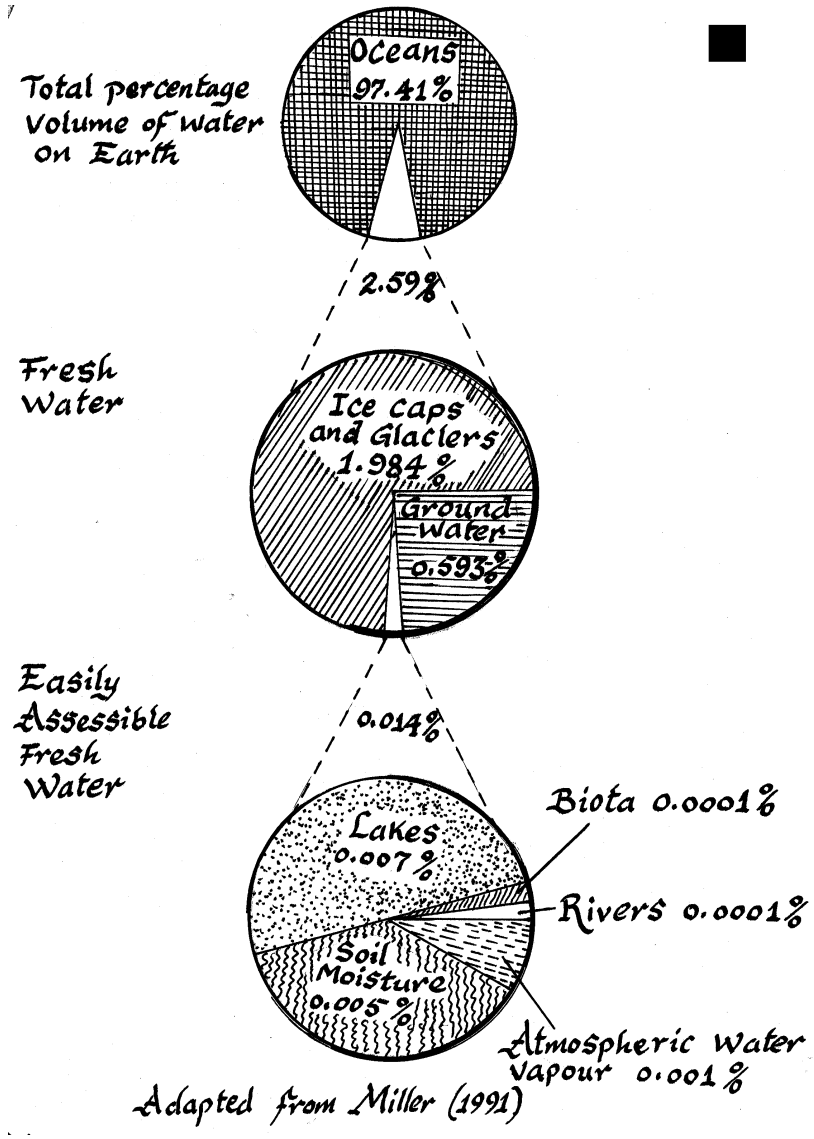
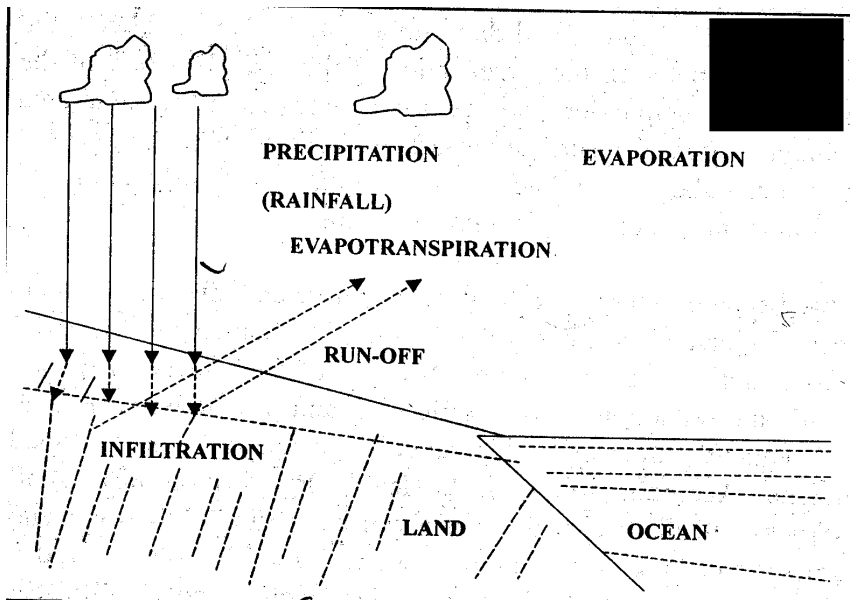


Fig. 2.2 Distribution of Water in the Hydrosphere

An initial view of the percentage of easily assessable fresh water to human might be frightful. Fortunately, and to the human advantage, the available fresh water has been made a generous supply by nature. This has been made possible according to Miller (1991) a continuously collected, purified, recycled and distributed in the solar-powered hydrologic cycle.

Below is a diagram of typical water cycle.

The Water Cycle

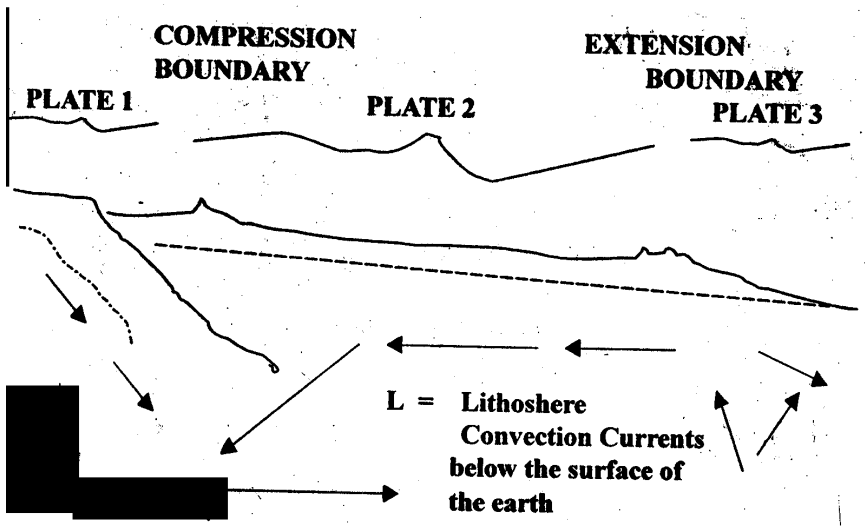


Source: Ahove (2001)

3.3 The Lithosphere

The lithosphere combines with the atmosphere and hydrosphere to shape the landforms create soils and help support a vast biotic species.The lithosphere refers to the outer crust of the earth which is made up of lighter rocks and its broken up into plates. The crust is thicker under the continents especially the high mountains between 30 and 75 kms and is driven beneath the oceans from 6 to 8kms.

Figure 2.4 Plates and Plate Boundaries



Source: Ahove (2001)

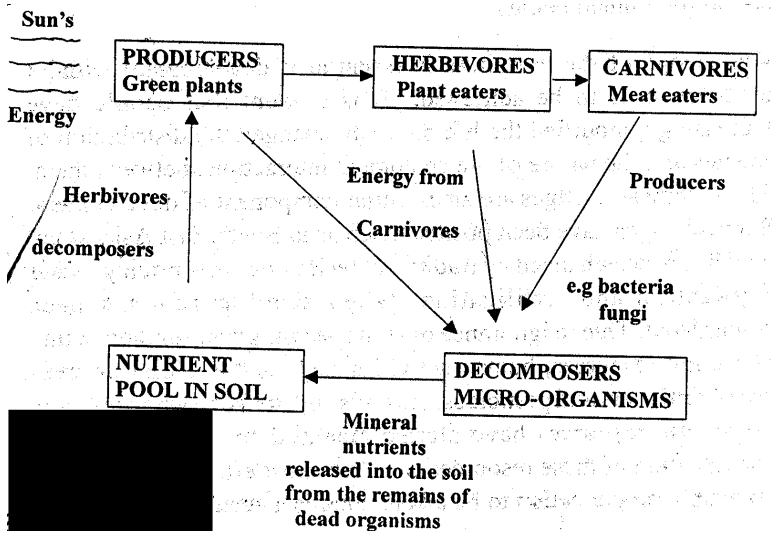
3.4 The Biosphere

This is the fourth system in the environment and a region that constitutes the living organisms i.e plants, animals and humans. It has an immense variety of living species numbering over four million species and over six billion human beings.

Knowledge of the biosphere is essential if development without destruction is to be achieved.. It is evident that humans have modified the earth's environment by changing the distribution of species and-the nature of the ecological interactions between them. The quest for development and the seemingly unlimited bounty of natural resources led humans to activities such as felling of trees, use of fertilizers and pesticides, oil spills and the increasing pollution of genetic resources (UNESCO, 1977).

To same this situation, it is important to show the interrelationship of living organisms with each other and with the physical environment. This implies that ignorance of the fact that human survival hinges on the sustenance of a natural environment has been a major problem to a healthy environment especially in a developing country like ours.

A unit where the relationship of living organisms is studied is referred to as ecosystem.



Source: Ahove (2001)

Figure 2.5 Energy and nutrient Cycle in an ecosystem

There are many types of ecosystem, examples include tropical -forest, Savannah, grasslands, pond and few others. You would learn more about these ecosystems under another course titled Introductory Ecology.

In the biosphere almost all energy is from the sun. There is an energy flow from solar radiation through plants to herbivores, then to carnivores,

omnivores and micro-organisms in the food chains or food webs. A simple food chain on land might be represented as shown below.

Grass → Insect → Food * Three link food chain

A simple food chain in water may be represented thus: Phytoplankton

Insert → larve → Small fish → large fish * Four link food chain.

Exercise 2.4

1. Draw an example of a food chain in any named ecosystem.

4.0 Conclusion

This unit has pointed out and discussed briefly on four major components of the environment. And that these components of the environment mentioned are also the major components of the Nigeria environments. Thus, discussion on these components is not different from what operates in Nigeria as our Environment.

5.0 Summary

The focus of this second unit was a discussion on the four major components of the environment, which also has implication for the Nigerian environment. These components are:

(l) Atmosphere
(2) Hydrosphere
(3) Lithosphere
(4) Biosphere.

The atmosphere was classified based on temperature, electrical properties and composition. Different waters that make up the hydrosphere were mentioned and their percentages, with fresh water being at a very low percentage volume. The Lithosphere and Biosphere's compositions were briefly discussed.

6.0 References and Other Resources

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UNIT 3 NIGERIAN ENVIRONMENT: COVERAGE AND GEOLOGY

1.0 Introduction

The previous unit discussed on the four major components of the environment, which also reflects on the Nigerian Environment. In essence all what we shall study in all the units in this course will emerge from these four components.

This unit will thus build on this by discussing on the coverage of the Nigerian environment in terms of size, location, boundaries, physiological and geological issues. These will help lay a clear and solid foundation in your mind about your country's environment.

2.0 Objectives

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

- Draw a sketch of Nigeria map indicating Rivers Niger and Benue and places that share boundaries with Nigeria.
- Explain some geological terms
- Illustrate the physiography of the Nigerian Environment.

3.1 Nigeria: Coverage

Our country Nigeria occupies a landmass of 913,072.64 sq. kms. It is located in the West Coast of Africa, south of the Sahara. It is located between 4-10^{o} North. Also, it expands from about 3° to almost 15° east of the meridian.

The maximum length of Nigeria's land mass that runs from the Northern to the southern boundaries is about 1,040km, while from the Eastern to Western boundaries is about 1,120km. Nigeria is bound on the north by Republic of Niger and Chad, on the South by the Gulf of Guinea, the east by the Republic of Cameroon and the west by the Republic of Benin.

Exercise 3.1

(a) With the aid of an Atlas of Nigeria (Macmillan Atlas is suggested) make a sketch of Nigeria's map

(b) Indicate places that share boundaries with Nigeria.

(c) Indicate by drawing straight lines on the map using your ruler and pencil, the maximum landmass of Nigeria from North to south and East to West.

3.2 Physiography

Agabi (1995) mentioned that physiographically, Nigeria is made of several extensive plateau surfaces including' the Jos Plateau, the Udi and North central high plains.

Within the coastal regions are young soft rocks, which are also often in the Niger-Benue trough (around Lokoja in Kogi State and the Lake Chad basin. In contrast to the coastal rocks mentioned earlier in most parts of the western and northern states the underlaying rocks are hard and old.

Inselbergs are prominent residual rock-mass which are often remnants of erosion can be found around old hard rocks. They may occur alone or in clusters in numerous levels of disintegration. The Igalla-Udi plateau is another area where inselbergs can be found. The plateau is underlain by young sedimentary rocks with most of them possessing plain tops and a large layer of indurate ironstone. Nsukka and Ilesha areas have dome-shaped hills (Agabi, 1995).

There are other worthy of note landforms such as the Enugu escarpment which rises abruptly above the plains of Enugu and descends into a slope penetrated by swift streams. There are volcanic hills in the Eastern boundaries, Jos and Biu plateau.

River Benue which is the major tributary of river Niger, confluence at Lokoja forming initially a single waterway which later empties itself into the Gulf of Guinea by means of several creeks and distributaries. These connecting web- like networks form the oil and gas rich Niger-delta zone of Nigeria.

Exercise 3.2

(a). Draw a sketch of the map of Nigeria and indicate:

(i) Rivers Nigeria and Benue

(ii) With the aid of an atlas, draw Rivers Sokoto, Kaduna and Gongola

(b). Draw a sketch of the map of Nigeria and indicate:

(i) Jos Plateau, Udi Plateau and the North Central high.

3.3 Geology: an overview

In Nigeria, there are two types of granites - the old and new generation. The old generation granites are widespread and form part of the basement complex. They are relatively smooth and rounded hills.

Many other minerals found in the Nigerian environment include among others petroleum, bitumen, natural gas, diamonds, limestone, coal, lead, zinc, gemstone, marble, tin, columbite and uranium. These minerals are specifically located in various geographical sites of the country.

About 60 million years ago, as illustrated by Agabi (1995), the sea deposited a heavy sequence of shales and sandstones within a belt of Nigeria which stretches from around Lagos to Calabar including parts of Western Nigeria. These deposits were however buried by beds of sands and clays. It was later discovered that these buried deposits in Delta, Imo and Anambra States contain seams of nignite. The Miocene period witnessed sedimentation in the Niger Delta Basin with alternating sequences of sands and shales of different layers. The sand deposits became the reservoir rocks while the shales became the rocks of the last hydrocarbon crude oil and gas reservoirs of the Niger Delta.

Note: Classification of terms

I thought it necessary to explain clearly to you my dear student some terms I have mentioned in the previous paragraph that may be strange to you assuming you are not very good in geography. They are discussed below:

l. Seams: strata of ore or mineral such as coal or crude oil.
2 .Miocene period: this period last for about 14 million years.

The environmental problem commonly noted with the exploration of crude oil and gases are:

l. That landscape is significantly modified through path construction trampling and vehicular movement

2. Consumption of space and displacing land use and land users for construction of helicopter landing strip, erection of a drilling rig and the general field camp.

3. Land and sea pollution and the attendant loss of land for agricultural purposes and death of aquatic organisms which have economic implications.

Seismic activities are carried out before crude oil exploration begins. When explosives are utilized during the activities it has often led to serious environmental consequences on human, agricultural and aquatic lives. There have been frequent, loud and angry reports of vibration from the use of explosives affecting inhabitants in and around areas where these activities are conducted. When an oil well or installation is on fire, the blaze and its consequences often affect several other people. This has been some experience of many communities in the Nigeria, especially in the Niger Delta region (Agabi, 1985).

What is Seismic Activities?
Seismic activities are activities geologist carry out which leads to occurrence of artificially produced earth tremors. This is done for the purpose of oil exploration.

4.0 Conclusion

This Unit has shown you how vast is the land and some territorial water of Nigeria. The size of Nigeria as shown in this unit is significantly large enough to support it's population of about 120 million. The physiographic and geological factors of this great nation as endowed by nature has given the country diversities of landforms and inland water ways stones, coastal and inland water ways and a host of mineral resources especially the crude oil, gas, bitumen and rich forest reserve. The topography of this country has also been a major contributor to the beautiful environment cum several natural endowment.

This will form the basis for the next unit on the topography of the Nigerian Environment.

5.0 Summary

This unit has interacted with you on the coverage and geology on the Nigerian environment. Remember that Nigeria occupies a total landmass of about 913,072.64 sq. km on the West Coast of Africa. Physiographic factors discussed include several plateaux, volcanic hills, plain and rocks. River Niger and it major tributary Benue were mentioned along size some major inland rivers like river Kaduna.

Introductory or overview of the geological features of the nation were mentioned.

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UNIT 4 TOPOGRAPHY OF THE NIGERIAN ENVIRONMENT: I

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1.0 Introduction

Welcome to Unit Four. This unit is unlike the three discussed briefly on Nigerian landmass and geology. This unit will interact with you in detail and systematically on the various topographical features of our beautiful Nigeria environment.

The normal geographical technique employed in the study of topography is based on vegetation belts. However, this technique will not be adopted in this module. A more detail approach will be employed, thus the topography of Nigerian environment will be discussed in units four and five.

2.0 Objectives

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

- Mention seven topographical features in the Nigeria environment
- Highlight the topographical features of Nigeria using diagrams.
- Describe the topography of southern Nigeria and the middle belt.

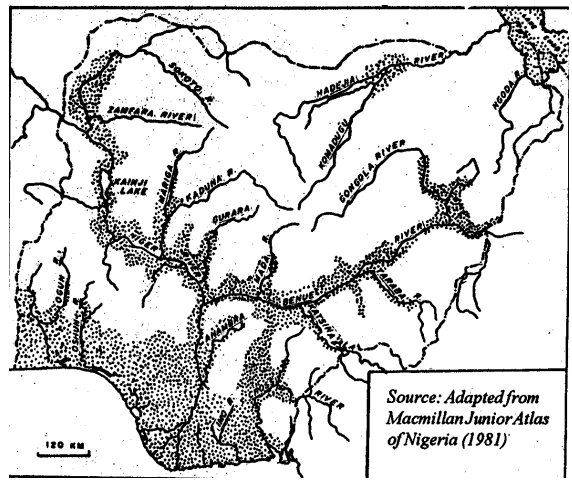

Figure 4.1 Topographical Map of Nigeria.

The names suggested are arbitrary. It must be remembered that in order tc produce a relatively simple sub-division of an area the size of Nigeria it is inevitable that any one unit should include a wide variety of landscape forms. The boundaries shown are therefore not clearly defined, except in a few cases, and the majority of the units plotted are capable of further sub-division

Source: NEST, 1991

3.1 The Niger Delta

The Niger Delta coast extends from the mouth of the Benin river, 500km to the mouth of the Imo River in the east (see Figure 4.2 above). There is a partial disappearance of sand giving room for the presence of mud. Figure 4.2 is a sketch map showing the extent of the Niger Delta from Benin River to Imo River. Adopted From Ajao, Oyewo & unyimadu (1996)

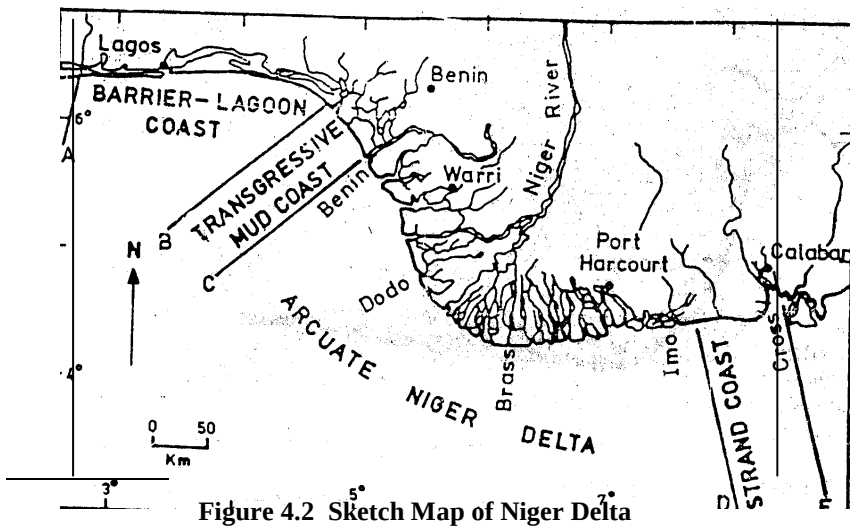

Figure 4.2 Sketch Map of Niger Delta

The Niger Delta is in plain form and is rimmed by a chain of sandy barrier islands about 200km^2 in area. These islands are truncated by tidal channels which leads to the mangrove swamp (Ajao, Oyewo and Unyimadu, 1996).

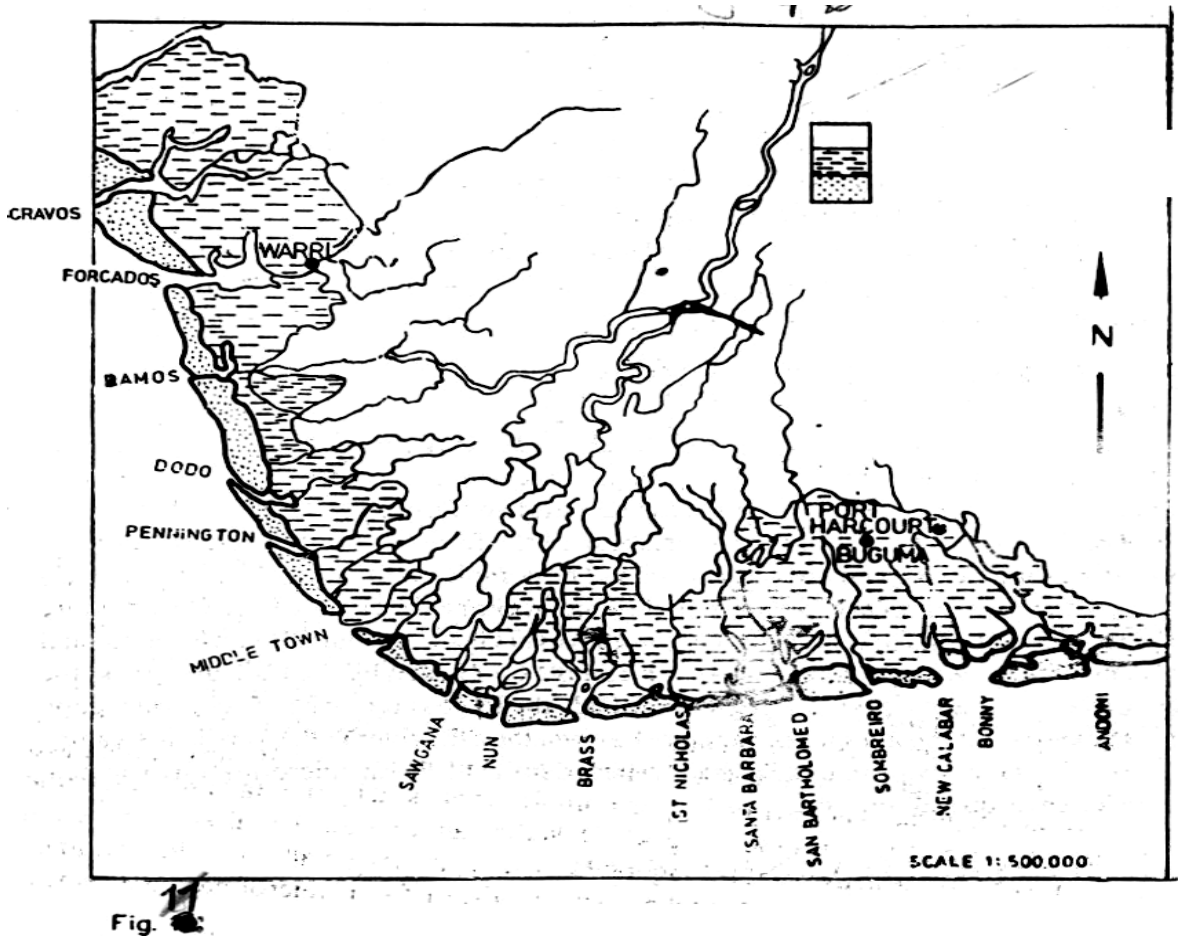

Figure 4.3 Sketch of the Ecological zones of the Niger Delta

Source: Ajao et al (1996)

Nigeria has the largest area of mangrove forest in Africa with an estimate of 9700km^2. The total brackish area is about 12,990km^2 and the saline swamps of the Niger delta occupies 750,000 hectares.

The radical pattern of the estuaries provides outlet to the sea through outlets of which include Forcados, Koko, Sawgana, Nun and Brass. These distributries. or estuaries are shown in Figure 4.3.The swamp extends over an area of 9000km` between the region of the Benin River to the Calabar-Riodel Rey estuary in the east.

3.2 The Dissected Margin

These are the most southerly of the mainland creating the linkage between the coast and high inland. They adequately reflect the dissected edge of the West African continental landmass evidently up-warping toward the interland arising from the coast.
The altitude varies from sea level to some hundreds of meters and landscape from the low scarps of the North Benin and the Ishan Plateau (Agabi, 1995). It also subsumes areas marked by relatively steep- sided valleys to areas not more than undulating.

The far southeast has this arbitrary division in the narrow belt of coastal mangrove and the Tiko plains North of Cameroon mountain (see figure 4.3).

3.3 Western Plains

Agabi (1995) mentioned that, Western Plain and ranges include all the areas of crystalline rocks west of the Niger and include different landscape. The landscape at Abeokuta has much in common with the northern parts of the dissected marginal areas, and shows common features of an area of active erosion, although with features typical of the rock types encountered. Examples are bare rocks faces and boulder strewn hills. Up north is a series of mature erosion surfaces with scattered inselbergs typical of much of crystalline basement of Africa -and well exemplified in Western Oyo.

A trip to Akure in Ondo State shows evidence of residual erosion domes. The highest altitudes attained were located in the Idanre hills, southwest of Akure. The various mature erosion surfaces are separated by areas of active erosion and youthful landscape forms (Agabi, 1995). lbadan is located in such an area.

3.4 South-East and Cross River Basin

This zone is mainly made of sedimentary rocks. Downlands, which subsume Anambra syncline, are principally made of upper cretaceous and the Cross River Basin is principally on the lower cretaceous. Towards the south are younger rocks giving a landscape similar to the red earth plains of Benin and Western Calabar.

The downland area (see Figure 4.2) shows typical scarp and dip-slope features as successive beds are encountered dipping to the West. So much of the landmass between Enugu and Awka is openly susceptible to erosion in Agulu-Nasnka gully erosion complex which is certainly one of the largest in the world (Agabi, 1995). Our nation is likely to remain agrarian for some years ahead as the greatest impact of erosion is still felt, with over 80% of the country being ravaged by it (Petters, 1993).

This problem is traceable to:

l. Volumetric loss of soil
2. Decrease in soil nutrient capacity
3. Moisture-retention capability
4. Organic matter content
5. Deforestation
6. Depth of soil

3.5 The Lower Niger Valley

As you go through this text, first locate "lower Niger Valley" in Figure 4.3, this will help you to understand and appreciate what we are discussing about on the topography of the lower Niger Valley.

This zone indicates, as you may have realized this from figure 4.1, a link between the wide flood-plains of the Niger and Benin troughs North of Lokoja. The river valley in the section is in shape contrast to the wide, mature valleys farther inland (Agabi, 1995). The experience here is that, when low water flow, the river channel is broken by low Island and sandbanks but these quickly disappear with the arrival of the flood water.

3.6 Niger trough

The first thing you should do before reading ahead is to locate the Niger trough in figure 4.1: This you will find very easy because it is a conspicuously large zone.

To navigate from Jebba to Yelwa may be near impossible because of rapids on the crystalline basement rock where the river runs. The trough has an upper cretaceous sedimentaries in the Niger valley and also the area of crystalline rocks across 'the Kontagora anticline from which sedimentary cover has been stripped.

The cretaceous rocks in the lower half of the trough include different flat- topped hills that are remnants of former erosion surface which can be distinguished from the bare rock domes (Agabi, 1995).

It has been perceived that the Niger trough is a representation of a broad down-warped area of upper cretaceous age, where sediments of that period were deposited.

3.7 The Benue Trough

In figure 4.1, you would notice that the Benue trough is adjacent to the Niger trough. The Benue river flows over sedimentaries throughout, and has suffered no transverse movements such as that of. the Kontagora anticlines.

The underlying basement is thus not exposed neither is the river gradient affected by the presence of rapids.

HINT A second thought on the last sentence above should make you realise the difference between the underlying basement of the Benue trough compared with the basement of the Niger trough.

Flat-topped hills of sedimentary origin occur in the lower parts of the trough, and again with more varied outline towards Yola, but the middle part of this region is characterized by small volcanic cones predicted to be of tertiary to recent in age.

3.8 Clarification of Terms

Cretaceous age: a geological age that covers between 136 to about 65 million years ago, when the **Tertiary age** began. The cretaceous is the last age of the **Mesozoic age**. There was a major phase of mountain building and associated volcanic and igneous activity in both North and South America. The cretaceous age is followed the Jurassic age.

Inselberg: an isolated, steep-sided, round-topped hill formed either by the differential deep weathering of bedrock to leave an upstanding feature of resistant rock, or by the slope retreat of an escarpment to leave a residual hill.

4.0 Conclusion

This unit has been able to give you a clear explanation on the topography of the Nigeria environment with specific reference to the southerly part of the country. You would have realised that different sub-divisions (as shown in figure 4.1) exhibit a gradient, which is influenced by several climatic factors, which depends on the geographical location of such area. These topographical diversities is a reflection of the rich and complex diversity of the Nigeria environment.

5.0 Summary

Since you have come to the end of this unit, you must have learnt about seven topographical features in the Nigerian Environment as reflected in figure 4.1. These features are labelled for the purpose of understanding as:

1. The Niger Delta
2. The dissected margines
3. Western plains
4. South-East and Cross River Basin
5. Lower Niger Valley
6. Niger trough and finally Benue trough.
7. Benue trough.

6.0 Tutor Marked Assignment

(a). Mention two differences between the topography of the underlaying basement of rivers Niger and Benue based on discussion in section 3.6 and 3.7.
(b). What is the implication of the differences mentioned above in region to navigation and safety.

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UNIT 5 TOPOGRAPHY OF THE NIGERIAN ENVIRONMENT: II

TABLE OF CONTENTS

1.0 Introduction

I do hope you find the last unit (four) stimulating and challenging. This unit like the previous one, we shall continue our discussion on the various topographical features of the Nigerian Environment. Within the confine of this unit we shall consider features up north, coastal waters and rivers in the south.

Consciously pay close attention to the maps/sketches that are provided or referenced. They will go a long way to assist you in conceptualizing what you are learning. Relax your mind as you concentrate on your learning.

It is important to remind you of the sketch map of the Nigerian topographical feature (figure 4.1). The sketch indicates all the features we shall discuss in this unit except coastal waters, which will be given more sketches to make your learning easier.

2.0 Objectives

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

- Mention five topographical features in the Northern parts of Nigeria
- Describe using sketch diagrams five topographical features in the Northern parts of Nigeria.
- Describe along with diagrams' four coastal zones in Nigeria.

3.1 High Plains of Hausaland

The high plains of Hausaland, as you will noticed in figure 4.1 (unit 4) is the largest size topographical feature in the Nigerian Environment. These plains of the Hausaland represent the major exposure of crystalline rocks in-the North. The plains are not homoges throughout and can be subdivided into a number of erosion surfaces, which are separated by scarps, or belts of youthful topography. These extensive peneplains often between 400m and 1000m are dotted by inselbergs and residual mass which may rise abruptly to 200 - 300m above the plains, mostly at North and West of the Jos Plateau and West of Kaduna.

Exercise: 5.1

Make an enlarged sketch\ of the High Plains of Hausaland

3.2 Jos Plateau

The Jos Plateau is situated on the South-East end of the High plains of Hausaland (see figure 4.1, unit 4). The Plateau is formed by a concentration of residual masses of older and younger granites between which are preserved Quaternary strata, partly volcanic which give rise to wide plains at
1000 - 1200m above sea level which the granite hills rise to over 1500m in Shere Hills. Some young volcanic cones have spilled larva down to the boundary escarpment (Agabi, 1995).

Exercise 5.2:

Make a sketch (an enlarge one with reference to figure 4.1) of the Jos Plateau.

3.3 Biu Plateau

This plateau has Tertiary to Recent volcanism which formed a distinct region of basaltic lava flows, volcanoes and vents at various stages of erosion. There are some steep boundary escarpments, especially facing the Gongola valley (Agabi, 1995).

Exercise 5.3

Make an enlarge sketch of the Biu Plateau

3.4 Sokoto Plain

The Sokoto plain is in the far North-West of Nigeria and is made of sedimentary rocks. The plains are regularly flat, with the presence of few hills which falls to an average of 50 meters, though, some are above. The Sokoto river with its tributary flows seasonally, especially during the raining seasons when it flows steadily north of Sokoto.

Exercise 5.4

Make an enlarge sketch of the Sokoto plain.

3.5 Chad Basin

Go to figure 4.1 in unit 4, as you locate the Chad Basin, you will realize it is on the extreme far North East of the country.

This area has an extensive sedimentary rock similar to the one in the North- West (Sokoto area). Most of this area has large plain features, not marked by hills.

Gradient on all the rivers are low, and very little water finally gets to Lake Chad. Most of this water in is lost by percolation or evaporation, swamps and marsh areas. Stream channels are ill defined and subject to frequent change (Agabi, 1995).

3.6 Coastal waters

In this section, we shall discuss on coastal waters, which will comprise lagoon, transgressive mud beach, strand coast and continental shelf. This region form a belt of varying width from the western to eastward, and ends somewhere in the creeks and estuaries of the Niger-delta. Ajao boundary et al (1996) classified the Nigerian coastal zones into four broad regions based on general morphology, vegetation and beach type.

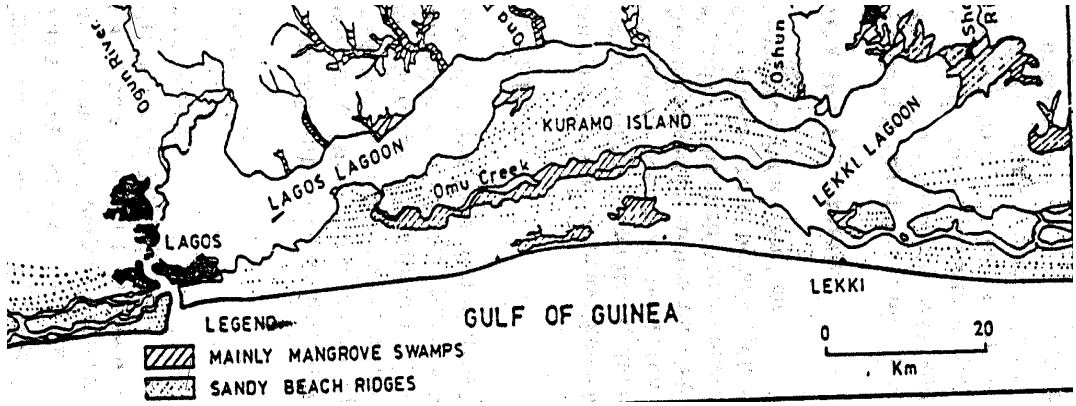
This classification is:

l. Barrier-Lagoon Complex
2. Trangressive Mud Beach
3. Niger Delta
4. The strand Coast

However, the Niger Delta zone will not form part of our lesson in this unit. You will recall clearly that we have just learnt about this zone in the immediate past unit.

3.6.1 Barrier-Lagoon

This part of the coastal waters has been estimated to cover about 200km from the Benin/Nigeria border eastwards to the western limit of the transgressive mud beach (see figure 5.1). Several studies on beach ridge and island-lagoon complex of Western Nigeria has shown that the formation of the complexes has been through sand ridging and prograding spits. The complex is the eastern most fringe of a chain of lagoon complexes adjacent to the Gulf of Guinea beginning from Cote d'Ivoire and passing through the mouth of the Volta River in Ghana, through Benin Republic and finally into Nigeria. The barrier - lagoon complex as shown in figure 5.1 below is be located in Lagos State. The complex is backed by the Badagry Creek, the Lagos Lagoon and Lekki Lagoon. Beginning at the margins of the lagoons and along the river valleys are low swampy areas. The lagoons are generally shallow with depth of l./5-3m, microtidal environment with often restricted circulation (Ajao et al, 1996).



Source: (Ajao et al, 1996).

Figure 5.1 Barrier Island - Lagoon Complex in Lagos and Lekki areas

3.6.2 Tansgressive Mud Beach

Ajao et al (1996) stated that the barrier lagoon complex grades eastward into a mud beach in the vicinity of Lekki Lagoon. They mentioned that the mud beach extends for 75km and terminates at the Benin river mouth on the northwest Flank of the Niger Delta (see figure).

The paucity of sand on mahin beach and environs is attributed to sediment loss to Avon and Mahin sub-marine canons off the delta toe. The mud beach is supported by fresh-water swamps that cris-crossed by Iortuos creeks.

3.6.3 The Strand coast

A study of figure 10 will help you locate a zone or band in the sketch labelled strand coast. You would realize that it streches (around Imo to Calabar) specifically from Imo River to Calabar River estuary at the Nigeria/Cameroun borders. The zone covers about 85km, and is a typical example of an estuary front.

A typical estuary front has the following characteristics:

1. Active mixing of river and oceanic waters
2. Build up of micro-deltas
3. Occurrence of anomalous tidal ranges

Two major breaks occur in this zone. First is a well-developed delta at the Qua-Iboe river mouth and secondary at the Cross River entrance. The entire coast is backed by mangrove swamps with species similar to the ones you find in the Niger Delta zone.

3.6.4 Continental shelf

Continental shelf is small in size averaging 20-25km in width in Lagos and 64km off cape Formoso at the nose of the Niger Delta, and reaching 75km offshore Calabar in the east. This continental shelf breaks often at 100-120m and occasionally at 160 meters (Ajao et al 1996). The midway to outer shelf is incised by submarine canyons (Avon, Mahin and Calabar) and many other smaller gullies. The shelf is known for semidiurnal tides and low 1-3m tidal range. Waves are generally spilling while the high angle beaches experience plunging breakers reaching 2 - 3m high.

3.7 Clarification of Terms

Quaternary: a period which is referred to as the present geological period that followed the TERTIARY PERIOD and began around 2 million years ago. Quaternary period can be divided into two,

l. Holocene (Recent) about 10,000 years ago
2. Pleistocene about 2 million years ago.

Tertiary Period: It took place between 38 - 65 million years ago.

4.0 Conclusion

You must have acquired adequate and clearer understanding of the topography of the Nigerian environment in general and in this unit specifically, you must have understood the various divisions of the topography of northern states. The gradient of the topography progresses higher as you move northwards but this is interjected by the Jos and Biu Plateau with a much higher gradient and then gradually descends.

Our coastal water is quite rich with four other sub-zones, which are rich with various and different bio-diversity creating a beautiful environment for recreation.

5.0 Summary

This unit has so far discussed with you systematically on the various topographical features of our beautiful Nigerian environment. We have discussed on the high plains of Hausaland, Jos Plateau, Biu Plateau, and plains of Sokoto and Chad. Graphic representations of these areas were also indicated. The coastal waters were also outlined which include Barrier - Lagoon complex, Transgressive Mud beach, strand coast and continental shelf. The coastal zones progress systematically into one another from the Barrier - Lagoon complex to the continental shelf as you move towards the shore.

6.0 Tutor Marked Assignment

1. Describe along with diagrams any two of the following:

   (a). High Plains of Hausaland
   (b). Jos Plateau
   (c). Biu Plateau
   (d). Sokoto Plain
   (e). Chad Basin

2. (a) (b) State three characteristics of an estuary front
   Mention two major breaks that occur in the strand coast 7.0

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MODULE 2

THE NIGERIAN ENVIRONMENT CLIMATE AND VEGETATION

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UNIT 1: CLIMATE AND THE NIGERIA ENVIRONMENT

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1.0 Introduction

This unit is focused on the factors that influence Nigeria as an Environment. Climate has influence on any environment and is a major determinant of what makes up an environment especially as it relates to the biosphere or living organisms including human. Climate also plays significant role and influence on other abiotic components. It thus works in creating a conducive place for human, plants and animals, what ecologist may regards as Ecosystem or perhaps habitat or simply a home.

This unit will take you systematically through a series of factors that influence your environment, which will help you appreciate the environment of variety of species.

2.0 Objectives

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

- Define the term climate
- State five significance of climate on environment
- Explain the relationship between solar radiation, movement of air masses and wind system in Nigeria.

3.1 Significance of climate factors

Climate is an essential indicator of the abiotic environment and the survival of the biosphere. This is not an exemption in the Nigerian environment.
The significance of climatic factors include among others the following:

l. Climate determines the way the topography of an ecosystem will look. This is because it directly affects the agents of slope formation by either reducing or increasing its effect thereby influence the gradient or slope of that ecosystem. The outcome or the form, which the terrain of a place takes low, high or undulating is described as the topography. This is the physical structure of that environment.

2. Climate directly influences a variety of animals' decision on where to settle down as "Home". It also determines their possibility of survival. No animal will continue to make an ecosystem a home if the climatic factors have changed to a point that the survival capacity of such an animal cannot cope with the climate. Decision will have to be taken between survival and retaining the "home". Survival being the first law of nature, such an animal will have to move to another ecosystem whose climate is tolerable.

3. Climate determines the 'kind of vegetation found in any place in Nigeria. The vegetation belt in Nigeria are determined by climatic factors. The type of trees found in the south is often very different from what is obtained in the north. We don't find rain forest for instance in Kano neither can we find desert encroachment in Delta State.

4. Climate determines the kind of cover or dress to put on.Clothing is worn to suit seasonal prevailing climatic condition. The south experience very often-thick cloud cover year round thereby shielding the sun's radiation, unlike the North where cloud cover is not as regular as the south. The implication of this is that cloths worn in the south are usually light all year round relative to the north. Also the intensity of the sun varies between the north (inadequate cloud cover and the south (adequate cloud cover).

5. Climate determines agricultural planting seasons and output. It is the climatic factors that determine for farmers in Nigeria what and when to plant and the yield to expect at the end of the day.

Climate is defined as the physical characteristics of the troposphere of an area based on analysis of its weather over at least 30 years.

3.2 Climatic Factors

3.2.2 Insolation

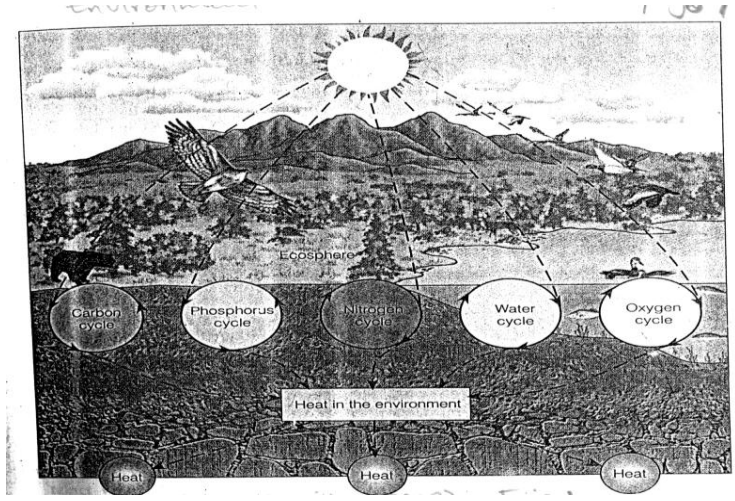
Insolation may be described as the amount of solar radiation falling upon an environment per unit area. The amount of solar energy, that gets to the outer atmosphere of the earth is called the solar constant.

Less than 50% of the solar constant pass through the atmosphere and arrive at the earth's surface. The remainder is reflected back into space by dust and clouds or is scattered by air. Molecules, water vapour and dust is absorbed by the atmosphere.

The solar radiation that penetrates through to the surface of the earth may be:
1 Reflected back into the atmosphere and eventually into space
2. Absorbed by the earth's land mass and water bodies, which is eventually lost through convention, conduction and long wavelength infrared radiation to the atmosphere.

The quantity of insolation experienced by an area hinges on solar constant, latitudinal position, season of year and the transparency of the atmosphere.

Insolation patterns are essential factor in the development of natural environments and also influence human activities such as agriculture.



Source: Miller (1999)

Figure 6.1 Sun provides Energy for the entire environment.

It is the most significant climatic parameter because it provides energy for the entire environment. Solar energy on earth initiates energy balance, water balance for plant

growth, light energy for photosynthesis, pressure systems and other associated weather characteristics (see figure 6.1 above).

Solar radiation is most often measured indirectly by using sunshine recorders. However, studies have shown that sunshine and the amount of solar radiation have direct relationship. This means that as sunshine increases solar radiation also increases and vice versa.

The sun being the source of solar radiation has been described by some scientists as a gigantic fireball of hydrogen (72%) and helium (28%) gases (Miller, 1999). Temperature on the surface of the sun has been estimated to be over 6000°C. Temperature and pressure in the inner core is so high that hydrogen nuclei fuse to form helium nuclei to release very large amount of energy.

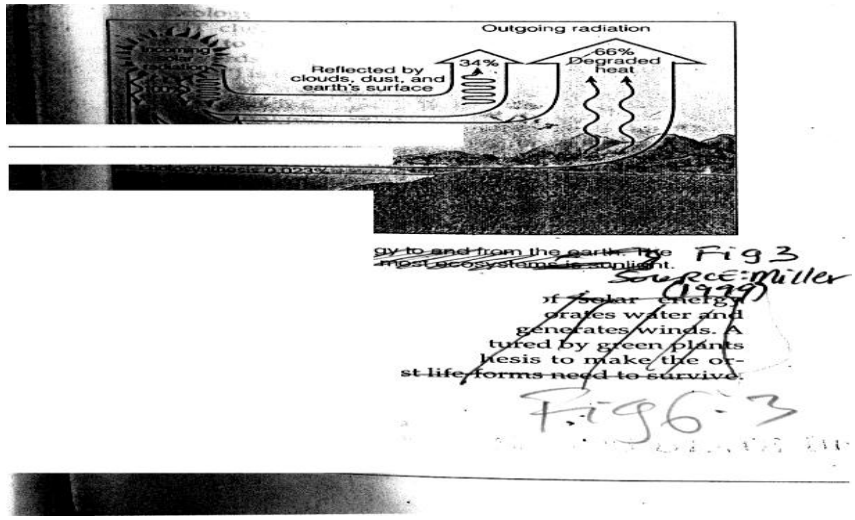
Solar energy in all directions in the electromagnetic spectrum differs in wavelength and energy content.

(Not to scale)

Source: Miller (1999)
Figure 6.2: The sun and electromagnetic radiation

This radiation moves at the speed of light and makes the 150 million km trip to the Earth in about 8 minutes. The earth is been compared to a grain of rice within the entire Milky Way.

The time space occupied by the earth gives the opportunity to receive only about one billion of this output of energy. About 28% of the solar energy reaching the troposphere is reflected back into space by clouds, chemicals, dust and the earth's land and water surface.



Source: Miller (1999)

Figure 6.3 Incoming and Outgoing Radiation from the Sun

Most of the remaining 72% of solar radiation warms the troposphere and land, energize the hydrologic cycle (see figure 2.5 in unit two) by way of evaporating water and cycles it through the biosphere, and generate wind.
Avery small fraction of about 0.023% is captured by green plants, bacteria, and stimulates the process of photosynthesis.

In Nigeria the average animal sunshine hours has been reported to be 1,300 in the south (example Delta State) while 3,200 hours were reported in the North (example Yola).

The hour of sunshine is more dynamic as you move southwards of latitude
9°N. To the north of the altitude where the change is more stable. The latitude 9°N is the approximate surface location of the inter-tropical Discontinuity (ITD) that is, the region of penetration of moist maritime air mass.

Please note that the values presented above are not the same for all the months, but varies with time. For instance, January - March, the average sunshine hours in the south vary from 200, to a maximum of 325 at Maiduguri (by January). Considering the period when rainy season should have begun, April, May and June, the increase in cloud cover reduces sunshine intensity to less than 300 hours in the North-East. The lowest sunshine records for our country are found between July and September when the Niger Delta zone records 20 hours of sunshine.

The length of sunshine hours does not make significant impact on an environment or in our country rather it is the system of net radiation for heat and water balance (see figure 1). This is what influences the Nigerian ecosystems or any other environment.

Note: Net Radiation is the balance between in-coming and outgoing radiation.
See figure 6.1 and 6.3 for graphic conceptualization.

Try and, imagine figure 6.1 buried within figure 6.3 specifically between in-coming and out-going radiation.

In Nigeria, it has been found that, the values of the net daylight radiation increase Northwards from the coast to around latitude 12°N. Then there is a fall towards the Northern boundary. At the surface, radiation follows the same format reaching about 60 kgcal$M^{-2}yr^{-1}$ along the coast, to 80 kgcal$M^{-2}yr^{-1}$ in latitude 8^0N and kgcal$M^{-2}yr^{-1}$ in the midst of Northern Nigeria (Ojo, 1972).

Exercise 6.1:

Locate latitude 12°N on the Nigeria Map.

Note: kgcal$M^{-2}yr^{-1}$ implies kilocalorie per meter square per year

The values indicate that the average net radiation is about 55 per cent of the total incoming radiation in Nigeria. However, in the dry season the skies are clear with few cloud cover with an average yearly value at 70% but declines to only 45% in the rainy season when more cloud exist.

3.2.3 Air Masses and Wind Systems

The apparent movement of the overhead sun which, causes seasonal variations in radiation results in periodic shifts of pressure belt.

Note: the sun does not move but the earth. I hope you do remember that in your geography, that is why it is said to be the "apparent movement of the sun".

These shifts are associated with the North-South movement of the I.T.D. between the dry sub-Saharan air and the humid maritime air from the Atlantic Ocean. The ITD and its' position at any point in time are significant in that they dictate the zonal patterns of surface weather on both the north and south sides (Agabi, 1995).

The ITD is usually situated at.the northeast of the Lake Chad Zone by July. By November, it migrates southward, moving from Northwest to southeast of Sokoto and Kano respectively. In January the ITD lies just a little north of the latitude of Lokoja. By March, it starts a northward movement again and now runs from Northwest to Southeast in the immediate North of the latitude of Jos.

The import of these shifts is that they influence the depth of a particular air mass over Nigeria at given seasons of the year. During the period, June to July when the ITD is situated Northeast of the Lake Chad Region, the prevailing wind over the entire Nation is the South westerly tropical maritime air mass (TMA). As the ITD migrates south Westerly tropical maritime air mass over Nigeria also reduces and only the central areas are under its influence. The North Easterly dry, sub-Saharan tropical air mass (EC) consequently penetrates deeper as the ITD withdraws southward.

As the sun moves north and south from the equator during its annual cycle, the land and water beneath is warmed. The warm air and water vapor rise and form a slight vacuum-a low-pressure zone. This area of calm, ascending air falls between the trade wind zones along the equator and was originally called the *doldrums.* Now, the more commonly used terms include the Intertropical Convergence Zone (ITZ or ITCZ), the Intertropical Discontinuity (ITD), and the Intertropical Front (ITF). This zone is important for African agriculture, because the rising air and water vapor caused by the warmth of the sun lead to clouds and rainfall. The line of rains tracking the sun's movement forms a wave-shaped pattern stretching east to west across the continent. Although the line is tracking the sun, atmospheric conditions can speed or delay the progress of the line, so its location is not exactly the same from year to year. This difference in location of the rains can make or break crops in their path, especially in marginal areas, such as the sub-Saharan Sahel zone. Doug LeComte of NOAA tracks the movement of the ITD.

4.0 Conclusion

This unit has been able to address the climatic factor that influence the Nigerian Environment. You must have realized that the Nigerian Environment is influenced by climatic factors which determinate our vegetation.

5.0 Summary

So far, we have learnt about climatic factors in Nigeria.Specifically we discussed about the importance of the climatic factors in Nigeria. Climate influences the ecosystem topography, the decisions of a variety of animals on where to live, kind of vegetation found in a particular location and the kind of cloths we sometimes put on. It also goes a long way to influence our agriculture - planting seasons and crop yield.

We learnt that insolation is the amount of solar radiation falling on a particular unit area. That this energy plays very significant role in energizing the ecosphere, and thus ensures the survival of flora, fauna and human.

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UNIT 2 CLIMATIC FACTORS IN THE NIGERIAN ENVIRONMENT

TABLE OF CONTENTS

1.0 Introduction

This unit like the previous one will guide you in learning about the factors that influence Nigeria as an Environment. This unit is a continuation and the second part of unit four. In this unit we shall discuss on temperature, humidity, rainfall, evaporation and evapotranspiration. We shall also study about how these climatic factors influence the ecosphere - ensuring survival of flora, fauna and human.

2.0 Objectives

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

- Point out climatic factors that influence our environment
- explain how climatic factors influence the ecosphere
- explain the temperature pattern of Nigeria
- explain the humidity and rainfall pattern in Nigeria.

3.1 Temperature

The temperature in Nigeria is similar to anyone within the tropical region. The mean temperature over most of Nigeria is about 27°C. The highest temperatures are often recorded during the month of March in most southern states but April for most Northern states are recorded usually during the month of July (peak of the rainy season) and for most Northern states it is December.

The temperature range of any environment is the difference between the mean maximum and mean minimum temperatures. This can be represented mathematically:

Temperature Range (TR) = Mean maximum Temperature (MMT_2) - Mean Minimum Temperature (MMT_1)

$TR = MMT_2 - MMT_1$

The mean maximum temperature for southern area was found to be 30°C while the mean minimum temperature was found to be 22°C. In the Extreme North, the mean maximum temperature was found to be 41^0C while the mean minimum temperature was found to be 20°C. Jos recorded a mean maximum temperature of 28°C and a mean minimum temperature of 17°C.

Note that the MMT_2 vary from 32°C from coastal states (Lagos and Delta) to 41°C in Northern states like Sokoto and Maiduguri. Also the MMT_1 drops also from 22°C along coastal states to about 17°C in the Jos Plateau. It then rises gently from 17°C to 21°C.

Exercise 7.1

1. Calculate the mean annual range temperature in southern Nigeria
2. What is the mean annual range temperature in Gumel(Jigawa State)?

You may wish to use your atlas to locate Gumel.

Along the coastal belt, the mean annual range of temperature reaches 7°C and rises steeply to 130°C in the Southern half of the country. Then there is a gentle rise to 16°C in the Borno State.

3.2 Humidity and Rainfall

3.2.1 Humidity

There exist a close relationship between the difference in temperature and humidity of the air.

Note: Humidity of an environment is the amount of moisture or water vapour present in a given air mass of that environment or an ecosystem.

Humidity of an environment is significant because it is an index of the moisture content in environment for the survival of the biosphere.

The pattern of humidity in Nigeria follows the south-north dichotomy. It is highest in the coastal areas where it reaches about 90% between June and October and falls to less than 25% in the North between January and April. It also fluctuates from one period of the day to another, being highest at dawn and lowest in late afternoon

3.2.2 Rainfall

The twin effects of temperature on pressure belts and humidity variations are reflected in the-pattern of rainfall.

Our rainfall exhibits the following characteristics and are mentioned by Agabi (1995).

1. The quantity and duration of rainfall decreases as you move from the coast to the interior except latitudinal effects in localised areas such as the Jos plateau.

2. The ITD is very influential in the determination of the time of inception and cessation of rainfall.

3. Rainfall is caused by the influence of many factors including
   (i) Closeness to the sea
   (ii) The wind pattern
   (iii) Storms and disturbances

Generally, the mean annual rainfall varies from above 3000mm around Brass and Calabar to between 1500 and 2000mm in Enugu and Ondo and less than 50cm in Sokoto and Maiduguri. Intensive rainfall is usually between June and September. The south experience rainfall earlier, longer and more intensive than the north.

4. Rainfall in Nigeria exhibits variability. The rainfall variability correlates negatively with the amount and duration of rainfall.

Variability of rainfall deals with the time of inception of the
first rains, the duration and length of the rainy season and the amount of rainfall expected in any place.

In this regard, rainfall variability index is smaller in the southern parts but increases northward. Thus, if rain comes earlier or later than when it is expected or in an amount that is unusual and last for an unprecedented length of time there could be a very serious ecological disturbance.

Rainfall sometimes could vary in quantity and intensity from time to time. This form of rainfall is labelled as **seasonal variation.**

Rainfall could also differ in quantity, duration and periodicity from year to year. This form of rainfall is often tagged as **annual variation.**

A particular number of years (5-7 years) may exhibit consistent variability pattern which makes it possible for one to conclude that they have similar rainfall pattern. These might be followed by another set of five to seven years which present remarkable regularity even though there are major differences from one year to another.

It is this prolonged change of water balance in the ecosphere which causes major ecological invasion and succession.

3.3 Evaporation and Evapotranspiration

Evaporation and Evapotranspiration are two related concepts to the rate of water loss from surfaces. While evaporation is used to describe a situation of water loss from surfaces, bare soil and rock. Evapotranspiration is used to describe water loss from both

plant and bare surfaces. Evapotranspiration determines the actual quantity of water that is available for plant and animal life.

The rate at which evapotranspiration occurs is determined by:
1. Vapour-pressure
2. Air temperature
3. Wind

Both process (evaporation and evapotranspiration) can be measured directly or indirectly through the application of meterological formula and water balance equations (Agabi, 1995).

Some of the methods employed in measuring evapotranspiration include evaporation pans, sunken tanks and raised tanks. Although final outcomes are not the same the differences is not quite significant and one can safely make general statement of high level of credibility in respect to the pattern of evapotranspiration over Nigeria. The values are always and generally highest in the North than in the Southern States. Ayoade (1976) recorded values five times higher than the mean annual rainfalls received at the stations.

3.4 Climatic Factors and the Ecosphere

Note that the climatic factors so discussed have implications for the ecosphere. The heat energy for plant growth is supplied by the sun. Thus insolation determines the potential energy in the ecosystem. Insolation also influence the pressure system, the prevailing air masses surface temperature, humidity, rainfall and evapotranspiration. A synthesis of these factors consequently influence light energy and the water balance in the ecosphere and the length of the growing season (Agabi, 1995; Miller, 1999).

4.0 Conclusion

This unit brings to an end our discussion on the climatic factors that influence the Nigerian environment. The processes of these climatic factors as discussed in unit six and seven have worked together to determine the various ecological zones in Nigeria today.

5.0 Summary

In this unit, you have learnt about climatic factors in the Nigeria environment. Factors such as temperature, humidity, rainfall, evaporation and evapotranspiration were discussed.

The temperature of Nigeria was described as being similar to any one within the tropical region, with a mean temperature of about 27°C. Calculation of. mean annual range temperature was also learnt.

The pattern of humidity in Nigeria follows the south-north dichotomy, though varies spatially and temporarily. It is highest in the coastal areas and lowest in the far north.

Rainfall has various characteristics such as quantity, duration and intensity.

6.0 Tutor Marked Assignment

I (a) Draw a map of Nigeria showing the mean maximum temperature and mean minimum temperature for the following states:

(a) Lagos
(b) Delta
(c) Kano
(d) Sokoto

1 (b) What is the annual range of temperature in these states.

2. What did you observe in the annual range temperature of south and north.
3. What are the implication of your observation in two above.

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UNIT 3 NIGERIAN ENVIRONMENT AND FOREST ZONE 1

TABLE OF CONTENTS

1.0 Introduction

In. the last two units we looked into climatic factors of the Nigeria environment. You will recall that these units related the importance and influence of climatic factors to the vegetation cover in Nigeria. To a large extent, climatic factors are the determinants of the kind of vegetation cover in each ecosystem.

Units eight to ten will pay special attention to the vegetation of Nigeria, although unit 11 (wet lands) will do the same, but will be discussed specially since the wetland ecosystem can be found in either the forest and savanna (few) vegetation of Nigeria.

You will therefore have to consider this unit as one that will lay the foundation of the next three units. It will also give you a clear pictorial representation of Nigeria's vegetation flow.

3.1 Global View of the Nigeria Vegetation

Natural vegetation cover in Nigeria gives us an array of products and services that play important roles in our national economy and general wellbeing.

Many Nigerians because of poverty (about 63%) and high level of illiteracy, (49%) have seen vegetation as an infinite natural resource thus it has been misused and abused. We have also taken its protection functions and potential worth for raw materials supply as not very relevant. We are missing the mark.

Believe it or not, the more we lose our vegetation cover the more likely we suffer from desertification, accelerated and intense soil erosion, rapid loss of soil nutrient for farming which will lead to low form yield and eventual loss of farmland.

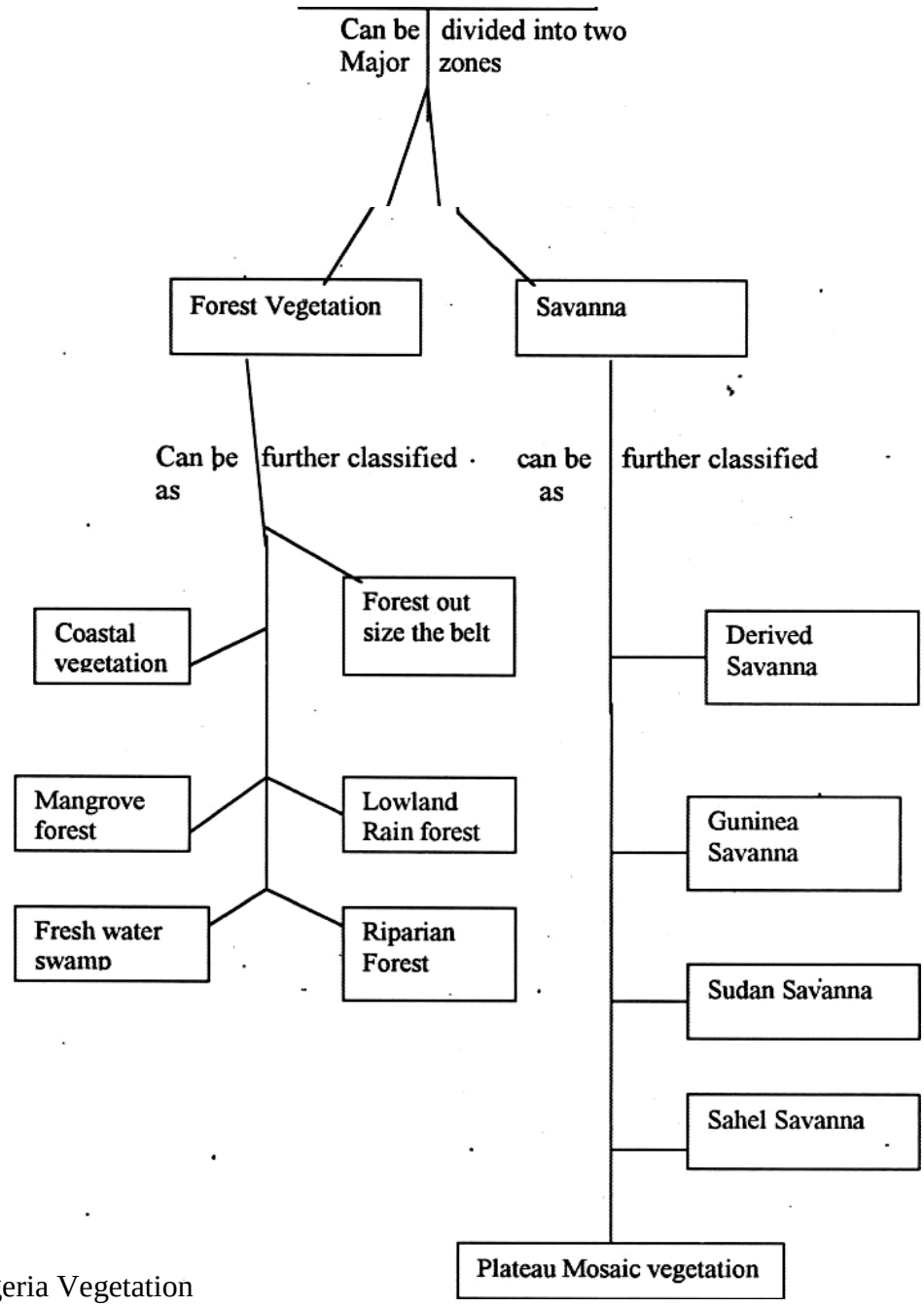
We are greatly blessed with great biodiversity in our natural vegetation, especially in the forest zone. This zone's rich flora are houses of several raw materials essential for the manufacturing of pharmaceutical products.

Information: Nature is Wealth Do All You Can to Preserve it

In 1993, divers exploring the seabed more than 3,500 meters under the North Eastern pacific discovered a community of giant tubeworms, and bacteria that live in underwater volcanic vents. No oxygen or sunlight; under great pressure, in temperatures well over 200^{o}C and in the highly toxic environment containing poison its hydrogen sulphide. Similar communities have been discovered in deep vents off the coasts of Japan. These totally new life, forms do not depend on photosynthesis, but actually thrive on superheated, hostile poison its water and smoke.

Scientists - especially from the Woods Hole Oceanographic Institution in the USA and the Japan Marine Science and Technology Centre (JAMESTEC) have found that these "thermophile" (heat- loving) bacteria live in symbiosis with the larger organisms, transforming the hydrogen supplied with the larger organisms, into nutrients. These bacteria have potential uses for waste treatment, food processing, oil well services, paper processing, mining application, and in the pharmaceutical industries. Their estimated potential value is 3 billion U.S Dollars per year. Japan is already investing researchers into potential industrial uses for these new life forms. Source: Ahove 200I

The vegetation cover of Nigeria can be classified naturally into two major types based on the north - south dichotomy. The entire classifications is explained diagrammatically as in figure 8.1



Nigeria Vegetation

Usually in the south / 1

Usually in the north /

Figure 8.1 Classifications of the Nigerian Vegetation using concept map

3.1 Forest Vegetation

Our forest vegetation is dominated by woody species, the majority of which are trees. About 60 years ago, such vegetation covered much of southern Nigeria. Logging, farming, particularly of the bush fallow and land rotation type associated with bush-burning, urban and infrastructural development and conversion to plantations have reduced the true forest area to patches found in forest reserves (NEST, 1999). These patches form about 10% of the forest land area.

A survey conducted between 1973 and 1977 covering 1.3 million hectares of forest reserves revealed about 1.1 million of true forest. Much conversion of forest reserves to plantation of fast growing exotics have taken place in these reserves since 1977 so that the area of true high forest in the south is probably for less than a million hectares. Aside the reserves, the vegetation in the forest zone is a mosaic of farms, fallow vegetation of various ages and degraded or converted land. Relics of forest maintained as sacred groves can be found in southern states near royal houses, priest's home or shrine, farmland and several other possible places. These religious reserved forest are usually small in size, often less than one hectare.

The FAO reported during the 1960s that amongst states in Nigeria that have tropical rain forests, Bendel was the best and most favourably placed for intensive forestry development from the points of view of suitability of soil, climatic conditions for tree growth, communications, etc. Yet today, just over
20 years later, Bendel State forest resources are-depleted to the point of exhaustion and the high forest is in great danger of becoming a faint memory of the past.

It may be too late to save most of the forests of Bendel State, but a serious attempt must be made to do so. The following require urgent consideration and implementation

(a) Plantation establishment, using both indigeNTIs and exotic species covering large and protected areas.
(b) Protection and regeneration of natural forest, particularly at Okomu and to Include the Wildlife Sanctuary.
(c) Vetting of -those allocated forests to ensure they are bona fide processors, willing to assist in forest regeneration.
(d) Total abolition of the laungya farming system in the forest estate.
(e) Stiff penalties for illegal felling and trafficking in illegally felled logs. and for corrupt officials.

Worldwide, over half of the tropical rain forests have already been destroyed. By the year 2000 a further 15.2% had disappeared, resulting in the extinction of many plant and animal species, soil erosion, flooding, drought and other types of natural catastrophes and disasters we read and hear about daily.

Nigerian Conservation Foundation Newsletter, Vol. (2), 1988.

3.2.1 Types of Forest

The forest zone located southerly may be classified into other zones which are:

l. Coastal vegetation

2. Mangrove forest

3. Fresh water swamp

4. Riparian Forest

5. Lowland Rain Forest

6. Forest outside the belt

This unit will discuss on the first two sub-divisions the rest will be studied in the next unit

3.3 Coastal Vegetation

The coastal vegetation is known for the formation of mangrove. This vegetation exist mainly as strand vegetation dominated by halophytes (salt- tolerant plants) growing at the edges of the mangrove swamps, near the seaboard, or mixed with the mangroves themselves. Strand vegetation consists mainly of shrubs.

Studies have shown that coastal vegetation along the entire coastline of Nigeria is made up mainly of 43 plant species. Landwards, coastal vegetation consists of a mixture of climbers, sedges, and thickets of shrubs and trees.

The total width of this type of vegetation varies from a few meters to about 100m (NEST, 1991). Perhaps because of its small extent and simplicity, Nigerian strand vegetation has been infrequently described. This vegetation is currently under the threat of extinction by oil pollution. The limit to which strands vegetation contributes in stabilizing beaches against coastal erosion in Nigeria is not known, but is definitely significant.

3.4 Mangrove

Immediately after the strand vegetation is the mangrove, mostly found in the Niger Delta. This type of vegetation is best developed in the delta area of large tropical rivers where the vigour of the sea surface is broken by sandbares and where rain forest climate is prevailing (NEST, 1991).

Mangrove also survives in marine and brackish ecosystem, between the high and low tide marks. It may be seen as narrow strips, for several kilometers inland, along the banks of the major rivers in the delta.

The mangrove in Nigeria is dominated by red mangroves (Rhizophoraceae) in association with White mangrove (Avicennia) and laguncularia racemosa. The red mangrove is of three types - Rhizophora racemosa, Rhizophora harrisonii and R. mangle. However, Rhizophora racemosa is the commonest species, covering over 90% of the mangrove area. It is the first species and next to it is r. harrisonii and R. Mangle respectively, as you move towards the drier parts of the swamps.

Unlike Rhizophora, Avicennia is a smaller tree, which grows singly on firm land. The distribution pattern of the Rhizophora species is apparently related to their salt tolerance, with R. racemosa being less tolerant than r. mangle.

The last mangrove specie haguneularia, are fewer in population and can be found mostly inland from the Avicennia (white mangroves) belt. The only salt-water fern in the world, Acrostichum aurum, occurs in older parts of the mangrove swamps, where dense swards of the fleshy herb, sesuvium portulacastrum also exist. The exotic but largely naturalized Nipa palm (Nypa fructican) is replacing native mangroves especially along the Andoni and Bonny Rivers.

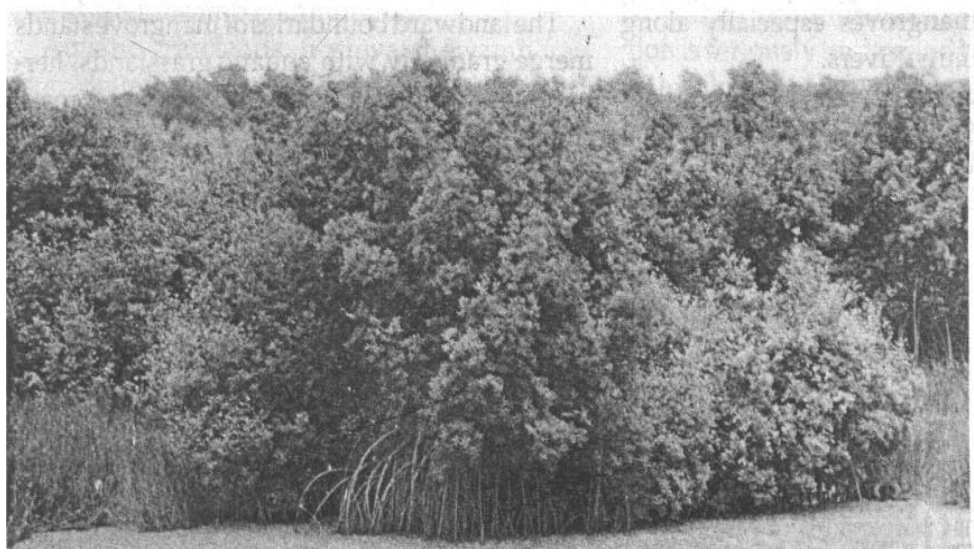


Figure 8.2 Mangrove Vegetation

Reforestation of mangrove trees requires fresh deposited soft mud that will enable the seeding to take firm roots. This will ensure their survival and establishment. The root-mat formed by the fine rootlets into which stilroots of Rhizophora species divide help consolidate the mud into firmer substrate on which any colonizing seedlings develop poorly.

The mangrove vegetation exhibits a pH of less 4, indicating high acidity of the sulphate soils. This explains why only few species are found in the mangrove zone. More than 80% of the mangrove swamps of the Niger delta are characterized by such acid soils which call for extensive liming before they can be effectively used for crop production or acquaculture.

Currently about 3% of the mangrove vegetation in Nigeria falls within forest reserves. The implication of this is that only 3% of our mangrove are adequately protected. Thus, an expansion of such reserved area, couple with, a regime of management for sustained production of benefits, is urgently required to develop our mangrove vegetation. Mangrove is perhaps the most extensive land ecosystem threatened by activities of the oil industry.

The landward boundaries of mangrove merge gradually with aquatic grassland, herbaceous swamps, freshwater swamp forests, riparian forests, or forest-savanna mosaics, depending on local conditions.

4.0 Conclusion

In this Unit, you have been led into an understanding of the diversity of the Nigeria vegetation. The vegetation zones in Nigeria divide naturally into two (south and north) creating the Forest and savanna respectively. The kind of vegetation cover in the south is basically forest, which is enriched with numerous biodiversity. The forest zone was the focus of this unit.

5.0 Summary

This unit has discussed the vegetation of Nigeria first from a global perspective. The Nigeria vegetation was presented systematically using a concept mapping technique, which enabled you to acquire a metacognition of the divers vegetation zones in Nigeria.

Specifically we discussed the forest zone located southward of the country which is sub-divided into other types namely coastal vegetation, mangrove forest, fresh water swamp, Riparian forest, lowland rain forest and finally forest out size the belt. More specifically, coastal vegetation and mangrove forest were discussed and a photograph of the latter shown.

6.0 Tutor Marked Assignment

(a) Using graphic representation outline the divers vegetation zones in Nigeria
(b) Mention a state in Nigeria where each zone outline above may be found.

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UNIT 4 NIGERIAN VEGETATION AND FOREST ZONE 11

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1.0 Introduction

This unit is a continuation of the last one. We shall discuss four other types of vegetation in Nigeria (See Figure 8.2). The presentation or discussion will flow logically and geographically as.you move hinterland from the fresh water swamp to the lowland rain forest and finally to forest outside the forest vegetation zone.

This will help you acquire a clear picture of how the forest vegetation in Nigeria progresses or looks like as you travel away from the coastal shores to the hinterland.

2.0 Objectives

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

- Fresh water swamp
- Riparian Forest
- Lowland rain forest

3.1 Fresh Water Swamp

The Fresh Water Swamp is located North of the Mangrove Forest. This area is composed of aquatic grassland, freshwater swamp, forests, deltaic swamps and differentiated swamps make up the freshwater area. It extends in lowlying places along waterways inland in the forest zone. In the late 1980s these communities were heavily protected from human activities by the swampy ground on which they exist. Today, their existence in the delta is challenged by the ingress of sea water along canals constructed by the oil industries to ease movement to the sea.

Studies around oil fields in the Niger delta show that massive destruction of vegetation has taken place. These freshwater communities are exposed to saline water introduced through these canals (NEST, 1991). In other places road-building activities threaten freshwater swamp communities. Damning of waterways and siltation alter the water regimes of the soils, leading to the death of the communities. You will observe these dead swamp communities along new roads especially when you are in Delta or Edo States.

The freshwater swamp community occupies about 21,000 square kilometers of the forest zone. Members of this community are:

1. Aquatic grassland and herbaceous swamps
2. Terrestial swamp forest
3. Undifferentiated inland swamps

Table 9.1

Showing spread of freshwater swamp communities in the forest zone states of Nigeria.

States	Area of Swamp Communities	Swamp Communities in Forest Reserves Sqkm
Edo & Delta	7682.81	879.70
Rivers & Bayelsa	5937.48	806.35
Cross River	2178.19	500.00
Akwa Ibom	1871.89	23.44
Ondo Ekiti	1504.73	-
Lagos	907.77	25.00
Ogun	625.01	46.88
Imo & Abia	426.57	148.44
Total	21,134.45	2,429.81

3.1.1 Aquatic grassland and herbaceous swamps

You can easily locate this community on the outer edge of swamp forest and mostly consists of floating vegetation of the grass Vossia Cuspidata. There are also several other grass species and dicotyledoNTIs herbs such as Jussiaea, Polygonum and IIpomoea species.

This is the habitat being increasingly invaded by the water hyacinth, Eichornia cassipes.

Grassland

Figure 9.1

3.1.2 Terrestrial Swamp Forest

The terrestrial swamp forest replaces the aquatic grassland inland from the water front. These formation is characterised by an outer edge, close to the water edge, dominated by Raphia.

Trees in this section of the swamp is hardly more than 15m tall. Behind this, the freshwater swamp may be as high as 45m. The commonly known species are the Abura (Mitragyna ciliata) timber. Other include ironwood species e.g Symphonia globiulifera and Lophira alata. Less well known include species of bitter kola and chewing sticks e.g Spondianthus Prevussii. Carapa Procera, Uapaca Spp., Garcinia Spp. (NEST, 1991). Canoe building trees are also found - Cloistopholis patens.

3.1.3 Undifferentiated Inland Swamps

This region experiences seasonal flood, which has made it to exhibit its distinguished characteristics. In the dry season, surface water is patchy or sometime absent. However, in the rainy season the forest becomes flooded. Thus, an undifferentiated structure emerges, being very irregular in the upper layers,, superficially resembling broken or secondary forest. These areas are usually unsuitable for farming or habitation and thus have remained fairly undisturbed.

Dense tangles of shrubs and lianas form an impenetrable growth in this zone. The undergrowth is mostly of climbing palms - rattans. At Patani, the vegetation near the Forcados River, in Delta State (see figure I I in unit 4), though a freshwater swamp community has a well-defined structure, with tress reaching over 50m in height.

The heavy gigantic mask of climbers, which completely cover and overhang the understorey trees, is the most fascinating feature of this kind of forest.

Figure 9.2 Undifferentiated Inland Swamp forest

3.2 Riparian Forest

They are commonly found at stream banks with closed strands of irregular structure. They are mature strand trees with close canopy and an open undergrowth. They don't have the same width along water course which they fringe.

These forests are less complex in structure than the local and moist forests of the forest zone however they are denser than similar woodlands in the savanna area. This forest could be employed in conservation since it can serve as corridors interconnecting forest blocks for the passage and protection of wildlife.

3.3 Lowland Rain Forest

The Lowland Rain Forest may be described as t'he main block of the Nigerian Forest formation found at the low and medium altitudes (see figure 10). High human population densities have greatly transformed the complex structure and species richness of this vegetation type. Most of this area has been transformed into rangeland, oil palm, cocoa and cola plantation and other degraded vegetation.

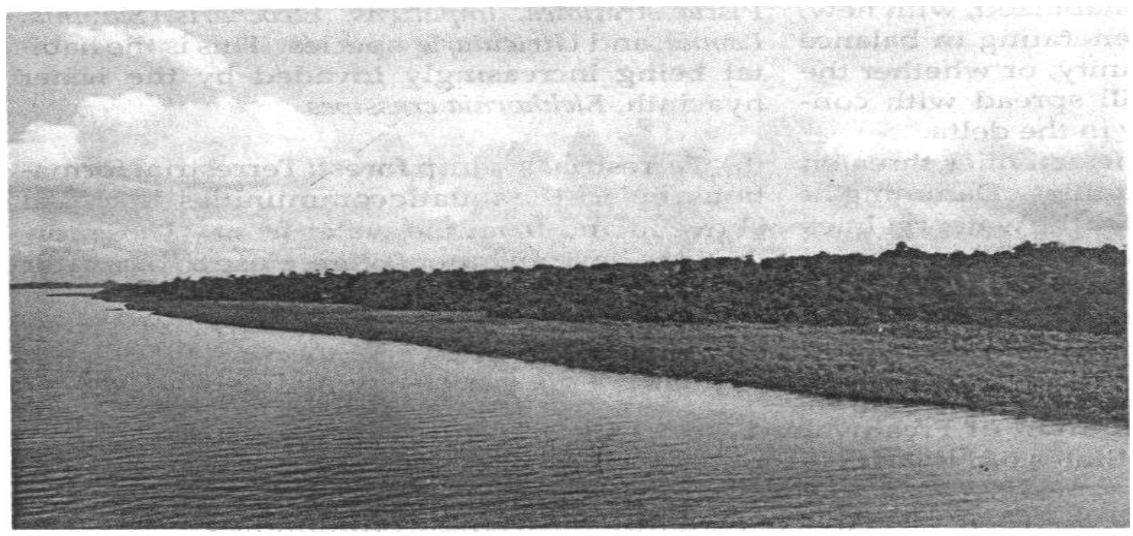

Figure 9.3

Pockets of mature patches can be found in some forest reserves or as isolated groves. About 28,000 square kilometer or 14.5% of the land area of the forest zone most southern states are covered by this kind of vegetation cover. The study conducted by FAO between 1973 and 1977 evidently showed that only 38% of the existing lowland rain forest could be classified as undisturbed by logging operations. The question is what percentage of the existing lowland rain forest is undisturbed today? The answer will be obviously far less than what was recorded then - about 25 years now.

Extensive groves of the oil (Elaeis guineansis) mark areas that have been long under cultivation, and in Eastern Nigeria, these groves are so dense that the palm belt appears to be a permanent replacement for lowland rainforest. The cocoa and kola farms are adequately developed _in Nigeria in these region, including the rubber plantation in Edo,

Delta and Cross River States, and oil palm plantation in various states, which accounts for over 130,000 ha in the forest zone states.

The rain forest covers western and eastern parts of Nigeria to the Cameroon Republic (see figure 10). It has varied width as it was for the previous vegetation described earlier. It has width of 120km on its western boundary (towards the Lagos end), 300km in the middle and 345km at the Far East boundary with Cameroon. The farthest extension of the rain forest, north of Ondo Township, reaches slightly beyond the 8°N parallel. East of the River Niger, the northern limits are represented by Anambra forest Reserve at Ogurugu.

Close to the eastern boundary, noth of Ikom, the northern side of Obudu, up to latitude 6°30'N. Lowland rain forest occurs only below 900m altitude, been succeeded by sub-montane and montane vegetation above this elevation.

Table 9.2 DISTRIBUTION OF LOWLAND RAIN FOREST IN NIGERIA

State	Land Area (Sq.km)	Low land Rain Forest Area Sq.km	Forest Area (Sq.km) converted to farmland	Area of Forest in Forest Reserves S .km
Anambra	17,078.13	(,756.24	10,374.43	23.45
Edo & Delta	38,882.84	5,796.82	14,865.65	3,964.14
Cross River & Akwa lbom	27,214.15	10,345.33	9,353.18	5,140.69
		10,345.33	9,353.18	5,140.69
Imo	11,534.42	479.70	9,328.23	3.13
Lagos	3,514.16	45.31	798.46	0.0
Ogun	17,179.69	2,209.39	8,735.97	1,196.89
Ondo & Ekiti	20,070.00	5,414.07	9,607.83	2,640.65
Oyo & Osun	36,892.29	1,501.59	834.38	953.17
River & Bayelsa	17,687.51	135.93	3,845.31	150.01
Total	190,053.19	27,684.40	67,742.44	14,072.08

Source: FAO 1981

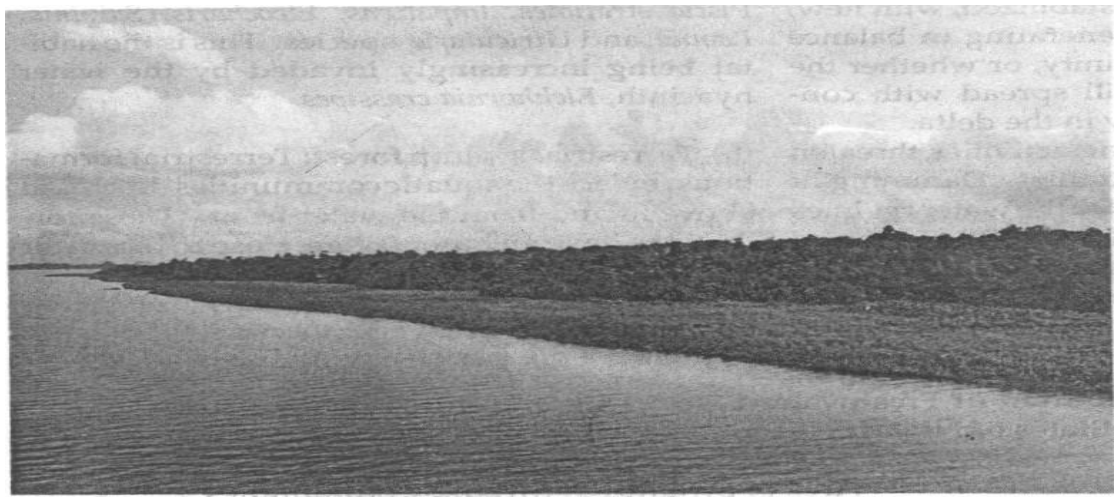

Figure 9.4 Coastal vegetation Map

3.4 Forest Outside the Forest

What we have discussed so far from unit 8 to the last paragraph above is the various vegetation zone or areas that can be classified as forest vegetation zones in Nigeria. This sub-section is a forest area that is "in and out" of the forest belt. I describe it in and out because it is partly with the forest belt and partly with the Savanna. They are also referred to as forest outliners, which include riparia forest and forest islands in the savanna zone. This zone areas include Adamawa State, Ben'ue State, directly north of the derived savanna in Anambra State and in Kwara State as well. Other islands can be found in Niger State, southern extension of Kaduna and Plateau States. These forest are usually found in moist lowlands or hollows and river valleys but may, as in part of Kainji Lake National Park, be found as relics on stony hill tops or
9ther relatively inaccessible sites unsuitable for farming.

Moist sub montane forest is found on the Jos, Mambilla and Obudu plateaux and on the vogel peak massif and outlying hills (NEST, 1991). Vegetation is varied with riverine forest communities in the valleys within the massif, lowland savanna, sacred forest groves and some montane plant communities.

4.0 Conclusion

This unit has taken you through the forest vegetation belt consisting of fresh water swamp, riparian forest, lowland rain forest and the forest outside the belt. You would have realised by now that three zones in the forest belt flow into one another systematically. Diverse flora and fauna are found in them. Yet they are similar because they are basically a forest region or belt.

5.0 Summary

You have so far learnt about four forest vegetation zones in the forest belt.

1. Fresh water swamp - located just after the mangrove zone.

The water within this area is fresh and not salty. This zone is further divided into:

(i) Aquatic grassland and herbaceous swamps
(ii) Terrestrial swamp forest
(iii) Undifferentiated inland swamp

2. Riparian forest - Located immediately after the fresh water swamp and commonly found at stream banks with closed strands at irregular structure and are good in conservation because they can serve as corridors interconnecting forest blocks for the passage and protection of wildlife.

3. Lowland rain forest - It forms the major zone (28%) of the forest belt. Most southern states in Nigeria have this zone.

4. Forestoutside the forest belt - This zone is neither here or there in terms of forest or savanna belt. However, it has forest characteristics in terms of flora and fauna and can be located within and without the forest and savanna belt.

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UNIT 5 NIGERIA VEGETATION (SAVANNA ZONE) AND SOIL

TABLE OF CONTENTS

1.0 Introduction

In the last two units, eight and nine we discussed closely and extensively about the Forest zone vegetation of Nigeria. You will notice that these zones are southerly. In this unit we shall discuss about the second phase of the Nigeria's vegetation which is the savanna zone.

The savanna zone occupies about 80% of the land surface (Forest occupies about 20%) of Nigeria. There is a nearly closed cover of grasses with minimum height of about 80cm. This zone is further divided into:

1. Derived savanna
2. Guinea savanna
3. Sudan savanna
4. Sahel savanna

Source: Agpbi, 1991

Figure 10.1 Savanna Vegetation Map of Nigeria

This unit will also attempt to describe the basic soil types in Nigeria and their economic importance.

2.0 Objectives

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

- List the types of savanna forest in Nigeria.
- Describe the types of savanna vegetation in Nigeria using diagrams.
- List the types of soil found in Nigeria.

3.1 Derived Savanna

Derive Savanna is best described as a transitional forest savanna, located north of the lowland rain forest belt. It occupies states such as Ogun, Osun, Oyo, Kwara, Kogi, Edo, Delta, Anambra, Ebonyi, Imo, Abia, Benue, Cross River, Akwa Ibom and Adamawa. It covers an area of about 75,707 sq.km (about 8% of the country) beig widest about 240km) north of Okigwe.

Dry season is usually being three months with mean annual rainfall of 1.440-1.780mm. It is assumed that this vegetation emerged from the forest zone as a result of

intensive cultivation and bush burning for several years. Hence the prefix "derived", since it is believed to be derived from the rain forest.

Tender forest trees are replaced within this zone by fire tolerant species and the vegetation changes rapidly in features over short distance such that low forest dense woodland and thickets alternate with open tree and grass savanna.

3.2 Guinea Savanna

Guinea Savanna is the largest vegetation cover in Nigeria extending over about 50% of the total landmass. The base of this zone begins where the derived savanna ends, where annual rainfall is between 1,020 to 1,520mm and a dry season is four to six months. The Guinea savanna can be traced through much of the middle belt, where the Fulani cattle rearers usually concentrate on. It is sometimes further classified as southern and northern zone on the bases of the type of trees found. The southern end is richer than the Northern end in trees or vegetation.

3.3 Sudan Savanna

This is the Northern most part of the savanna belt in Nigeria, aside the Sahel in the far northeast. It runs East to West of the North occupying over 250km band width. Mean annual rainfall is between 510 - 1,140mm, the dry season lasts between 5 - 7 months.

Increased seasonally and irregular rainfall has led to the.formation of a semi- arid condition on the zone. This is the zone that is currently being ravaged by desert encroachment. There are extensive areas of seasonal.swamps. Cultivation is intense, coupled with heavy grazing, bush burning and cutting trees for fuel and building, has promoted desertification in this zone (Agabi,
1995).

3.4 Sahel Savanna

Sahel savanna can be located in the far northeast of Nigeria occupying part of Yola and Maiduguri. The mean annual rainfall was reported to be 500mm and long dry seasons between seven to eight months.

The main vegetation cover is mostly low-growing shrubs mostly Acacia species and also dominated by sorghum grass. It is also sparsely vegetated with bare and sandy ground.

3.5 The soils of Nigeria

The soils of Nigeria can be broadly grouped into four zones

1. Zone of alluvial soil
2. Southern belt of forest soils
3. Interior zone of laterite soils
4. Northern zone of sandy soils

3.5.1 Zone of alluvial soil: The soil in this zone was formed as a result of recent deposit found on the flood plains of rivers. Apparently, the underlying parent rock was an essential factor in the formation of the soils of this zone. Since this zone extends from the coast inland, and towards the valleys of the Niger and Benue, it implies that these soils do not depend on climatic factors and vegetation for their formation. In the Delta region of Nigeria, the soil is usually muddy, dark grey in colour and waterlogged for most part of the year. Rice is the principal cereal crop grown here because the soil holds much water for long periods of the year.

3.5.2 Southern Belt of Forest Soils: This region is known for heavy rain fall that encourages leaching and erosion. It is not unlikely that these processes taking place simultaneously in the rainy and dry seasons combine with other factors to form the type of soils called laterite. The soils are poor in quality. Reddish in colour, stick and resists water penetration. Since clearing has to be done before planting can be attempted. The soils are further deprived of the little fertility there is. It is not the best soil for growing cash crops.

3.5.3 Zone of Sandy Soils: This zone lies in the northern most part of Nigeria. The soil here appears to be formed essentially by wind deposition because of the dry nature of the area. In states such as Borno, Yobe, Jigawa, Katsina, Zamfara, Sokoto and Kano the soils are friable in nature, loamy and little leaching takes place here. This is why cash crops including groundnuts, millet and dawa grow well in these states. The extension of this soil also found in the Zaria area, but here we find a blend of soils that may have disintegrated from the local granite found in further North. It is the combination of this soil that is favourable to the famous Zaria cotton.

Exercise 10.1
Make a list of all the states in Nigeria, and for each identify the soil type or types that can be found in the state.

4.0 Conclusion

You have understood from this unit that generally speaking the savanna vegetation zone is located northerly in Nigeria usually from the Midle belt zone.(as it is now called) to the extreme northern part of Nigeria which is more of a desert region especially areas like Gumel in Jigawa State and parts of Maiduguri and Sokoto. The Nigerian soil is highly diversified, this is typical of the geographical spread of the country.

5.0 Summary

So far this unit has enlightened you on the types of savanna vegetation in Nigeria. The vegetation we discussed in this unit include:

- Derived savanna
- Guinea savanna,
- Sudan Savanna, and
- Sahel savanna

These zones progress northward from derived savanna to sahel savanna located at the extreme borders of northern Nigeria.

Also we discussed the types of soil in Nigeria. The major soils found in Nigeria are:

1. Alluvial soil
2. Forest soils (Southern belt).
3. Laterite soils (Interior zone).
4. Sandy soils (Northern belt).

6.0 References and Other Resources

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MODULE THREE

ENVIRONMENTAL PROBLEMS IN NIGERIA

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UNIT 1 WETLANDS IN NIGERIA

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1.0 Introduction

We have discussed a lot about the vegetation of Nigeria in the last three units. An important aspect of our ecological component or environment yet to be discussed is wetlands. wetlands exist in all the vegetation zones discussed in units eight, nine and ten.

Even though many are yet to recognize the significant role of wetland in our environment it vital role to human survival and several millions of species whose survival is dependent on wetlands cannot be over looked.

Wetlands are areas of marsh, fen, pestland or with water that is static or flowing, fresh brackish or salty. It subsumes areas of marine water as shallow as six metres. Wetlands possess the natural capacity both structural and functional to survive in more or less continuously waterlogged, sometime saline or acidic soil conditions.

Wetlands also comprises of marshes, swamps, flood plains, mudflats, estuarine and the littoral areas of large bodies of water.

2.0 Objectives

By the end of this unit you should be able to;

- Locate wetlands in different parts of Nigeria on a sketch map,
- State the importance of wetland
- Outline the problems limiting the development of wetland

3.1 Geographical Spread of Wetlands in Nigeria

Nigeria wetlands may be classified into two broad categories, namely:

1. Coastal mangrove swamps
2. The freshwater flood plains

The mangroves swamps cover 9,000km^2 in the eight coastal states of Lagos, Ondo, Ekiti, Edo, Delta, Rivers, Akwa Ibom and Cross River States.

Table 11.1; Geographical Spread of Wetlands in Nigeria

Coastal Saline Wetlands (Mangrove Swamp)		Freshwater Wetlands (flood Plains	
Name	Spread (ha)	Name	Spread ha
Niger Delta	617,00	Niger Delta	1,177,000
Cross river Estuary	95,000	Benue River	242,000
Imo & Qua Iboe	36,000	Cross River	250,000
Rivers	110,000	Imo river	26,000
Other Estuaries		Lake Chad	25,000
	'	Ogun/Osun Rivers	38,000
Total	858,000		2,100,000

Source: (NEST, 1991.

The non-saline wetlands, are scattered throughout the nation. Some of the important ones include the Hadejia-Nguru (Beturiya), Lake Chad, Kemadugu Yobe, Kanji Lake, Adiani-Nguru, Margadu/Kabok, Kiri Kasamu-Nguru, Sokoto-Rima, Ogun, Osun, Katsina ala, Adamawa, Imo and Cross river floodplains. See figure 11.1 below for the distribution of wetlands in Nigeria.

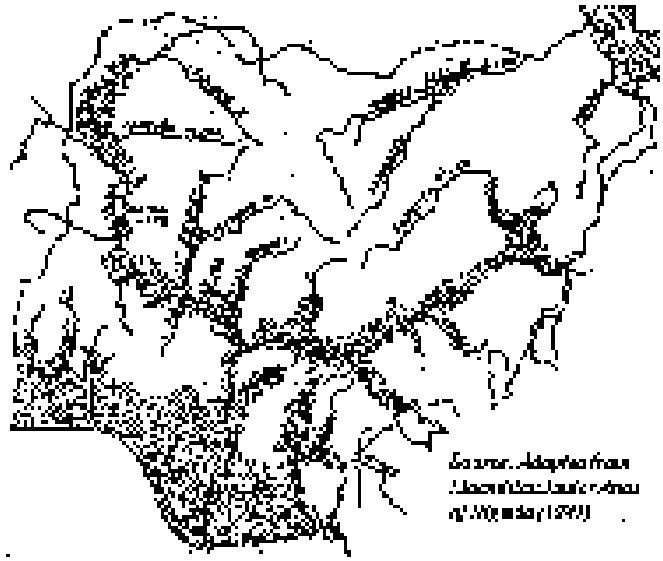

Figure 11.1 Distribution of Wetlands in Nigeria

The flood plains of the Niger and Benue trough and their tributaries are included in this category. Also the highly dispersed waterlogged interdune depressions of the North-East and the Valley bottoms locally known as fadamas in the Savanna region (Agabi, 1995). The fadamas are not always liked with rivers, but exists on impermeable clay pans. Some flood plains support vegetation, only during the rains, but others that are semi-permanent and deep, have stunted vegetation all the year round.

The total area of wetlands in Nigeria is about 3 million ha, with the coastal wetlands being the most extensive. These coastal wetlands include those of large lagoonal systems with mangrove swamps, raffia palm-pandanus swamps and reed swamps west of the Niger. Lagos and Lekki lagoons are worthy examples of these. Other examples can be cited East of the Niger, the Niger Delta itself and the estuaries of the Imo, Qua lbo and Cross River are known to possess large areas of mangrove forest and seasonally as well as permanently inundated freshwater swamps.

Wetlands play the important role of support for high forest vegetation.An example of such is the coastal rain forest found mainly on the coastal sandy ridges along the Atlantic seaboard. They vary in width from less than lkm around Akassa to well over 10km at the widest point south of the Ramos River.

3.2 Importance of Nigeria's Wetlands

Nigeria's Wetlands has several benefits, many of which are yet to be realised, and many are yet to be exploited. Some of the benefits of these wetlands is highlighted below:

1. The Coastal Wetlands help to reduce coastal erosion and stabilize estuarine floodplains. Rather than flooding coastal cities or towns, the wetland serves as a reservoir for ocean or river overflow or surge. Thus, wetlands are free flood control zone.

2. The detritus and nutrients from these wetlands form the food base of many marine and freshwater organism of economic importance. Estuarine wetland forms important spawning grounds for fish, while the inland floodplains are very important for both indigeNTIs wildlife and palearctic and Afro-tropical wildfowl.

3. The algae that are usually found in our wetlands occur in symbiotic existence with fungi. The algae play essential roles in the physical improvement and protection of soils and also in nitrogen fixation in paddy rice cultivation. These wetlands also help to reduce pollutants in waters.

4. The mangrove swamps are potential areas for rice production. In 1933, attempts were made to develop the mangrove swamp for rice cultivation in areas like Calabar, Oron, Warri, mbiakapa and Oloibiri. The pilot tests on the Warri and Calabar areas conducted in 1934 evidently was successful. Production had an average of 2,000 and 2,700 kg.ha in Warri and Calabar areas, respectively, during the first few years of cropping (NEST, 1991). From 1938, however, the yields obtained began to decree and, by 1944 the Warri mangrove began to appear incapable of supporting further rice cropping.

5. The Coastal rain forest area, well-drained non-saline soils is very suitable for cultivation of plantains, bananas, oil palm, coconuts, cassava and maize.

   In 1981, about 510,000 tonnes of fish were produced by artisanal fishermen in coastal and brackish water lagoons and rivers, using the traditional and outmoded canoe fishing methods, characterized by low output. The current fisheries development programme of the Federal government include the modernization of traditional methods, from the craft to the gear, and the provision of better methods of fish handling and preservation.

Why Wetlands are important

The richness of wetlands is reflected in the fact that virtually all early civilizations (Egyptian, Tigis-Euphrates, Indus, Indochinese) were founded on their high productivity. Even today, many rural communities are dependent upon wetlands where they exploit their diverse communities including pasture and agricultural resources. Wetlands are key habitat areas for biological, hydrological, and economic reasons. However, the public value of wetlands goes beyond purely exploitable resources. The ecological services provided by many of them, particularly flood control and removal of excess nutrients can, for any one wetland, add up to many millions of naira.

One of the most important benefits, yet difficult to quantify, is the recreational value. Millions of people in Industrial societies all over the world use wetlands each year for bird-watching, swimming, fishing, sailing canoeing, wild fowling or simply to walk beside and admire their beauty.

Wetlands conservation is a prerequisite for the conservation of waterfowl, fish, and amphibians (many of them migratory species) and for many species of mammals and reptiles, as well as a wide variety of plants (many with important applications to human needs).

Economic benefits from fisheries, agriculture, water storage and flood control, tourism, and recreation are all directly related to wetland conservation. Their conservation is therefore of particular urgency.

Nigerian Conversation foundation - September 17, 1985.

3.3 Problems Facing Wetlands in Nigeria

There is a great misconception among many Nigerians and surprisingly among some of our elite that wetlands are unproductive. This is evident on the way and manner we destroy our wetland, and the rate at which they are destroyed by "the rich" for residential purposes - Victoria Island, Ikoyi and Lekki are common examples.

But studies have shown that these wetlands are ecologically important. Our wetlands are currently being faced off, we are loosing them very rapidly. Some of these problems are highlighted below.

1. We are loosing several hectares of wetlands to development projects annually. Construction companies and industries have turned our wetlands into dumpsites. These wetlands are being reclaimed for construction of residential building by converting them to refuse dump sites. Dredging and cutting off water source into these wetlands by construction firms are among contemporary problems our wetlands are facing today.

Exercise 11.1

What is happening in your community, local government or state? Go and find out.

2. Illegal and improper sand-filling dredging and reclamation of swamp in the Niger Delta .Very often, poor road construction has often led to the silting and disappearance of large portions of wetlands in the Nigeria Delta in the past 35 years. This has resulted into the death of both flora and fauna that depend on that peculiar ecological environment for survival.

3. Another problem facing wetlands is pollution from Industries and homes. Untreated wastes from industries and factories are freely discharged into the swamps. Virtually all the swamps in Rivers and Bayelsa states are polluted with untreated industrial wastes. The pH or hydrogen ion index level of water from Trans Amadi Creek in Port Harcourt is as high as 12 (River State environmental Protection Agency).

5. Oil exploration and spillage. Frequency of oil spillage and improper oil cleaning exercise has continued to cause very great damage to wetlands in' our oil producing states. The laying of oil and gas pipelines is also harmful to wetlands or marshlands. Studies and experiences from Alaska pipeline (In the United States) have proved that mangrove vegetation usually disappear where the pipelines traverse the wetlands (Agabi, 1995). Cutting of the roots of mangrove vegetation and the dispersal of their premature seeds during each activity cause the death of mangroves, the dominant plants of wetlands.

Threats to Nigeria's Wetlands

Chief threats to wetlands species diversity include overfishing, pollution, drainage, reclamation increasing variability of flow, siltation due to watershed deforestation, diversion for irrigation, and damming for flood control and electricity generation.

Wet land drainage is probably the most important and certainly the most evident of the many threats in the industrial world.

Rivers and wetlands have traditionally been used as disposal sites for industrial and domestic wastes. But, increasingly, water draining from agricultural land into lakes and rivers now carries with it pesticides and fertilizers which lead to eutrophication, the process by which nutrient levels are greatly increased and which results in excessive algal growth. This leads to depletion of the oxygen content of water and mortality of aquatic life. With increased use of fertilizers, the problem of eutrophication, seen in Europe, will, in a warm tropical climate, be severely aggravated. Furthermore, pesticides, such as DDT, now banned in most industrialized nations, are widely used in developing countries like Nigeria with devastating effects on fish populations, a major source of protection in these countries.

The construction of dams and irrigation systems in wetlands, and so the productivity upon which the expectations of these developments are based. As dams are built to provide irrigation water, the consequence upon the natural resources further downstream and the people dependent upon these can be catastrophic. Following the construction of the Aswan High Dam on the Nile, for example, the silt load carried by the river is now deposited in the lake itself and no longer provides an annual fertilization of delta lands. Agriculture in the delta now requires the increased use of fertilizers.

Since the benefits we obtain from wetland habitats are many and varied, it is imperative that a major effort be made to ensure the continued existence of sufficient number and diversity of wetlands throughout the country in order that we may continue to obtain these benefits.

Adapted from Nigerian Conservation Foundation Press Release, September 17, 1985.

3.4 You too can do something

Don't you believe you can do something to help our wetlands.
In 1982, a California rancher, Jim Callender bought 50 acres of sacrament valley rice field that had been a marsh. The owner had destroyed it, bulldozing, draining, leveling, uprooting the native plants and spraying with chemicals to kill the snails and other food of the waterfowl.

Callender and his friends set out to revive the marshland. They hollowed out low areas, built up islands, replanted tules and bulrushes, reintroduced smark weed and other plants needed by birds and planted fast growing Peking willows.

Six years of determination and care, hand planting and annual seeding with a mixture of watergrass, smartweed, and rice, the marsh is once again in part of the pacific flyway used by migratory waterfowl. Many birds pass through on their way south in autumn and north in the spring, and some mallards and wood ducks nest there (Miller, 1991).

What a challenge by Jim Callender and his friends. They have shown you and I that at least a part of Nigeria's lost or destroyed wetland can be revived if we plan with a determined hard work. They were not waiting for government.

This kind of revival of wetland is good, but it is better to prevent and protect the existing ones. You too can do something!

4.0 Conclusion

There are several evidences that wetland in Nigeria are being polluted, disappearing and destroyed. The absence of some flora and fauna like the tall or red mangroves and the appearance of nips palm and dwarf or white mangroves is linked to the phenomena. The growing scarcity of and gradual disappearance of Oysters, crabs, periwinkle and other mollusces have also been linked to the destruction and pollution of our wetlands.

5.0 Summary

This unit discussed and showed you how wetlands are distributed in Nigeria. You will realise that wetlands can be found in virtually all the vegetation zones of Nigeria. This unit also mentioned the importance of wetlands to plants, animals and human comfort and survival. Also we discussed on the various problems that our wetlands are facing and .the current negative attitude of citizenry, due to - ignorance perhaps, towards our wetlands. We concluded by saying that our wetlands are disappearing very fast and that you my dear students can do something. Take the challenge from Jim Callender and his friends. You too can do something.

6.0 Tutor Marked Assignment

l. Using the diagram in figure 11.1, identify the various states where wetlands can be located.
2. Explain three benefits of wetlands in Nigeria

3. Mention four problems limiting the development of wetlands in Nigeria

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UNIT 2 FLOOD IN NIGERIA

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1.0 Introduction

This unit will take you through a common environmental problem in Nigeria - Flood. It will define and describe what is flood and explain its geographical spread in Nigeria. The causes and control measures will be discussed.

The problems created by the natural disaster of floods are worsened by human negative interaction with the environment. This calls for urgent action on your part as an individual and government. This unit will adequately enlighten and spur you to act.

2.0 Objectives

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

- define flood
- describe how flooding occurs
- state the causes of flooding in Nigeria
- recommend control measures to check flooding in Nigeria.

3.1 Flood: Definition and Description

Flood may be defined as a body of water, which moves over and above an area of land, which is not normally submerged.

Flood, like droughts are usually described as natural disasters. However, it may be induced by human's misuses and significant alteration in the environment. Since the 1960s human activities have led to a high increase in flood deaths and damages. Today, flood contributes to about 39% of global death from natural disasters - more than any other type of such disaster (Miller, 1999).

While many floods may cause little damage and are usually soon forgotten, except by those most directly affected, some may result in major disaster. This involves

structural and erosional damage, disruption of socioeconomic activities, transportation, communications, loss of life and property, displacement of people, destruction of agricultural and contamination of food, water and the environment in general.

3.2 Causes of Flood in Nigeria

Natural flooding through streams, is the most regular or common form of flood, which is caused basically by heavy rain down pour (and rapid meeting of snow - in temperate regions). This causes water in the stream or river to flow beyond it boundary move to nearby settlement - called floodplain.

Marine coasts also experience flood from wind-driven storm surges and rain- swollen streams linked with tropical typhoons and hurricanes. Flooding can also occur on the shorelines of large inland lakes.

Floods result from several causes of which the most important are climatological in nature. The usual universal cause of floods is rainfall, which is heavy, excessively prolonged, or both. However, smaller amount of rainfall may also produce flooding on an area that is already saturated with water. Other types of flooding in the Nigeria in which climatological factors are only partly or indirectly responsible include:

(a) Ponding back of streamflow by rising tides, particularly during spring tide conditions;

(b) Rivers and tributaries carrying water flows very much in excess of their transporting capacities due to concentration of runoff,

(c) Main rivers backing up the water in their tributaries;

(d) Peak floods occurring at the same time in a main river and its tributaries;

(e) Heavy rainfall synchronizing with spills of rivers;

(f) Inadequate and inefficient drainage of low-lying and flat areas to the outflow; and

(g) Flooding of low lying coasts by excessively high tides associated with storm-surge effect (NEST, 1991)

Flooding as an environmental hazard is, however, not totally a physical phenomena. -In the society, floods only become a hazard when they impinge unfavourably upon human activity, as they frequently do because of the affinity which human rend to have for floodpains and coastal locations. Based on this, a flood hazard is also a socioeconomic phenomenon. Moreover one major cause of flooding is human interaction with his environment in the form of urbanization, agricultural activity, and deforestation. Human activities are undoubtedly assuming greater importance as a cause of flooding.

As urbanization intensifies, natural surfaces are replaced by buildings, pave roads, and concrete surfaces, which do not allow water to percolate readily into the ground. The effect is that a large proportion of the rainfall which should normally infiltrate into the soil, or be intercepted by the vegetation and thus delayed for some time before running off, is immediately available for surface run-off into streams and rivers, making them flood

Attempts by human to harness available water resources have resulted in the construction of dams and other water control structures. The failures of these structures, infrequent as they may be, have resulted in floods, a typical example being the collapse of the Bagauda Dam near Kano in August 1988, which had disastrous environmental consequences. The encroachment of buildings on the floodplains of streams and rivers flowing through towns and cities and the deposition of waste materials in their courses do facilitate flooding. In general, bad planning also causes floods, in addition to the natural rain-induced causes.

Bad Planning Causes Flood

The planner "must project on the wastes, which must be generated - human wastes and industrial wastes". Without a comprehensive study of the area of which the planner wants to draw the master plan, he said, problems would drop up. He blamed the increasing rate of flooding in this country on lack of organization, adding, "the stage of preparedness of the government is very low".

What prevents the government from setting up as standing task force that can tackle the problem like what operates in the western world?

It is lack of organization on the part of the government.

Government to operate the Land Use Decree according to its provisions.

The government to always plan ahead of the population so that the idea of unplanned houses and cities will be a thing of the past.

Government to establish the services of garbage collection in every part of the city since human beings and industries generate wastes.

Communities can utilize the water for transportation of humans or goods, and floodplain (due to it flat structure).

3.3 Geography of flooding in Nigeria

Floods are common and recurrent phenomena in Nigeria and, in some parts of the nations, they occur on a regular perennial basis. The geogrphical areas, which suffer from this hazard in Nigeria, are:

(a) Low-lying areas in the southern parts of the nation where annual rainfall

is very heavy;

(b) The Nigeria Delta zone;

(c) The floodplains of the larger rivers, namely, the Niger, Benue, Taraba, Sokoto, Hadejia, Yedseram, katsina ala, Donga, Tarabe, Cross River, .Imo, Anambra, Ogun, Kanupe, Kaduna, Guarara, Mada, Shemanker, etc;. and .

(d) Flat, low-lying areas around and to the south of Lake Chad which may be flooded during, and for a few weeks after, the rains (NEST,1991).

By far the largest single area subject to annual flooding is the Niger Delta zone. This is a flat, low lying, swampy area of alluvia deposition across which the distributaries of the Niger meander. It is a natural reservoir for the enormous Niger-Benue catachment area and its inefficient outlet to the sea. Its rivers are bordered by levees. When these rivers are in flood, the levees are overtopped and extensive areas are submerged.

The zone is subject to two types of floods. First, there are the floods of the rainy season which are the result of rainfall within Nigeria and especially rainfall in the delta area itself which ranges from 2000mm -to 4000mm per year and is concentrated in a few months.

The second type of flood is the river floods nearly all of which are caused by water coming from as far away as the Fouta Djallon Highlands in Guinea. Actually the water is the run off from the previous year's rainfall on these highlands slowly making its way down to Nigeria.

Virtually all parts of the Niger Delta, except the northern parts suffer flooding at one time of the year or the other. The flooding affects towns, villages and agricultural lands -in the Sagbama and Yenagoa in Beyelsa state, parts of the riverine areas of Delta, Edo, akwa Ibom and Cross River States.

It is to be noted that the construction of dams on some of the country's rivers has led to flood control over large and increasing are since the Kanji Dam was commissioned in 1968. Some of the areas affected are part of the Niger Delta and the floodplains of the Niger (Kanji Dam, Jebba Dam, Shiroro Dam); Sokoto-rima (Bakolori Dam and Goronyo Dam); Kaduna (shiroro Dam); Gongola and Benue (Dadin Kowa Dam, Kiri Dam) and Hadejia (Tiga Dam, Chalawa Gorge Dam).

3.4 Case Studies

Some recent documented flood disasters in Nigeria afford a good insight into the extent of flooding and flood-related problems in our country. ILORIN 1973, 1976, 1979 and 2012. In the flood event of 1976 alone, 24 houses were submerged and 56 others had to be evacuated. The floodwaters also washed away vegetables and sugarcane farmlands, while many roads in the city were rendered impassable.

"Lagos floods hold up classes".This was the creaming headline of the lead story in the Evening Times of June 14, 1985.The story described how most of the classrooms of primary and post-primary institutions in Lagos were turned into pools of water after a downpour, holding up classes for one week. It sums up the annual situation with respect

to the menace of floods in Lagos, a low-lying coastal city. No matter where one lives in Lagos, it is the same story of flooded streets and homes almost each time it rains heavily, especially from June to September. From Victoria Island to Ikoyi, from Maroko to Agege, from Isolo to Oworonsoki, Lalgos floods are no respecters of persons, and the story has been the same over the years. In June 1988, when it rained for three days straight in Lagos, the `river' near the Lagos University Teaching Hospital (LUT) in Surulere over-flowed its banks and rendered Ishaga road at that point impassable. The same was true of Awolowo road, Ikeja, Ijora Causeway, - Bodija, Agbo Malu, Apapa, and the Apapa-Oshodi Expressway at the intersection leading to the Murtala Mohmmed International Airport.

Residents of Chief Natufe Street in Surulere, Lagos, woke up on Saturday, July 9, 1988 to find themselves virtually in water. The previous night's rain, which started from dusk and continued right through the following morning, had caused untold havoc, throwing everybody into a state of panic. Some people were trapped in their homes because of the floodwater, which was waist high. They had to be rescued by people who provided them all kinds of materials like old bath tubs and refrigerator frames as canoes, for a price. Some sewage tanks overflowed and mixed with underground water tanks thereby polluting people's drinking water many days. The cause of this flood was unfortunately, largely man-made. A canal which runs from LUTH right through certain parts of Surulere into Orile-Iganmu,which was supposed to be a channel for the evacuation of water, had been blocked by solid waste and sediments and should have been dredged before the peak of the rainy season.

Floods constitute such a permanent feature of life in Lagos that it is an inexhaustible theme for cartoonists who from time to time hit at the government for its apparent helplessness..

Semi-arid Sudan Savannah environment, was affected by floods in August 1988. A rainfstorm, described as one of the heaviest in an 80-years instrumental record, persisted over Kano for a few days, generating floods in various parts of the State. The rainstorm and the floodwaters, which it produced, caused the Bagauda Dam near Kano, with a storage capacity of 22 million cubic litres of water, to reach an unprecedented volume of 142 million cubic litres before it collapsed on August 17, 1988. The havoc wreaked by the collapse of the dam and the rainfall floods resulted in the loss of 146 lives, destruction of Kaduna: Not many parts of Northern Nigeria were spared by the raging floods of 1988. On August 18, for example, many roads in Kaduna were flooded, leaving motorists stranded. The road to the Kaduna International Airport was taken over by floods.

BAUCHI: In the Misau Council area of Bauchi State, four persons were killed and over 750 houses and property, including crops, worth hundreds of thousands of naira were destroyed by floods, following a heavy downpour. Heavy rains in various parts of Borno

State resulted in the loss of 52 lives, and the destruction of over 170 houses and much property. Niger State, crops estimated at more than N100,00 were washed away by floods in Gawu district of Suleja Local Government Area alone. KEBBI: The River Niger flooded Bagudu, Bunza, and Argungu Local Government Areas and, as a result, about three hundred villages and settlements were submerged.

Hundreds of farms were also flood and crops (e.g rice, maize, millet and sorghum) destroyed. In addition to the sacking of hundreds of families, the total value of things destroyed by the flood was roughly estimated at 100 million naira.

In September 1989, heavy and continuous rainfall resulted in the flooding of about 130, 0000 hectares of agricultural land in some parts of Cross River and Akwa Ibom States as a result of the Cross River overflowing its banks. This flood was estimated to have left about 150,000 farming families homeless and destroyed food crops (e.g rice, yam, cassava, cocoyam, and maize) and economic trees worth millions of naira. In Uyo alone, about 500 families were displaced and property worth millions of naira were destroyed.

Not only is flooding becoming more frequent, especially in our cities, it has also become more severe and devastating over the decades. The increasing frequency and severity do not stem from increased rainfall. One the contrary, rainfall amounts have overall, been on the decrease.

Rather, they are in response to an increasing rate of urbanization in the absence of well-articulated and comprehensive physical more frequent and more damaging floods than planning and planning control. For example, many of our coastal cities as a result of bad Ibadan, a non-coastal city, has been afflicted by planning.

2012 Flood Disaster in Nigeria; Causes and Way Forward

It would be recalled that in 2012, following the sudden bursts of the Cameroonian and Guinean dams coupled with the heavy rainfall experienced between May and September, over 20 states in the federation were affected by flood waters. Yet it did not come without a warning. As at November 5, 2012, over 363 people had died as a result of the flood with about 2 million displaced. The states most affected were Adamawa, Taraba, Plateau, Benue, Bayelsa, Kogi, Niger, Lagos, Rivers and several others (Obebi, 2012).

The water level in these states rose several meters high swallowing whole buildings and entire communities. Even the home of the President in Otuoke, Bayelsa State was not spared as nature unveiled its rage and tempestuous fury on mankind.

In a swift reaction, several states set up flood rehabilitation committees which collaborated and networked with the private sector and international agencies to ameliorate the impact. Several monies were collected and applied for this purpose. Or so it seemed. But needless to say that, for most of the victims, life has never been the same again after the floods. The federal Government as well as notable philanthropic individuals also doled out whopping amounts to assuage the impact and ensure proper rehabilitation and reintegration process.

For a start, there are several causes and types of floods. Fundamentally, when the ground is already saturated and therefore loses the ability to absorb more water faster than rain or snow falls, flooding begins. Because of heavy rainfall, the water within a river may overflow its bank and surreptitiously spread around the surrounding land or there could be a flash flood which occurs very quickly by rapid rise of extremely dangerous water travelling at a speed of 2.7meteres per second. There is also coastal flooding in oceans and is driven by storm surges, hurricanes and tsunamis. More importantly, failure of dams or

other structures constructed to retain water may engender flooding. This is often attributed to negligence by engineers during dam construction. Of course, global warming and climate change is yet another causative factor.

But not a few persons contend that increased urbanisation, inadequate urban planning laws, lack of drainage facilities and erecting buildings in flood plains contribute substantially to exacerbate the effect of flood when they occur. Even so, dam failure and global warming have been identified as significant factors.

Last year, sequel to the massive destruction caused by the flood, farmers all over the country suffered huge economic losses. Challenges of food storage, processing and marketing arose culminating in spiralling prices of other consumables, even in unaffected areas. In many parts of the country, commercial activities ground to a stultifying halt as businesses lost billions of naira and schools were hurriedly shut down.

Given the destructive socio-economic impact of the flood, it is critical that mitigating and attenuating measures be put in place to forestall resurgence. This is proactive rather than reactionary. It is dangerous, if not precarious to wait for it to happen in the hope of profiteering from the calamity by swindling funds meant to alleviate the excruciating pains suffered by victims. In 2011, the United States lost a stupendous $8.4billion to flood. Nigeria has lost several billions to the 2012 flood. We cannot afford to lose more and hope to make up for the loss by donations which end up in the pockets of a few chauvinistic, misguided and egocentric individuals.

As a first throw of the dice, therefore, the states and federal government must expedite action on the construction of major embankments on rivers such as River Benue to keep off flood water. The construction of the Kasambilla Dam should also be pursued with renewed vigour to ensure that excess water that should have been released into the river is absorbed.

Indeed, state governments in conjunction with civil society groups, NGOs and faith-based organisations must embark on aggressive environmental awareness campaign and build capacity to reduce people's vulnerability. Certainly, communities living in flood plains should be made to relocate to higher grounds on time.

In some states, roads are built without proper and adequate drainage system and wastes are dumped in drainages. This is totally unacceptable and negates global best practice in civil engineering.

As a matter of necessity, flood control measures should be introduced by government. As far as practicable, the use of Self Closing Flood Barrier (SCFB) systems in protecting people and property from inland waterway flood should be encouraged in the country. In the United States, for instance, millions of documents at the National Archives are protected by SCFBs. This can be replicated here.

What is more, river defences should be erected to prevent rivers from bursting their banks while buffer dams should be built at strategic locations in the country. Coastal defences such as Tide-gates, Sea walls, dykes, culverts and barrier islands could be constructed to curb flood occurrence in coastal states of the Niger Delta.

Multinational Oil companies who indiscriminately flare gases that precipitate global warming and climate change in Nigeria must, as part of their corporate Social responsibility, partner with government to bring about lasting solution to this ignominious menace.

During flood disasters, governments must have evacuation and recovery plans and scrupulously and dexterously implement them. There is also need for pre-flood risk assessment, post-flood damage assessment, and massive adequate investment in mitigation measures while professional counselling services and advice and training, financial assistance to the elderly and other disadvantaged groups should be incorporated into the rehabilitation programmes.

In addition, homes, public buildings and schools and other critical social infrastructure should be built above flood level in communities in flood-prone areas. Flood hazard maps and community plans of action could also be developed to ensure better understanding of what to do.

Of course, states and the federal government must enhance the capacity of their strategic grain reserves which could come in handy during times of acute food shortages arising from flooding.

Finally, the state Emergency Management Agencies must be made functional and fully equipped with the right logistics to take on the onerous task of combating disasters. It is agonising that in several states, the agency lacks functional and even the institutional framework to manage disasters. This has often led to escalation of the damage (Obebi, 2012).

lbadan Floods: The Case of a Man-Made Disaster

Ibadan, the second largest city in Nigeria, is located in the area, which was originally covered by forest vegetation which has been destroyed by man. It is characterized by a mean. annual rainfall of 1244mm distributed over a period of nine months (March-November). The area does not posses the type of high-intensity rainfall regime which favours frequent flooding. Yet the city is one of the most frequently flooded non-coastal cities in the country. The question is whether the flood disasters that have ravaged the city over the years are natural or man-made.

The fisrt recorded flood in Ibadan occurred in 1933, when Cege River drawned the houses of these living on it bank. In 1951, a two-day heavy downpour between July 9 and 10 caused considerable damage to property along the banks of the major rivers that pass through the city. Trees, vehicles, and houses were swept away in June 1955 by the flood that followed a two- day heavy rainfall that totalled 137mm.On 17th August, 1960, the city was again ravaged by the flood waters of swollen rivers and streams when many lives were lost, over 1,000 people rendered homeless, and property estimated at over N100,000 was damaged. In addition, considerable damage was done to roads, railways, bridges, motor parks, and markets. Again in late August,1963, a more devastating flood occurred causing damages to property worth over N200,000.00 The story was the same in May

1969 with floods damaging property worth over N100,000.00 Flooding was not witnessed again in the city, until nine years later. The flood that took place in April 1978 destroyed almost all the structures near the major rivers in the city while more than 30 lives were lost, and over 15,000 rendered homeless. The most catastrophic and most publicized flood to hit Ibadan occurred on August 31,1980. It was caused by a twelve-hour downpour from the night of August 30 through the morning of August 31. By the time the rain stopped, over 300 lives had been lost, 50,000 rendered homeless and property worth over N300 million destroyed. More recent floods in Ibadan are those of 1982, 1984, April 1986 and June/July 1987.

The phenomenal increase in the frequency of floods in Ibadan in recent years corresponds with the phenomenal growth in the desity of houses and the real extent of the city in the last two decades. Studies have shown that more and more land along the city's major rivers (e.g Ogunpa, Ona, and Kudeti) formerly under cultivation or natural vegetation, are being built upon.The rapid rate of urban development in Ibadan, particularly since 1950, has resulted in increasing encroachment of buildings on the flood plains of the rivers due to the increasing shortage of building space on the well-drained upland slopes. The result is that swamp areas (floodplains) which used to serveas natural reservoirs for excess floodwaters have been drained and built upon. Thus, natural surfaces gave way, on a large scale, to artificial surfaces (e.g buildings, paved roads and concrete surfaces) with low infiltration capacities. Building encroachment on floodplain means that most of the rivers passing through the city are hemmed in and possess little overflow plain on which to deposit the eroded materials they carry. Consequently, they are forced to deposit their excess loads in their channels, and thus raising them. The combined effects of the increase in the area of impervious surfaces, the hemming in of rivers and the raising of their beds vastly increased runoff and flooding.

Moreover, despite its hilly topography, rapid urbanization, and building encroachment on the floodplains, Ibadan has a very bad drainage system as a result of poor. planning. The city, at least by 1978, had no storm drains, sewers, or even large gutters. Thus the roads also served as drainage channels during rainstorms. In addition, because of very inadequate waste disposal facilities, there is the common practice of dumping refuse and debris into any available open space, including drainage and river channels, which become blocked. The obstructed channels therefore are incapable of accommodating fast running flood waters from the hilly surroundings and the water spills over into streets and houses to cause havoc. Apart from destruction of property and loss of lives, the solid waste materials carried by floods also become serious pollutants of the drinking water facilities and dangerous instruments of damage as witnessed in 1980. By and large, therefore, the increasing frequency of floods and the resultant loss of lives and damage to property are attributable to lack of planning.

Mitigating Flood Damage

Because damages caused by floods have been on the increase in recent times, preventive options, involving structural and non-structural measures, need to be adopted and implemented, especially urban measures that could be used to control periodic inundation of the areas that are liable to flooding. They include check dams, levees, flood walls, and

adequate drainage systems in the form of flood ways and canals. These structural measures would prevent inundation of a floodplain in different ways. For example, dams reduce peak flows; levees and flood walls confine the flow within predetermined channels; improvements to channels reduce peak stages; and flood ways help divert excess flow. The adoption of structural measures alone; however, could lead to sub-optimal development of the floodplain and may even invite greater loses when storms occur which exceed the design limits of the structures, as the collapse of the Bagauda dam clearly shows.In addition, structural measures are expensive. Therefore, there is also the need to regulate floodplain development with the adoption of non-structural measures.

Exercise 12.1:

Draw a sketch map of Nigeria. Identify in the sketch using "dots" places where flooding has taken place.

3.5 Control and Management of Flood

Miller (1999) outlines various strategies of managing flood.

(1) **Channelization** is a method in which a part of a stream, river is depened, widened or straightened to allow more rapid runoff. Although channelization can reduce upstream flooding, the increased flow of water can also increase upstream bank erosion and dowstream flooding and deposition of sediment.

(2) **Artificial levels and embankment:** This can reduce the possibility of water overflowing into nearby floodplains. It could be permanent or temporary (such as sandbags placed when a flood is imminent), Levees, like channelization, contain and accelerate up stream flow and increase the water's capacity for doing damage downstream. If a levee breaks or the water spills over it, floodwater may persist long after the stream discharge has decreased. A levee can increase destruction of life and property when major floods occur, but the destruction takes place at the lower course of the river each levee. Thus, landowners at the lower course need levees to protect against stream levees. The result is a spiraling levee race that can eventually cause destruction for almost everyone when the incredible force of a hugely flood-swollen river inevitably spills over or lower runs levees.

(3) **A flood control Dam** built across a stream can withhold, store, and release water more gradually. The dam and its reservoir may also provide such secondary benefits as hydroelectric power, water for irrigation, and recreational facilities. A reservoir can reduce floods only if its water level is kept low. However, it is much more profitable for dam operators to keep water levels high (for producing electricity and supplying irrigation water). As a result, after prolonged rains the reservoir can overflow, or operators may release large 'volumes of water to prevent overflow, thereby worsening the severity of flooding downstream. The reservoir may gradually be filled with sediments (that once characterises downstream floodplain) until it is not beneficial, and may also has other drawbacks. Some flood control dams have failed for one reason or another, causing sudden, catastrophic

flooding and threatening lives, property, and wildlife. The Bagauda Dam is Kano is an example to be remembered at this point.

This disaster also demonstrated that dams, levees, and channelization can give a false sense of security and encourage peopleto settle on floodplains and thus worsen the severity of flood damage. Some countries are realizing that the risks of managing natural water flow can outweigh the benefits. Germany, for example, plans to bulldoze through dikes and allow parts of floodplains to flood regularly.

(4). From an environmental 'viewpoint, floodplain management is the best approach. The first step is to construct a flood-frequency curve (based on historical records and an examination of vegetation) to determine how often on average a flood of a certain size occurs in a particular area. This doesn't tell us exactly when floods will occur, but it provides a general idea of how often they might occur, based on past history. Using these data, a plan is developed:

(1) To prohibit certain types of buildings or activities in high-risk zones
(2) To elevate or otherwise floodproof buildings that are allowed on the legally defined floodplain, and
(3) To construct a floodway that allows floodwater to flow through the community with minimal damage.

Floodplain management based on thousands of years of experience can be summed up in one idea: Sooner or later the river (or the ocean) always wins.

4.0 Conclusion

You have just concluded your study on flood, a common disaster that has ravaged several places in Nigeria for several decades. This disaster has form a part of our regular environmental problem. Floods have killed thousands of people in Nigeria in the past and tens of billions of Naira worth of property damaged.

We have no choice than to learn to control and manage this problem to preserve life, proper and the environment as a whole.

5.0 Summary

This unit has assisted you in learning more about flooding in Nigeria. Flood was defined as a body of water which moves over and above an area of land which is not normally submerged. It is a natural disaster as well as human induced when waterways and adjacent landmass are tempered with by human activities.

Flooding is caused by heavy rainfall, removal of water-absorbing vegetation especially on hillsides, urbanization, and poor planning.

Flooding has affected several places in Nigeria, with records dating as early as 1933.

Several management techniques may be employed which included among others,

channelization, artificial levees and embankments. Other techniques include construction of flood-control dam and finally floodplain management.

6.0 Tutor Marked Assignment

1. Define the term flood
2. Mention five causes of flood
3. State any three management strategy for the control of flood
4. What were the 3 peculiarities of 2012 flood in Nigeria? List any 10 ways forward.

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UNIT 3 EROSION

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1.0 Introduction

Between 1975 and 1992, our country's vegetation witnessed sharp loss. Over 90% of the original forest were lost due to unplanned land use. This has led to loss of quality of our soil. and has continued to pave way for erosion.

Erosion is a major environmental problem in Nigeria with about 80% of the country ravaged by it. Almost every part of Nigeria has an experience on one form of-erosion or the other:

This unit will lead you through to what erosion is, types of erosion in Nigeria, causes, consequences and control measures for erosion.

3.0 Objectives

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

- Define erosion
- Explain the different types of erosion in Nigeria
- List the causes of erosion in Nigeria
- State ways of controlling erosion

3.1 Definition of Erosion

Erosion is the wearing down and removal of soil, rock fragments and bedrock through the action of running water, glaciers, wave and wind (Ahove & Oduwaiye, 2000).

Erosion may also be defined as the gradual removal of rock or soil particles from its initial deposit by the means of wind, waves, water, glaciers, soil slope or by human activities.

Lawal (2000) says erosion is concerned with moving particles of soil or lumps of rock from one point to another. It is the detachment and transportation of soil particles by running water, wind and waves.Water, ice, wind and waves are regarded as agents of erosion. They transport loose soil, sand, gravel and deposits them in new places.

3.2 Types of Erosion in Nigeria

There are five types of erosion in Nigeria. These are pointed out by (NEST, 19991) as:

1. Wind erosion
2. Coastal erosion
3. Sheet erosion
4 Gully erosion
5. Rill erosion

l. Wind erosion: Is a process, which occurs mainly in the Sudan Sahel belt where rainfall is low and soils are sandy. But it is localized both in space and time. It is frequent in the dry season and the early part of the rainy season in areas carrying a scanty vegetation cover or none at all. It is a major problem in northeast Sokoto, where roads have sometimes been completely burried by drifting sands.

During the planting season, drifting sands often smother young crops. Areas which are known to be particularly affected by wind erosion in Sokoto State include the area between Tangaza and Gwadabawa and the areas around Gwambilla, Melle, and Illela.

Wind erosion is also a menace on the cover sands of northern Kano. In Borno State, it is particularly serious on the ancient sand dunes of Manga country where the village of Kaska has been shifting progressively away from one of the moving sand dunes:

The highest of these active dunes was about 45-50 feet (15-16 metres) high, and together with a second one of about 30 feet forms a formidable creeping front which has already completely buried not less than twenty houses and about a dozen trees. Evidence of already completely buried houses can be seen from their exposed dark, flat top. At the time of the visit we saw a 'soro' in the process of being buried. The gate... was facing the east and there was a Kurna tree (Ziziphys spina-christi) about 10 feet in front of it. These sand dunes which have already completely buried the tree... at first piled up at the door and then continued to pour into it till at last the roof of the soro was pushed down... Audu (the occupant of the house) on his part said that before he finally vacated the room about four years ago, he used to sit and rest under the Kurna tree.

2. Coastal erosion afflicts virtually all the eight states bordering the Atlantic ocean. These are Lagos, Ogun, Ondo,Delta, Rivers, Bayelsa, Akwa lbom, and Cross River States. As sea waves break on the shore, land is pulled off and washed into the sea. In the actively eroding parts of Rivers and Delta States, shoreline recession is more than three metres annually. In Ondo State, coastal erosion is now a constant source of worry for many fishing villages.

Nigeria's most notorious case of coastal erosion is that of Bar Beach at Victoria Island in Lagos. The problem is directly associated with the construction of two prang stone moles at the entrance into Lagos lagoon to keep it free of a sand bar that

had been an obstacles to the free movement of ocea-going ships into and out of Lagos harbour. With the construction of moles, vast quantities of sand, which normally moves by longshore drift from west to east, have piled up against the West Mole, building out the land in the process. By contrast, the moles have cut off the supply of sand to Bar Beach, triggering off rapid wave erosion of the beach sands. The erosion of Bar Beach threatens public and private property on Victoria Island worth billions of naira.

Very much akin to this coastal erosion is riverine erosion along some of the country's rivers and creeks. Here erosion is caused mainly by the waves generated by the movement of watercraft, canoes and speed boats in particular, but also by rises in water level during floods. Riverine erosion is a serious problem in the Niger Delta.

The Niger Delta is an extensive plain cris-crossed by a maze of meandering rivers and creek. The banks of these water channels consist of levees, which slope down into backswamps and flooded depressions. When the Niger River and its distributaries are in flood, they erode these banks, especially on the outside of meander bends, which are turned into vertical faces. The flooding normally lasts from three to five months in the year and the height difference between low water and flood water may be as much as six to ten metres. As the floodwaters recede, riverbanks become unstable and large masses of earth collapse. Rates of bank erosion may be from two to five metres per year along the larger channels. Tidal movements also aid bank erosion in some places. Bank erosion poses serious threats to towns; villages, and farmland in the region.

3. **Sheet Erosion:** It is the slow removal of the thin surface layer of the soil by surface runoff down the slope. It affects the finer particles which help the soil to hold both nutrients and water and to make them available to crops. Their removal by sheetwash is, therefore, invariably a serious loss. Sheet erosion is normally a slow natural process, which occurs on all land, which is not flat, which has a soil cover, and receives rainfall high eNTIgh to produce runoff. However, what has happened in many part s of the world, including Nigeria, is that man has removed or altered the vegetation cover so much that rates of sheet erosion have been accelerated considerably.

Because it goes on unnoticed until it has completely rendered the soil useless for the farmer, it rarely gets into the news. Yet because of its widespread nature and the longterm damage which it does to the soil, it is a more serious problem than gully erosion which receives so much media attention.

In the forest belt, the replacement of the original vegetation cover by cultivated and secondary vegetation of various types has led to a general increase in rates of sheetwash, which is particularly serious in areas of exhausted soil and poor vegetation cover. Examples include the areas of sandy soils in Anambra and Imo States as well as exposed land surfaces in many other parts of Nigeria.

Sheet erosion, which is serious eNTIgh to cause concern, has been reported from all

the ecological zones of the Nigerian savanna. In the wetter savannas, severe sheet erosion is usually a localized problem, occurring mainly where the vegetation cover has been removed and where shortened fallow have led to soil deterioration. Some examples are the northeast part of the Federal Capital Territory, the Jos Plateau, the Yelwa area of Kebbi State, the Zinna area of Taraba State, and the Ejiba area of Kogi State.

In the drier savannas, sheet erosion is both graver and more widespread especially in the Sudan belt where it occurs commonly on land not being cultivated and not under fallow. Such land includes forest reserves, which are often overgrazed, and areas of poor or shallow soils, as well as open spaces within and around settlements. Although sheet erosion is by far the most widespread form of erosion in Nigeria, and the most pernicious, it is the least readily perceived. Consequently, it is the least known, researched, and measured, and also the least feared.

4. Gully Erosion

This situation is in very sharp contrast to that of sheet erosion. Occupy an aggregate of the smallest proportion of eroded land in Nigeria; gullying is the most observable, best-documented, and most frightful type of erosion in the country. For these reasons, it is very often reported in the news. In area of softrocks, such as Anambra and Imo, gullies can develop with astounding rapidity. On a perfectly flat terrain in this area, a gully can start off within warning in a rainy night and without a few months, grow into a monumental gash 100 metres long, over 20 metres wide, and 15 metres deep.

Within the savanna, gully erosion has affected a broad east-west belt from the Eastern Highlands of Taraba State to the Sokoto basin. The headwaters of virtually all the major drainage basins in this belt have been extensively gullied. These include the upland areas draining into the Rivers Kano, Chalawa, Matari, Gari, Sokoto, Zamfara, Taraba, Donga, and Katsina. Most of the thousands of gullies in these areas are, however, shallow.

Moreover, within the wetter savannas, such as in the area between Kaduna and Birnin Gwari, the gullies have become stabilized by natural vegetation growth. In the drier savannas and on the Jos Plateau, most of the gullies are still fresh and may be quite active. The most catastrophic forms of gully erosion are to be found in Imo and Anambra States, where a combination of weak, sandy soils, widespread deforestation, and high rainfall has promoted accelerated erosion.

In spite of our earlier statement that the total area taken up by gullies in Nigeria is very small, certainly less than 0.1% of the country's 924,000 square kilometres, the number of gully erosion sites is dauntingly large and the size of some individual gullies is astonishingly enormous. Every State in Nigeria suffers from gully erosion, although the southern states easily dominate the scene when it comes to the size of gullies. Among them, Imo and Anambra hold the unenviable record.

As at September 1989, according to the Federal Minister of Works and Housing, "active gully complexes have been identified in Imo and Anambra States" alone. Indeed, the largest single erosion gully complex in Africa, for long a major tourist attraction, exists in the Agulu-Nanka district of Anambra State.

Gully erosion within settlements deserves separate mention because of the threat, which it poses for buildings and other structures and the danger to human lives. The towns affected include Abiriba (Imo State), Auchi (Edo), Efon Alaye (Ondo), Ankpa (Kogi) and Gombe.

At the same time, human activities have contributed immensely to Nigeria's soil erosion problem, translating what would have been a benign process under a natural cover of vegetation into a serious problem in some areas and a calamity in others. Among the numerous human activities, which encourages accelerated soul erosion in Nigeria are;

- Wrong crop cultivation practices, ranging from improper tillage and ridge-making across the contour, to clean cultivation and sole croping or monoculture;
- Quarrying and some other mining operations, including the removal of buildings materials like laterite, sand, and stone;
- Road construction without adequate attention to the provision of safe side drains or any drains at all;
- Ill-advised channelization of storm runoff, especially in built- up areas;
- Indiscriminate destruction of vegetation cover or reckless selective removal of plant species, through bush burning, lumbering, fuelwood collection, establishment of construction sites and other activities;
- Use poorly-located footpaths to streams, markets, farms, schools, etc;
- Overgrazing, path creation, and trampling by livestock; and
- Vibration on land caused by the passage of vehicular traffic, especially heavy automobiles (tippers, trailers, Lorries, and buses), and the compression and creasing of poorly-made road surfaces by the same vehicles.

6. **Rill erosion** is intermediate, in appearance and impact, between sheet and gully erosion.

3.3 Causes of Erosion

The outer-part of the earth's crust is just about half and a metre thick. It is this small layer of the earth that human's existence primarily hinges on. This is because nearly all of human's food, fibre, energy, crops and livestock obtain their source and sustenance from this region. This region has been under assault of human and natural agents, which are linkable to the cause of erosion in Nigeria.

These agents according to Adara (2000) and Miller (1999) include:

l. Ocean, rivers and streams
2. Rainfall
3. Wind
4. Vegetation
5. Topography
6. Soil factor

Aside from water and wind (which fall into the first three categories the last three terms above do support or impede wind and water erosion. Their propensity to do so will be discussed below.

Topography

The topography of a landmass is a natural factor that could reduce or increase the likelihood and intensity of erosion within that area. Note that as the gradient of a place increases propensity to erosion increases. So also will the speed of the flowing or running water increase which is directly proportional to the erosive force of the flowing water. A doubling of velocity of run-off water increases the kinetic energy or erosive power four times and causes a
32-time increase in the amount of material of a given particle size that can be carried (Adara, 2000).

Vegetation

The Vegetation cover significantly helps to reduce the effect of erosion on an area. This is possible by the obstruction formed by the vegetation usually stem grass-cover and root systems. The vegetation cover holds tightly the topsoil together and thus reduces the rate of erosion.

However, farming, logging, construction, overgrazing by livestock, deliberate burning of vegetation and other activities that destroy plant cover make the soil vulnerable to erosion.

Soil Factors

The structure and texture of a soil determines its propensity to erosion. In soils with large pore/air spaces for rapid infiltration of water, build up of erosion run off is delayed. In the same vein, a sandy-textured soil with high porosity enhances water infiltration and limits flooding and erosion. Conversely, on a poor-structured soil; which has low number of crumbs and air spaces; typical of a clayey-textured soil, erosion is facilitated. The key physical soil factor which influences water erosion therefore remains the presence of seepage paths for water, that is the air spaces. They influence the permeability of the soil, which in turn affects the level of water erosion.

Table 13.1 Soils with Different Textures

Soil Texture	Nutrient Holding Capacity	Water-Infiltration Capacity	Water holding Capacity	Aeration	Work ability
Clay	Good	Poor	Poor	Poor	Poor
Silt	'Medium	Medium	Medium	Medium	Medium
Sand	Poor	Good	Good	Good	Good
Loam	Medium	Medium	Medium	Medium	Medium

3.4 Consequences of Erosion

Through various activities people initiate or greatly worsen soil erosion, just as sea waves, rainfall, or wind action can start or worsen it. Its impact can be utterly devastating in extreme circumstances. For Nigeria, a largely agrarian country and a nation likely to remain agrarian over the next several decades, the greatest impact of erosion lies in the outright volumetric loss of soil and the decrease in the nutrient capacity, moisture-retention capability, organic matter content, and depth of the soil. With the soil being so seriously impoverished, crop and livestock production suffers.

Table 3.1 shows, in comparative statistics, the sharp differences in the degree of soil loss attendant upon variations in land use. For every tonne of soil eroded in a forest, unburned savanna loses ten tonnes. In monocultural production of crops, the loss varies from 40 to 90 tonnes depending upon the type of crop grown.Further, in a field study of soil wash in one rainy season in the Sudan savanna region of Zaria in Kaduna State, Leow and Ologe have calculated that roughly one centimetre of soil was removed every 28 years or about one metre in 2,800 years.

To a considerable extent, the loss of soil from cultivated land contributes to the decline in agricultural production in Nigeria. Moreover, eroded soil has to be deposited somewhere on the land permanently or'temporarily, or in water bodies. On land the deposit can be a major nuisance, burying fertile arable land or crops and pastures already in place as well as clogging up irrigation channels and rendering access to agricultural fields difficult or costly. In some regions, the thickest of such deposited material exceeds 20 cm in just one rainy season.

Apart from its agricultural impact, soil erosion affects Nigerians adversely in numerous other ways. According to Igbozurike (1990), they include:

- Siltation of inland and coastal waterways, thereby impeding transportation, endangering or dislocating sources of water supply, and leading to the eutrophication of water bodies, fouling up of aquacultural and related production systems, reduction in the lifespan of hydroelectricity and other reservoirs, etc'
- Truncation of harbour works, expressways, feeder roads, and other transport installations.
- Damage to, and sometimes total loss of, residential buildings, schools, water pipelines, electricity installations, industrial grounds, patches of forest and wildlife habitats,

recreational spots and visual amenities, etc.

- Enforced and expensive population resettlement, as well as the realignment, relocation, or reconstruction of structures, and
- Death of human beings and livestock through falls into erosion channels.

3.5 Controlling Erosion

There has been a long-standing search for remedies to soil erosion in Nigeria. The search formally began in the early 1920s. It has led to a wide range of measures conceived and executed by an assortment of agencies. The results have been sometimes merely cosmetic. Sometimes they are worse than what the problem had been in the sense that an attempted solution to a local erosion problem has, in fact, precipitated an even worse erosion disaster. Notable examples of the latter situation are Ihioma community in Orlu Local Government Area (LGA) in Imo State , as well as Okpoko Layout in Onitsha town, Anambra State.Sometimes, of course, antierosion measures have been tangibly effective, even if they are not readily visible. They are not usually. visible on farmlands. Nobody ever goes out looking for an uneroded farm.

Anti-erosion measures in Nigeria have varied widely in scope and in effectiveness. At one end are legislative provisions, in practically every state; against such erosion inducing activities as bush burning, farming in erosion- sensitive zones, quarrying in certain regions, and unapproved road construction designs and procedures. Even where the wording of these laws is unambiguous and even where their interpretation is sufficiently foolproof, the big difficulty remains the lack of political will to enforce them, as well as the fact that most Nigerians have no idea that such laws exist.
Thus:

(a) A continuing and serious public education campaign should be launched on the menace of erosion. The role of the public in tackling it include:
    (i) Protect the soil with trees and other plants
    (ii) Plant grass on the soil around your buildings
    (iii) Stop indiscriminate felling of trees
    (iv) Plant grass on verges of roads
    (v) Plan the drainage before startind to cultivate
    (vi) Every house should have proper drainage system
    (vii) Discourage unplanned, unwarranted, and willful bush burning
    (viii) Farm in strips, and use mulch where possible
    (ix) Farm on contour ridges, instead of mounds
    (x) Legumintis cover crops should form part of crop rotation
    (xi) Alternate footpaths in villages and avoid their becoming channels for run-off
    (xii) Build check dams across gullies

(b) The relevant law enforcement agencies should be made to sit up and do their work, if these legislative provisions are to have the desired effect.

At the other end of the remedial measures is a group of interrelated activities,, comprising

"exclosural zonation, population resettlement, structural alteration, and community surveillance", and specified for the largest single gully erosion problem in Nigeria. This is where big money and bold plans come into play. And when the Federal Government informs Nigerians that between 1987 and 1989 it disbursed N368.9 million to 12 states "to fund 12 erosion and flood control projects", we applaud the government but quickly and respectfully add that there are well over 1,200 large erosion gully complexes in the country, requiring an investment of more than N10 billion, at 1989 prices! Again, it demands a very large measure of political will, and an elementary awareness of the fact that erosion inevitably increases with time, to make adequate financial allocations now that the situation has not yet gone out of hand in many locations across the country.

4.0 Conclusion

This unit has been able to discuss with you on erosion, which is depleting our environment at an alarming rate. Erosion occurs in all states of the federation. Between 25-30 million tones of soil loss are recorded annually in Nigeria due to gully erosion covering between 0.5% - 0.6% estimated land surfaces. This problem is more intense in the eastern parts of Nigeria. In northern states, wind erosion is quite common on farmlands and dune sites.

5.0 Summary

This unit focused on the problem of erosion in Nigeria. Erosion was defined as the wearing down and removal of soil, rock fragment and bedrock through the action of running water, glaciers, waves or wind.The types of erosion in Nigeria were mentioned as

(1) Wind erosion
(2) Coastal erosion
(3) Sheet erosion
(4) Gully erosion, and
(5) Wind erosion.

Erosion is caused by water or wind and is facilitated by steep topography porous soil and de-vegetation. Erosion has serious negative consequence on land, agricultural loss, loss of property, homes and life. Erosion has to be controlled on time by use of structures, to impede water flow, reforestation, educating the citizenry, legislation and several other measures.

6.0 References and other Resources

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UNIT 4: DESERTIFICATION

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1.0 Introduction

We are discussing on desertification especially as it affects us on this part of the globe. This is another environmental problem in, Nigeria that is claiming and displacing human habitat. Nigeria is one of the countries south of the Sahara faced with a rapid desert encroachment problem. Except we take the bull by the horn the desert may win eventually.

2.0 Objectives

By the end of this unit, you should be able to:
- Define the term desertification
- Mention human activities that encourages desertification
- Describe the extent of desert encroachment in Nigeria
- List ways of controlling the spread of deserts

3.1 Desert and Desertification: Conceptual Understanding

Desert is an area of land with santy rainfall and therefore little vegetation ad (under natural conditions) limited human use. Desertification, therefore, is a process of land becoming desert. Desertification is a process whereby the productivity of arid or semiarid land falls by 10% or more (Miller 1999).

Mild desertification is a 10-25% drop in productivity, serious desertification is a 25-50% drop and very serious desertification is a drop of 50% or more, this may lead to serious gullies and sand dunes. In a desert, the rate of evaporation is higher than precipitation. Precipitation is typically less than 250mm a year and is usually unevenly distributed throughout the year. In tropical deserts, as the one encroaching into Nigeria, temperatures are usually high year-round and there is very little rainfall. Deserts are known to have few plants and animals, and a hard, windblown surface strewn with rocks and some sand. Desertification is a

very serious environmental problem rapidly ravaging the world over.

A definite climatological definition of a desert is near impossible as a result of local variations, but usually, in areas where the annual precipitation is less than 20mm or 2cm. Deserts regions can be subdivided into:

1. Semi-arid region in which the ratio of-precipitation to evaporation is less than one. Yearly these areas experience a reduction in rainfall, which is usually between 38-76cm. Although there is a short lasting moist season.
2. Arid region (or true desert) here the yearly precipitation is between 12.5 - 38cm and this occurs as a short torrent with in between months of complete drought.
3. Extreme arid regions here the interval between rain may be up to five years. However, when rain falls it may be more than 50cm on the average (Jones, Robertson, Forbes & Hollier, 1990).

The quantity of "natural" true desert and semi-arid desert is small compared to human induced desert that is currently on the increase.

Deserts can be classified as hot deserts e.g Sahara desert or cold deserts eg Khashdesert in the lee of the Himalayas - China. In the cold deserts, usually winter temperature may be as low as O^{o}C daily. Contrarily hot desert has no cold season but night temperature may be lower than O°C.

The term desert vegetation is used for the vegetation type which has developed in response to very low annual rainfall. Desert vegetation usually shows:

1. Marked transition in appearance from humid grease along the arid centre of a desert.
2. Usually, wood like plants are gnarled and form a spreading pattered
3. The quantity of species and individuals becoming smaller, leaves become reduced and finally form vestigial spines or blades. These are the characteristics features of a desert vegetation.

Characteristics features of desertification or desert encroachment include:

1 Improvisehment of vegetation cover
2 Deterioration of the texture, structure, nutrient status and fertility of the soil
3 Accelerated soil erosion
4 Reduced availability and quantity of water encroachment of sand.

Exercise 14.1:

List out the differences between the characteristic features of desert encroachment and a desert.

Table 14.1: Desert areas of the World:

Desert	Area Million Km2	(%) of /world desert area
Sahara desert	9.07	41.7
Australian desert	3.37	15.5
Arabian desert	2.60	11.9
Turkestan desert	1.94	'
North American desert	1.29	5.9
Patagonian desert	0.67	3.1
Thar-sind	0,60	2.7
Kalahari/Namib desert	0.57	2.6
Taklimakan & '	6.77	_
deserts	0.39	1.8
Iranian desert	0.36	1.7
Atacama desert	0.13	0.6
All other deserts		
Total area	21.76	100.0

Source: Jones et. al, 1990

3.2 Human Activities Leading to Desertification

The causes of desertification are numerous and complex. Some are traceable to nature others are human induced. There are 45 identified causes of desertification, 38 of which have been traced to human activity on the environment. This idea was buttressed by the United Nations Conference on Desertification held in1977 - held as a result of Sahel drought in 1968 - 74.

Few of these human activities include:

1. Overgrazing on delicate arid and semiarid rangelands beyond land capacity
2. Deforestation without corresponding aforestation.
3. Surface mining without reclaiming the land.
4. Irritation techniques that led to increase erosion.
5. Too much intensive form of cultivation
6. Salt building and waterlogged soil through poorly managed irrigation system
7. Farming on land without proper terrain or soils
8. Soil compaction by farm machinery and cattle hoofs
9. Misuse of water resources
10. Misuse and abuse of flora and fauna.

The consequences of desertification include among others a worsening drought, famine, falling standard of living and alarming population of environmental refugees that have lost their land to desertfication. Thus, they cannot farm nor feed their livestock.

Alarming Information

About 8.1 million sq km (about the size of Brazil - see your world map) have become desertified in the past 50 years. Not less than 900 million people in
100 countries have their livelihood threatened.

SOME NIGERIANS ARE INVOLVED

The danger is, 1.2 billion people will suffer the same fate within few years if the trend continues.

Every year, low to moderate new desert emerge and are estimated to be about 60,000 sq km and another 210,000 sq.km undergo severe desertification and lose so much soil and fertility that are no longer economically valuable for farming and grazing.

3.3 Extent of Desert Encroachment in Nigeria

In 1977 three international organizations came up with the desertification Map of the world they are: Food and Agriculture Organization (FAO - a UN organization), the World Meterological Organization (WMO) and UNESCO. ABOUT 15% of Nigeria is prone to desertification. It subsumes both arid and semi-arid areas where the evidences of true desertification are showing up on an extensive scale.

(i) Shrubs have largely replaced grasses or have spread to such an extent that they dominate the flora.
(ii) Sheet, wind, and water erosion have largely denuded the land of vegetation and large gullies are present; or
(iii) Salinity has reduced crop yields, may be by more than 50 percent, or
(iv) all of the above conditions are combined (NEST, 1991)

The areas of the country that are faced with serious desertification are inhabited by 28 million people and over 58 million livestock.

How fast is desertification advancing in Nigeria?This is an important question, which is still difficult to answer. This is because various governments, until recently, have not seen desertification as problem requiring high priority attention. Consequently, there has been no real monitoring of the rate at which arid and semi-arid areas of the country are being degraded. Estimates by scientists vary from less than 1 km to about 15km per year. On the other hand, other scientists contend that it is not moving along a linear front but occurs in patches, which expand in various directions and at rates that vary considerably. As the degraded patches grow they may link up to produce extensive wasteland as in the extreme northern part of Borno State where communitities such as Bula tura, Kaska, Bukarti, Toshu, Tubtulowa, and Yunusari, among

others, have been either completely surrounded by sand dunes or are about to be buried by them.

Notwithstanding the absence of absolute figures on the rate of spread of desertification in Nigeria, an indisputable fact is that most of the region north of latitude 12°N is heavily prone to ecological degradation. For example, more than 65 percent of Sokoto State is said to be under seige, while about 55 percent of Borno State is afflicted. In Gida Kaura, a village 90 km northwest of Sokoto sand dunes have been reported to have invaded vast areas of farmland and swept a whole village of nearly 300 houses out of existence.In the extreme northern part of Borno state, a post-primary school established -some years ago could not be put to proper use because moving sands make access to it difficult. Also people have been moving southwards to areas around Gashua, Nguru, Kukuwa, and Monguno, which themselves are within the fragile environment. Today it may be said that hundreds of thousands of square kilometres of arable land have been lost to desertification states such as Sokoto, Zamfara, Katsina, Jigawa, extreme north of Kano, Yobe and Borno states.

How are the desert lands formed? Why is land degradation worsening in many parts of northern Nigeria, in spite of the well-known devastating effects of desertification on society?

Desertification is merely a physical process by which, first, the plant cover, species diversity, and primary productivity of arid or semi-arid ecosystems are serious reduced. Reduction in the vegetation cover increasingly exposes bare soil to large microclimatic changes which alter the soil structure and surface, making it more vulnerable to wind and water erosion. Because the perennial plant species are reduced in density, deflation is no longer compensated for by sand deposition and wind erosion may accelerate, removing all movable fine and loose particles and leaving the land surface covered by pebbles or stones. At this level permanent plant life may become impossible because lack of water reserves in the remaining shallow soil may prevent seedlings from surviving the first prolonged drought period. In shifting sands that accompany deflation, perennials species cannot get established because as soon as the seedlings emerge, they are uprooted and blown away. Degraded vegetation cover also exposes the bare surface to the impact of torrential rains that are usually characteristic of the short wet season of the arid and semi-arid areas. Large raindrops associated with these rains disperse the finer particles of soil and wash them into the soil pores. This effectively seals up the soil surface, which, in turn, reduces the infiltration of rainwater, and increases the rate of surface runoff. This partly explains the spectacular and destructive gully erosion, which has laid waste vast areas of Sokoto and Katsina states.

The cumulative effect of these mechanisms resulting from vegetation reduction produces a land surface where the regeneration of plants is difficult and where there is a general decrease in the productivity of the ecosystem. Eventually the environment becomes unusable to society.

Desertification, in its most widespread form, is generally represented as a function of the interaction between people and the environment. It is the result of three major factors:

(a) Inherent extreme variability of climate as manifested in drought
(b) Disruption in the ecological system caused by a long period of improper land use by man and the ever-increasing demand being made upon the available land resources by socio-economic systems of the affected areas; and
(c) Failure by people to develop appropriate conservation measures (NEST, 1991)

3.5 Controlling Desert Encroachment

Alleviating the impact of drought and combating desertification require data on their occurrence and severity. Thus, the monitoring of these environmental hazards is an absolute necessity. The development of early warning system for drought occurrence, for example, would help in the planning of relief measures. Modern monitoring tools can provide useful information on the physical and social factors of desertifiction. In addition to ground truth sampling and aerial photographs, orbiting weather satellites and earth resources satellites can be used to survey the climate, the status of the arid and semi-arid ecosystems, man-induced vegetation changes, changes in land use, shifting sands, and the general degree of ecological instability over a period of time.

Drought mitigation measures may take short-term or longterm forms. In general, short-term remedial measures include strategic irrigation, matching crop types and management with moisture supply, adjusting livestock numbers, constructing new wells, bore-holes, and stock ponds, drought information dissemination and drought relief. Long-term measures may include minimum tillage, large-scale irrigation, weather and microclimatic modification, alternate crops,.. improved cultural and agricultural practices, water harvesting, soil evaporation reduction, selective plant breeding for drought tolerance, water impoundment, and transfer of water from areas of surplus to areas of persistent drought.

Because the factors of desertification vary from place to place, measures for combating it would differ from one affected region to the other. In general, however, measures, such as proper water resources planning, development, and management; rational rangeland and livestock management; afforestation; and dune stabilization may be used in checking further ecological degradation of the arid and semi-arid ecosystem.

3.5.1 Nigerian response to Drought and Desertification

The above are well-known technical solutions to drought and desertification. But what has been the actual response to them by people on the one hand and the government on the other?

Nigerians have reacted in several ways to these twin hazards of a marginal climate. Recent studies have identified the following forms of actions:

- Shifts away from drought-sensitive crops such as groundnuts, guineacorn, late millet, and cowpeas;
- Attempts to find land for dry season irrigated farming;
- Reduction in manure use, as manure tends to raise soil temperature if the soil is dry
- Finding alternative employment to, for example, firewood selling, and hunting.
- Liquidating accumulated assets, such as livestock and personal clothing;
- Mobilizing social networks by which, in accord with Islamic injunctions, wealth is redistributed from the relatively rich to the common people
- Utilization of the edible leaves, roots and fruits of a great variety of plants; and
- Migration into the cities, wetter areas farther south, and into neighbouring countries (NEST, 1991).

Apparently, all of these actions are only temporary stop-gap measures until normal rains return. Most of them have the potential to further degrade the environment. Other than out migration, permanent remedies to the problems of drought and desertification are not in sight for the farmers and pastoralists who live in our dry belt.

Government response to these problems has been slow, limited in scope, and to some extent, misdirected. It was not until the 1940s that a small action programme in the form of a tree planting campaign was launched. The drought of 1969-73 was recognized as a national disaster and the government responded to it and to subsequent droughts in four main ways:

- The setting up of emergency relief packages;
- The encouragement of tree planting,
- The establishment of afforestation programmes; and
- Dam construction and irrigation.

Drought relief packages in Nigeria have usually been well-founded but poorly managed. They have focused on the provision of subsized food; water, using water takers, where this is feasible and sinking wells and boreholes, where it is not; seeds at planting time; and basic medicare. Several governments have tried to inculcate in Nigerian in general, and in people in the North in particular, a tree planting culture. It has high hopes in it as a measure that would help in halting desertification and outmigration from the affected areas. Thus, while launching_ the 1986 National Tree Planting Campaign in Gubio, the Military Governor of Bgrno State said that such outmigration:

Fighting Desertification in Sokoto (Now includes Zamfara State)

Most of Sokoto state lies between latitudes 12 and 14 degrees North in the Sudan and Sahelian Savanna vegetation zones. Thus it lies on the fringes of the Sahara Desert. Studies carried out in the wake of the 1973 drought, which hit Sokoto as well as other

parts of the country, indicated that about two- thirds of the state's total land area was threatened by the fast-advacing desert.

More recently, a government report has also revealed that of the 52 gazetted forest reserves in the state, with an area of about 20,410 square kiloemtres, only a few in the southern parts of the state have an appreciable quantity of trees. The rest consist of nothing but shrubs, grass and widely scattered trees. Consequently, the report continued, desert encroachment on the state has been estimated at an average rate of five kilometres a year. Many areas that were fertile in recent memory have now been turned into sand dunes, and as a result people in a number of locations like Gidan Kaura have had to migrate to other less inhospitable areas.

The denudation of the land has been aggravated by man's activities which include uncontrolled grazing, large scale felling of trees, and bush burning. Despite official campaigns and the introduction of punitive measures as a deterrent, these practices have persisted and in some cases have even increased in scale.

Measures to check the menace of deforestation date back to the 1960s. At the launching of the 1980 tree planting campaign, Governor Ahmadu Daku said that the government through its "community involvement strategy" succeeded in raising a total of 10,854 hectares of plantations, including woodlots and shelterbelts planted by individuals communities. In 1988, 1.5 million assorted tree seedlings were produced in all government nurseries which went into nurturing 50 hectares of fuelwood plantation, 10 hectares of gum arabic plantation, and 18 kilometres of shelterbelts.

The state government's campaign to halt the rapid rate of desertification is received much needed boost from a World Bank-assisted forestry project. Under the programme, 102 kilometres (as at October 1980) of shelterbelts were established while two million assorted tree seedlings have been produced. Similarly both the Energy Research Centre of usman Danfodiyo University, Sokoto, and the state Polytechnic have developed improved wood stoves, biogas plants, solar cookers, solar heaters, and solar dryers in a drive to reduce the use of firewood as fuel for cooking.

Furthermore, in an effort to curb the indiscriminate felling of trees the state government enacted an edict banning the use of firewood in all state and federal institutions. It has at the same time unveiled a plan to change the people's cooking habit, which at present shows a heavy dependence on firewood, by introducing a programme under which it would spend N3.8 million to purchase kerosine stoves and gas cookers for popular use.

In the meantime, the old environmentally damaging habits continue in the face of the government's planning to transform old habits. Indiscriminate felling of trees, overgrazing and bush burning are still common features in the state. Unofficial figures indicate that at least 30 lorry loads of firewood are sold daily in Sokoto, the state capital, alone. A dealer in firewood in the town, Muhammadu Sani, in fact states that the business is booming, and he attributes the boom to the high market prices of gas cookers and kerosine stoves, as well as the fuel they use. He pointed out that the price of a gallon of kerosine at most local outlets was N3 to N4 while a cylinder of cooker gas could cost as much as

N60. Today kerosine goes for about N100 per gallon and cooking gas for about N800 for a cylinder.

A forestry official blamed the flouting of law on bush burning and other similar offences on the inability of the official agency to enforce the law due to inadequacy of personnel. He said the forestry department is too grossly understaffed to be able to carry out this onerous task.

Meanwhile, what can be done while the arrival of the 42,000 stoves ordered by the government and the setting up of depots for stocking gas and kerosine at strategic locations is a waited? There appears to be little choice for the government but to, in addition, strengthen its forestry department's policing section to enable it wage war against bush burning and indiscriminate tree felling. Moreover, tree planting campaigns as they are presently carried out appeared to be mostly annual ceremonial events. A more energetic action to involve traditional rulers, schools, local authorities, clubs, and societies in the campaign would demonstrate serious concern to save not only our vegetation but by extension our own selves.

(NAN-FEATURE).

Adapted from NEST 1991

Exercise 14.1:
Conduct an opinion within your community among 50 people randomly to find out if they think desertification will reduce or increase based on the current cost of kerosine and cooker gas.

Fighting Desertification in Borno State
With about 55 percent of its land area under siege from desertification, Borno State is one of the most threatened land areas of Nigeria. It suffered from a protracted fifteen-year drought in the period 1972-1987. An indication of the extent and severity of the drought is the southward shift of the 300 mm isohyet of the mean annual rainfall for a distance of over 20 km between 1969 and 1983. In 1987, there was no rainfall in the extreme northern part of the state.

In addition to the persistent drought problem, Borno State's land and water resources are under increasing pressure from human ' and livestock populations. The human population grew from about 2 million in 1963 to an estimated 5 million in 1979, and the high growth rate persists. The rapid population growth rate is increasing the pressure on the state's forest resources because of increasing demand for fuel wood. It has also encouraged the extension of cultivation into erstwhile marginal agricultural lands.

There are no accurate data on the livestock population of the state, but estimates put it at about 3.33 million cattle, 2.81 million sheep, and 3.09 million goats in 1983. Of special concern is the rather large number of goats, which constituted about 38 percent of the state's livestock population. Because of their destructive grazing habits, goats are known to inflict the' worst form of overgrazing and degradation on plant communities in arid and semi-arid ecosystems.

Increased intensification of the use of the fragile resource of the land in recent years has led to progressive degradation and destruction in many areas. The process of desertification may continue in such areas even in years of normal to good rainfall.

Thus, inspite of the above-average rainfall in 1980 and 1989, satisfactory flora recovery in the northern parts of the sate has not been achieved. It is now feared that the initial damage by drought and population pressure may have resulted in the genetic loss of some valuable plant species. The desert- like conditions being experienced in the state are characterized by the following processes:

(a) The disappearance or permanent degradation of the vegetation as in the northern boundaries of Nguru, Gashua, Geidam, kukawa, and Monguno Local Government Area where new active sand dunes are common.
(b) Increased soil degradation through loss of organic. matter content and loss of ability to retain water;
(c) Increased wind erosion and local sands storms;
(d) Increased run off and sheet erosion;
(e) Continued decline of crop yields and recurring crop failures, leading to constant state of famine;
(f) Dune formation or reactiveation in sandy areas of Kaska (Nguru LG), Kukawa, and Geidam; and
(g) Breakdown of traditional community relations as well as socially and economically accepted farming systems.

The Borno State government is very much aware of the general extent and severity of the problem of desertification. It has, therefore, initiated remedial and preventive measures as follows:

- The Felling of Trees (Control) Edict (Borno State Edict No. 8) promulgated in 1987 to control the use of wood for fuel and to check the pressure on the State's meagre forest resources.
- The .Burning of Bush (Control) Amendment) (Borno State Edict No. 7) promulgated in 1987 to control bush burning.
- A new Ministry of Animal and Forestry Resources was established in 1989 to coordinate all desertification control project in the state and to serve as the headquarters for the Borno State Implementation Agency for the National Committee for Drought and Desertification Control in Nigeria.

- Ambitious forestry schemes was embarked upon, leading to the reservation of 1,229 ha of "forest" land for fuel and poles around towns and villages between 1960 and 1980; the planting of 190 ha of gum arabic between 1987 and 1988, ten ha of Borassus aethipum (Gingiya) in the Shanni LGA, two ha of parkia higlobosa (Dorowa) between 1987 and 1988, 104 ha of village woodlots, 86 km of roadside plantations, about 100 ha of tree plantations, fenced and fully equipped with a borehole as part of the state's multipurpose Block Forestry' project; the distribution of over 20 million tree seedlings annually to various afforestration projects; and the trial planting of indigentis tree species for shelterbelt establishment.
- Grass planting programmes planned.

In. spite of these efforts and achievements, Borno State still lacks a coherent and systematic desertification control strategy. Such a strategy should take into consideration statewide differences in the extent and severity of the problem. For example, while the establishment of wind breakers and the stabilization of moving dunes should be a priority in the northern parts of the State, the main focus of action in the southern areas should be the rehabilitation and protection of forest resources. It is necessary to review the Felling of Trees (Control) Edict of 1987 for rational implementation. In Kano State appropriation in this area has greatly encouraged the rehabilitation of threatened farmlands, resulting in a remarkable regeneration of Acacia albida (Gawo). around Damabatta

Adopted from NEST, 1991

4.0 Conclusion

Unless the development and management of the traditional resources in our marginal areas are carefully planned, the type of environmental catastrophe that is afflicting Ethiopia may also occur in Nigeria in the next few years.An Ethiopian peasant at the peak of the drought scourge of 1983, said: "Now all I have is a harvest of dust", hope this will not be a true statement in Northern Nigeria! Except individuals, NGOs, CBOs and Government act now, this may become a reality.

5.0 Summary

This unit has taken you through a major environmental problem in Nigeria - desertification. We have defined desert and desertification, thus, you should be able to draw a line between the two concepts - a desert is the "place" and desertification is the process of being a desert. There are several human activities that lead to desertification in Nigeria. Such common activities include: overgrazing, overcultivation, deforestation and bush burning. Desert has encroached into virtually all the extreme Northern States in Nigeria. Several steps to control and manage drought and desertification in Nigeria include among others: good water resources management, tree planting and afforestation programmes, reduction of wood for fuel use, good land management and several others.

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UNIT 5: SOLID WASTE: DEFINITIONS AND PROBLEMS

TABLE OF CONTENTS

1.0 Introduction

This unit, like the previous one will focus on solid waste problem in Nigeria. It will however focus more on the background to the problem of waste generation disposal and collection in Nigeria. Definitions of wastes and solid waste will be outlined and discussed. You will find it interesting to know the type of wastes that we generate within this country.

2.0 Objectives

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

- Outline the genesis of solid waste generation
- Define waste
- Define what is solid waste
- Outline the quantity of waste generation in some states in Nigeria.

3.1 Genesis of the Problem

The last century and especially after the Second World War there has been a dramatic increase in the production of waste, indicating unprecedented global levels of economic activity. This can be attributed to the industrial and scientific revolution that preceded World War 11, especially in developed nations. The increase in waste stream of western economies can be attributed to factors such as cheaper consumer products, the proliferation of packaging; changing patterns of taste and consumption, and the demand for convenience products (Gandy, 1994).

Since the 1960s, the reduction of waste through promotion of recycling has steadily worked its way to the environmental policy agenda and was endorsed at the 1992 UN Rio Conference.

The Agenda 21 declaration called for the promotion of sufficient financial and technological capacities at the regional, national and local levels to implement waste and

recycling policies, and actions. Yet the process of recycling is not just a reaction to environmental crisis but a reflection of the change of culture.The prospects for sustainable waste management should be placed in the context of the trend towards urbanization. By 1950, 600 million people lived in cities worldwide but by the 1980s there were about 2 billion living in over 23 mega-cities world over. This is significant because the problems in municipal waste management are particularly severe in urban centres. The problem of urban waste management since the 1970s and leading to conflict between environmentalist and politician, demands for comprehensive recycling strategies to tackle the growing waste stream.

Waste has been and will perhaps remain the focus of environmental attention and research for the first quarter of this century. This prediction is based on the realization world over of the hazardous effect of mismanagement of waste on biodiversity, environmental quality and especially on human health. The search for improved quality of life, scientific and technological development, cum the problem of population stress on the environment will continue to make waste and its management a central focus for discussion. Critical to our management of waste is the need to employ sustainable waste management techniques, which is an index to living.

The collection and disposal of sewage, liquid and solid wastes is a major public health issue and a vital factor affecting the quality of the environment. The problem of solid waste disposal, especially in our cities, has become one of the most intractable environmental problems facing us today. There has been a phenomenal increase in the country's waste within the past few years. This is due, largely, to the increasing rate of population growth, urbanization, industrialization, and general economic growth. In many Nigerian cities, the volume of solid wastes have overwhelmed urban administrators' capacity to plan for their collection and disposal. Thus it is not uncommon to find urban streets and roads practically blocked by solid wastes. This has been observed to contribute to the problem of flood disasters in cities such as Ibadan and Lagos.

In several urban and rural centres throughout Nigeria, the arrangements for waste disposal have been ineffective or insufficient. Thus these wastes are often indiscriminately dumped on open plots of land and, particularly, along and streets. Consequently some of the affected streets may be rendered impassable for several weeks or months. Every Nigerian city is marked by this malaise, and its end appears not to be in sight.

3.2 Definition of Waste

Several definitions have been mentioned of what constitutes a waste or what a waste is. These definitions vary from individuals based on their perception of waste. Barrow (1993); quoting Douglas (1992) says, waste is something for which we have no further use and which we wish to get rid of. From this definition, a waste is any material we wish to dispose off, but these materials may still be very useful for other purposes but may not be, for the individual that wants to dispose it or perhaps he does not realize its economic value. On the other hand the individual who wants to dispose it may realize the usefulness or economic value of the waste but may not be willing to keep the material any further as a possession for whatever reason that is reasonable enough for that individual.

Barrow (1993) defined waste as any damaged defective or superfluous materials that may end-up being hazardous. Waste can be defined as what we assume to be no longer of use to us (Osuafor, 2000). She argued that as long as a commodity, which may even be valued, has no use it becomes a waste.

Waste is any substance for which the user has derived sufficient benefits and needs be disposed of, or has perceived that the substance or material is not of value or importance to him and therefore wishes to dispose of it. This does not imply that the perceived waste is useless, except to the user who has disposed of it or may realize its useless but that usefulness may not be meaningful or important to the individual who has disposed of it.

Production of wastes is inevitable, because most environmental wastes are by-products of inevitable and profitable human activities upon which our continual survival hinges on and the demand for improved quality of life. Faced with this need the challenge before us is to evolve techniques of managing man's numerous wastes without depriving future generations of the benefits from the environment. This development will go a long way in minimizing waste's negative impact on the physical environment, and will lead to sustainable development.

3.3 Definition of Solid Waste

Solid waste according to Douglas (1992) is an extremely heterogeneous mixture of constituents that appears to vary according to season, the social characteristics of the neighbouhood and changed lifestyles. But Miller (2000) defined solid waste as any unwanted or discarded material that is not liquid or gas. Longe (1994) and Adinna (1997) as cited by Osuagor (2000) says solid wastes are non-liquid, non-gaseous residue from manufacturing industries, construction firms, cookking recreation or agriculture. Solid wastes generated from a number of sources, which include homes, hospitals, schools, markets, businesses and a few others, are referred to as **MUNICIPAL SOLID WASTE.**

Table 15.1 Classification of solid Waste

S/N (a)	**Types (b)**	**Essential Composition (c)**	**Sources (d)**
1.	Agricultural waste.	Harvest residue, garden prune, manure, Animal waste, dead fish, Abattoir waste	Animal farms, farms animal feeds, Abattoir
2.	Abandoned Vehicles	Bicycles, Automobiles & Trucks	Homes, Mechanic workshops, Road sides

3.	Construction & Demolition waste	Lumber concrete, empty cement bags, plaster, tiles roofing pipe, roofing sheets, , planks, conduit pipe, wire	Construction & Demolition sites
4.	Industrial wastes	Scrap metal, plastics, paper, fly ash (removed by air pollution control equipment in industrial & electrical power plants), cinders, sludge from industrial waste treatment plants, glass	Chemical industries, glass industries, manufacturing companies
5.	Municipal Solid		
a.	Organic waste	Waste. from cooking and cooked food or left over papers, wood, unused wooden furniture, rags, cartons, flowers, trees, dead pets	Street, parks, beaches, households institutes & businesses in or near urban places
b.	Inorganic waste Incombustible	Metals, cans, metal foil, stones, ceramic, glass	Same as above
c.	Mineral waste	Earth & Rock from mining extractive and relining	Mines, process & minerals refunding plants
d.	Radioactive/hazardous waste	Pathological waste explosive, radioactive materials, poison, hazardous chemical & pesticides	Industries and Institutions
e.	Sewage treatment residue	Coarses screening, grit, septic tank sludge & chambers	Sewage treatment plants

3.4 Problems of Solid Waste Generation and Disposal

Solid waste constitutes a major problem to countries world over. The United States, with about 4% of the world's population produces about I1 billion tones of the world's solid waste (Miller, 2000). On the other hand, Nigeria with about 2% of the world's population (120 million) generates about 12 million tones of world's wastes. This prediction is based on the estimate of Ekwo (1997) that the average solid waste generated by Nigeria with a population of 100 million was found to be 10 million. This implies that on the average each individual will generate 10 tones of solid waste per year. The population of solid waste collection and disposal has become one of the most intractable environmental problems facing us today especially in many of our urban areas.

The unsanitary conditions in which the solid wastes are collected, processed, and disposed of contribute greatly to urban environmental degradation. Few Local Governments have regulations or bylaws, which specify the type of containers to be used for storing refuse and, as a result of this lapse, many households use various inappropriate containers as dustbins. Perhaps more important is the fact that there is a need for central depots or dumps where each household can deposit its wastes for collection later by garbage trucks. Unfortunately, most households (71%) throw their refuse in any available open space, to be collected later, if at all, by the garbage trucks. Only about 22% of the sampled households disposed of their refuse in proper depots for which there were containers either of metal, plastic, concrete blocks, or mud walls. About 5% of the households threw their solid wastes in its exist in their areas of the cities. However, more important is the variability among the states. While about 83% of the sampled urban households in Niger and Bauchi States reported the non-collection of their refuse, only about 4% of Sokoto and Ogun States reported likewise.

However, it must be realized that even within individual cities, there is a degree of variability in the frequency of collection of refuse by the authorities. Some areas in the cities, such as the Victoria Island and Ikoyi in Lagos, Bodija in Ibadan, and the various G.R.As in other cities, receive more attention by having their refuse collected more regularly than other areas, especially those inhabited by the low-income group.

Table 15.2 Nature of Solid Waste Depots or Dumps in 15 Nigerian Cities

Type of Depots/Dumps	Frequency (%)
Ground surface	71.0
Metal/Plastic container	17.8
Walled structure	4.0
Pit	6.4
Others	0.8
Total	100.0

Source: NEST, (1991)

Table 15.3 Past Records. of Estimated and Projected Volumes of solid Waste Generation in Some Nigerian Cities

Urban Areas	1982	1985	1990	
	2000 (Tonnes Per Year)			
Lagos	625,399	681,394	786,079	998,081
lbadan	350,823	382,224	440,956	449.882
Kano	319.935	348,580	402,133	535,186
Kaduna	257,837	280,925	324,084	431,314
Onitsha	242,240	263,929	304,477	386,593
Port Harcourt	210,934	229,821	265,129	352,853
Oshogbo	131,903	143,712	173,720	253,841
Aba	131,903	143,712	169,719	236,703
Jos	99,871	111,905	135,272	197,660
Warri	67,477	75,607	91,396	133,531
Gusau	44,488	48,471	57,243	79,835
Potiskum	15,434	16,816	19,399	28,347
Uyo	12,508	13,628	15,721	20,336
Suleja	9,383	10,514	13,311	21,336
New Bussa .	5,690	6,200	7,152	9,518

Source: Federal Ministry of Housing and Environment,

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Exercise 15.1

1. Identify and classify the types of solid waste that are generated in your home.
2. Which type of solid waste do you generate most and why do you think this is true?

3.5 Collection of Solid Waste

The volume of solid waste that is visible, especially in the cities, testifies to the ineffectiveness of the authorities responsible for them. About 28% of all sampled households reported that their wastes were not collected at all, while only 21% reported a daily or twice-weekly collection. Non collection seems to be higher for cities like Gussau, New Bussa, Oshogbo, Aba, and Kaduna. Lagos seems to have the lowest rate of non-collection of all the big cities (NEST, 1991-)

In-another study conducted under the auspices of NISER in 1984, about 31% of the respondents reported that refuse collection did not 57.7% dispose of their refuse at public dumps. In other words, more than half disposed of their refuse at public dumps. About

3% threw it into gutters, drains, or river channels, thus blocking these drains and creating a widespread flood hazard.

One of the important factors responsible for the current ineffective solid waste disposal in most Nigerian cities is. the inadequate financial resource available to the authorities directly responsible. Governments have problems in financing solid waste collection and disposal system because the possibility of cost recovery is very low. It is very difficult for government to get people to pay for this kind of service, despite its essential nature.

Another factor relates to the structure of most Nigerian cities. A typical Nigerian city is made up of a traditional inner core and a modern section. Most often no form of refuse disposal service is provided for the traditional core areas because of lack of easy access to these areas. The houses are invariably located haphazardly. Most of the roads and pathways are too narrow to be motorable and are generally impassable during the rainy season. Thus even where garbage truck are available, they may not be able to pass through for the evacuation of refuse.

Exercise 15.2

l. Find out from at least 30 individuals/homes who collects their wastes:
   (a) Government agencies or
   (b) Private waste collection
2. If the collector in question 1 above is neither government nor private collector, where do they dump their wastes
3. Draw a table indicating who or where individual/home waste are collected/dumped.
4. Present the percentage of who or where it is collected.

Example:

Individaul Who collect waste or where is it dumped?

1	Mr or house No of	Government agency
2	Mrs or house No.	Private collector e.g cart pusher or approved government agent.
3	Miss or house No of	Dump in the river

4. Present the percentages of who or where it is collected

Source	No. of individual	Percentage
1. Government agency 2. Private collection 3. Dumped indiscriminately		

4.0 Conclusion

This unit focused on solid waste generation, collection and disposal in Nigeria. You must have realized that solid waste disposal is a serious and expanding problem in both rural and urban communities in Nigeria. This problem acerbates with increase in population, illiteracy, and inadequacy of equipment for waste collection and development.

This therefore calls for proper waste management strategies. This will be the focus of the next unit.

5.0 Summary

In this Unit, various definitions of wastes have been given. In addition, waste have been classified into various groups. This unit has also discussed the genesis and problems of solid waste globally. Increase in economic activities after the Second World War, industrial and scientific revolution and the quest for improved lifestyle are some of he causes of waste generation. Illiteracy and rapid population growth are also contributors especially in Nigeria.

Nigeria is still faced with the problem of solid waste collection and disposal. This is traceable to her population growth, inadequacies, of government agencies in charge of waste and citizenry's negative attitude to waste disposal.

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MODULE 4

WASTE OIL, MINING AND GAS FLARING MANAGEMENT IN NIGERIA

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UNIT 1: SOLID WASTE MANAGEMENT IN NIGERIA

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1.0 Introduction

This unit is a continuation of the last one, unit 15, The previous unit discussed more on background issues of waste disposal and collection including the problems of waste generation. However, this unit will discuss on the management aspect of solid waste and techniques that may be employed in managing waste in Nigeria. Case studies of waste management in various places will also be discussed. Sustainable solid waste management technique will be mentioned and recommendations will also be made.

2.0 Objectives

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

- Relate the influence of economic crisis in Nigeria to waste recycling
- Outline strategies for managing solid waste
- Recommend ways for improving solid waste management in Nigeria .

3.1 Solid Waste Management: Lagos State Experience

The present Administration in the State has re-shaped the private sector involvement in waste disposal. The new technique adopted has proved effective in some local governments.

In the second quarter of 1998, the state government came up with the idea of privatization of refuse known as private sector participation (PSP), first at the level of the Ministry of Environment and Physical Planning and later i.n 1999 at local government level. The state government launched last year the private sector participation (PSP) programme in which it brought companies to assist in clearing mountains of refuse and manage waste disposal. The introduction of bags with which residents are expected to dispose their refuse to the PSP operators for a fee introduced. This made residents to dispose their waste properly.

The Local Government Administration is now faced with the challenge of recommending PSP to the people of Lagos State. And it is the job of the health officers and administrators of the local government to ensure that the government succeeds in this manner of privatization of waste management. Thus, in the last months various PSP operators have emerged from various parts of the state. Although the awareness of this programme has not been fully reached but the people should be informed of government policies and programmes as it affects PSP. This is because policies cannot be fully effective for the improvement of the majority when the people are not supportive of the policies.

Since the local government are not without allocation of values, the success of PSP will be determined by the promptness of the local government in dealing with PSP issues (Ahove & Kola Olusanya, 1999).

In the management of municipal solid wastes, collection and transportation from refuse dumps take up to 75% of the refuse expenses of waste disposal. Little wonder therefore that Lagos State Waste Management Authority (LAWMA) has not been able to cope amidst the teaming population of the state in the face of financial constrains cum equipment incapacitation.

This, waste collection and disposal are being contracted out of private sector whose primary goal is to maximize profit.

3.2 Economic Crisis and Economics of Waste Management

The present harsh economic crisis in the nation has led to the emergence of interest in waste recycling. It is now common to see human scavengers at work on most waste dump sites salvaging all items they believe to be salvageable, usable as they are or in demand as industrial raw materials: bottles, rusty pots and pans, broken metals, chairs, leaking plastics containers, old car tyres and plastic shoes, clothes buttons, and zip fasteners, as well as milk tins, etc. Milk tins, for example, are in very high demand. As you might have known they can easily be transformed into cups, for measuring food stuffs

in the market or for cooking bean cake (moimoi) in the house. Despite the obvious health hazards which scavenging poses to both the scavengers and their customers, it must be admitted that it is helping us to cope with our solid waste disposal problem. And in 1989, the country's policy makers put a stamp of approval on the scavengers' industry by launching a nation-wide Waste-to Wealth scheme (NEST, 1991).

Making one's daily bread from scavenging is a thriving business. My interaction with some of these scavengers proved that some have personal. cars while others have built their houses. This is good business, good money with a risk on health.

A study conducted by Muoghallu (2000) on the economic value of waste paper, plastics and metal scraps in Lagos State is worthy of note. The study covers a total of 270 people from three groups involved in the collection, processing and recycling of wastes. They are (40) scavengers, (182) individuals from processing companies and (48) individuals from recycling companies.

Scavengers: The study reported that the scavengers were involved in this work because of the reasonable economic gain they make from selling waste plastics, papers and metal scraps. They find it very easy to collect enough of these materials and sell to processing companies.

The problem they encounter in the work is sorting of the wastes, According to the study, paper waste is the most abundant, followed by plastic and then metal scraps. The waste papers are mostly wet and thus, not good enough when sorting for this plastics are more accessible. They concluded that recycling is economically viable.

Processing Company: Wastes are processed for recycling companies, ready enough to be recycled. It was reported that the waste is in constant supply from contractors that relate with the study showed that of the residents 100% agreed that processing of waste have economic value. 63% agreed that waste paper is more available for processing, 20% says plastics are more available while 17% of them supported the fact that metal scraps are more abundant.

Recycling Company: Seventy-five percent of the companies involved in the study says recycling has low cost of production compared to virgin raw materials. Seventy-three percent of these companies mentioned that there is constant supply of the needed processed materials and all 100% agreed that the raw materials are reliable. Seventy-seven percent of the respondents say the end products have strong market competition relative to products from virgin raw materials and that these products are even cheaper. They also mentioned that the removal of these solid wastes from street and dumpsites for recycling has positive effect on our environment. It was further agreed (77%) that solid wastes have economic value and that the future of recycling is bright in Lagos State.

3.3 Strategies for Management Solid Waste

Ahove (2001) mentioned that there are several strategies used for managing solid wastes, which include;

(1) Open dumping Open dumping is deposition of solid waste in a land disposal site, left uncovered, with little or no regard for control of scavengers, diseases, air pollution, aesthetics and water/and pollution problems.

Advantages:

(1) Very easy to operate within a short period
(2) It is not expensive

Disadvantages:

(l) It is a disease-breeding strategy
(2) It results in air-pollution when burnt
(3) Leaching results in contamination of groundwater, and surface water
(4) The bad odour and contaminated water can affect man, animals, and plants. (quite unsightly)
(5) Putting the land into use becomes a big problem.

2. Sanitary Land filling: It is an upgraded version of open dumping strategy. Here, the site is located where water pollution from run-off and leaching is minimised. The wastes are spread in thin layers, compacted, and covered with a fresh layer of soil each day.

Advantages:

(1) It minimizes pets and aesthetic loss,, diseases, air-pollution and water pollution problems
(2) It is good for land reclamation or it enhances the land value.

Disadvantages:

(1) If not well managed, it can degenerate into an open-dump.
(2) There might not be space for landfill site because of human activities (house construction, farming, etc.)

However, it requires a high level of commitment, changed attitude and sincerity of purpose.

3. Secured Land filling: The use of a land to store hazardous solid and liquid wastes, usually stored in containers and buried. Such sites are restricted and monitored

Disadvantages:

Not safe for neighbouring inhabitants.

4. Incineration: a strategy in which solid, liquid or gaseous combustible material is burnt on a piece of land (in a pit) or in a conthiner.

Advantages:

(1) It reduces the volume of waste by 80%
(2) It removes odours and disease carrying organic matter
(3) It needs little land space.

Disadvantages:

(1) It is expensive and needs skilled labour
(2) If not well managed, it results in air-pollution and respiratory diseases because of discharge of carbon monoxide, sulphur dioxide, poisonous gas and harmful particles.

5. Composting: Dumping of bio-degradable solid waste into prepared pits, later covered with top solid, allowed to breakdown (through bacteria) to produce a humus-like end product referred to as compost such biological decomposition of organic wastes under-controlled conditions requires that wastes be sorted to garbage pack.

Advantages:

(l) It converts organic wastes to solid conditioner, or for fertilization
(2) It improves crop yields

Disadvantage:

Where the wastes are not properly sorted out before dumping, some undercomposed metallic objects and nylon can obstruct plant growth.

6. Resource Recovery Plant Usage

This strategy turns waste to useful resource health in 2 ways:

(a) Low Technology Approach: This requires homes and business houses to deposit recyclable wastes paper, glass, metals and food scraps into separate containers for onward transportation to crap dealers, compost plants, manufacturing plants for recycling.
(b) High Technology Approach: This requires collection trucks to transport mixed urban wastes to plant sites where they are spread and sorted out to recover glass, iron, aluminium and other valuable items which are later recycled to produce new products for market. Other combustible wastes .are later burnt to produce steam, hot water, electricity, etc.

Advantage:

It turns household, agricultural and industrial wastes to useful materials.

Disadvantages:

It can cause air-pollution if not properly managed.

Nuclear and Toxic Waste Disposal:

Nuclear wastes are radioactive materials which are dangerous to most forms of life. Nuclear industries and uranium mills generate them.

Toxic wastes are generated from toxic chemicals and metals, which are poisonous to human beings and wildlife. Examples of metal wastes, which could be toxic, are lead, mercury, cadmium and arsenic. Toxic pesticides include DDT, aldrin, lindane, endosulfan, potassium and phosphine.

Disposal Methods:

Since majority of highly radioactive waste takes a number of years to decay, disposal takes different forms:

1. **Dumping (wastes in Poor countries)** e.g. the koko waste dump of 1988. A German ship, THE LINE, dumped toxic wastes at Kokofort in Delta State of Nigeria, before it was removed back to EURIPE in same ship.

2. **Storage in stainless steel tanks:** The ultimate goal is soliciting the waste in glass through nitrification. Such tanks are constantly cooled and monitored for a length of time.

3. **Exporting** nuclear wastes to deserts in exchange for nuclear technological know-how e.g Germany exports (waste China for burial in Gobi Desert.
   (i) Effects of Nuclear &Toxic Waste Disposal: the effects are numerous on man, the flora and fauna of our environment, health problems such as convulsion, dermatitis, irritation of nose/throat, anemia, skin burns, chest pains, blood disorders.

   (ii) Compulsion of manufacturers to label their products with adequate disposal instructions (e.g cans, yogurts, pure water, etc.

Anaerobic Bacterial Digestion: This is another method of converting solid waste into beneficial products the waste is subject to anaerobic bacterial digestion to produce combustible biogas and organic fertilizer. Under strict anaerobic conditions microorganisms generate combustible gas, with manure or organic fertilizer being produced as a by-product can digest solid wastes. Bio-gas provides energy for cooking, lighting, and drying farm produce and electricity generation. Bio-gas is a mixture of gases comprising 70% o methane, 30-49% dioxide and traces of the gases such as hydrogen sulphide, nitrogen, hydrogen and carbon dioxide.

3.4 Sustainable Solid Waste Management: The shell Experience

The example of the Shell Petroleum and Development Company (SPDC) is worthy of mention. They have a waste recycling deport for several waste streams such as batteries, papers, plastic, bottles and metals. These segregated wastes are on a weekly/quarterly basis sold to vendors who recycle them to useful products. The batteries are sold back to Exide, Ibadan where they extract out the lead and plastic content of old batteries, which serve as a feed stock for the new ones.

Waste papers are sold out to vendors who transfer them to tissue paper making industries; the plastic and bottle wastes also serve as feed stock for new plastic and glass products. Composting is another method of waste recycling used as sanitary process for treating municipal, agricultural and industrial waste. What Shell does -is to collect all the food wastes and send to the composting center where they are biologically decomposed under controlled condition to a state in which they can be handled, stored or applied to land without adversely affecting the environment. Generated compost for, the composting facility was achieved at a lower- cost than inorganic manure comparable in quality. The composting process leads to generation of large quantity of maggots, which were channeled as fish feed to the SPDC fish farms (Ahove, 2001).

5.1 Why Our Environmental Campaigns Fail

The vast majority of our working population who fall outside government employment or the organized private sector; those who in their own little ways must eke out a living are certainly in no position to acquire or rent properly zoned premises for their operations but must make do with some improvised locations.

Bearing this as well as their socioeconomic role in our present economic circumstances in mind, one is constrained to say that it is a rather drastic measure to uproot them without .due consideration for their well-being and means of livelihood through the provision of appropriate alternative facilities.

The fault, of course, has primarily been with our approach to urban planning which is heavily influenced by unrealistic and abstract foreign standards. For even in those districts, which had the benefit of formal planning from the onset, little or no consideration appears to have been accorded these inevitable and essential land use requirements.

The trouble is that we cannot wish them away and can only continue to ignore them to our detriment, for they are realities and facts of life, which we must contend with. The paucity of properly organized open-air market places in our towns is a notable case in point. Considering their enduring role in our economic and business culture, their inadequacy is a serious indictment on our urban planning practice.

The only hope for a truly lasting solution to the chaos caused by these informal uses in our urban areas is for authorities to determine the real extent of their land requirements and .that to embark on a deliberate effort to carve out and provide properly organized spaces and facilities for them in appropriate locations.

Furthermore, the authorities must bear in mind that for any environmental campaign to succeed, there must be a programme for sustained effort and continuous surveillance rather than a once-and-for-all affair. It has taken decades of neglect and abuse for the environment to degenerate to its present detestable state and it is therefore unrealistic to expect that the situation can be eradicated in one sudden and explosive swoop. The decision of some State governors to reintroduce the services of Public Health Inspectors at this time is, therefore, most appropriate and commendable step in the right direction.

The physical environment is, as-it were, a living organism and needs to be tendered and catered for. The factors which compel its development and dictate its emerging physiognomy are the nature and extent of the very human activities.

3.6 Way Forward Towards Successful Waste Management

In view of the thrust of this unit, the following recommendations as outlined by Ahove (2001) are made to enhance sustainable solid waste management in Nigeria:

(i) Set a goal of achieving not less than 70% effective sustainable waste management techniques in the volume of municipal solid waste generated in the country in the next 10 years.

(ii) A focus at the level of literacy in the state is a pointer that Environmental Education (EE) is an essential tool for sustainable waste management. Environmental Education should be employed in leading citizenry to, see that the ecosystem should not be damaged waste. It should include awareness on waste prevention. Environmental Education should be employed in bringing about favourable conceptual and effective change and enrich content knowledge especially in school's curriculum.

(iii) The media should be actively employed in communicating to citizenry on sustainable waste management techniques such as re-use, recycling and waste prevention.

(iv) Community participation on street-by-street basis educating and re-educating on waste separation. This method involves educating an individual (representative) in a street on the need and how to separate household waste into paper, plastics, metal scraps, batteries, waste food and waste oil should be employed at the grass-root. This individual can then educate others on the same street.

Waste collection will then be on the basis of these separations which will facilitate re-use and recycling processes. Households that comply should be motivated, for instance individuals that effectively comply in 6 months may be given a "trade-off' the seventh month or given tax relieve. This household waste separation should be given adequate legislation and enforcement at the local levels. Government offices,

institutions and private companies should be encouraged to follow the same principle.

(v) Government should encourage markets for recovered products i.e. encouraging jobless youths in. the business, cutting down taxes of companies involved and government institutions should patronize the sale of recycled products.

(vi) Develop and implement through the collaborative approach guidelines and blueprint of integrated management of municipal solid waste.

(vii) Review and strengthen existing laws and regulations and ensure strict compliance with such laws.

(viii) Ensure provision, upgrading and maintenance of necessary infrastructure for collection, transportation and disposal of municipal solid waste at state and local government levels.

(ix) Encourage and provide enabling environment for active private sector participation, non-governmental organizations, community based organizations and the commercialization of municipal solid waste management.

(x) Strengthen local capabilities through effective collaboration, co-operation and provision of necessary technical support.

(xi) Promote:

(a) The development and adoption of appropriate technologies - simple, inexpensive, easy to use;

(b) Community/locally based technological initiatives for recovery, recycling; and

(c) Conversion of organic municipal solid wastes to compost and develop markets for its use as solid conditioners.

(xii) Encourage industries to produce biodegradable packaging materials. Devote reasonable proportion of the budget to municipal solid waste management and ensure a safe and healthy environment.

4.0 Conclusion

Waste Management is highly problematic in Nigeria due to large human population, the need for improved standard of living, modernization, increased tastes and dumping of more wastes, especially the non-biodegrable pollution by- products of plastic and metals The problems of waste management are still with us till date. The government should be seriously determined to educate the citizenry. on sustainable waste management techniques. In addition, government should create opportunities for private participation in waste disposal, encourage recycling of waste and purchase of products from recycled materials.

5 .0 Summary

So far we have discussed solid -waste problem and management in Nigeria. Specifically this unit has focused more on strategies for solid waste management. Strategies employed in Lagos State include the involvement of government parastatal and private participation in the collection and disposal of waste to landfill sites. The influence of economic

problems on the nation forced some individuals into the business of scavenging and recycling of renewable materials to earn their living.

Several strategies for managing solid waste were articulated including their advantages and disadvantages. Several recommendations were also made that will improve waste disposal and management techniques.

6.0 Tutor Marked Assignment

l. Briefly discuss strategies for managing solid waste
2. Mention two advantages and disadvantages of each strategy mentioned above

7.0 References and Other Resources

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UNIT 2: MINING AND OIL EXPLOITATION IN NIGERIA

TABLE OF CONTENTS

1.0 Introduction

The unit will interact with you basically on mining in Nigeria and will serve as introductory discussion on oil exploration and its attendant environmental problems. We shall look into the historical background of mining in Nigeria and the types of minerals that are being mined. Specifically we shall consider coal, tin, iron and limestone. These are some solid mineral mined in our nation. The environmental consequences of such mining will be addressed.

Alongside mining, we shall briefly discuss and introduce you to oil exploration in Nigeria. This aspect will form an introductory part of our subsequent discussions in other units ahead.

2.0 Objectives

3.1 Mining in Nigeria

Nigeria began mining many decades before the arrival of the Europeans. This was done through traditional methods with locally available technology. Gold, clay, iron ore, tin, salt, and soda were among the minerals. The minerals were used in body adornment, for the fabrication of weapons, tools, vessels, for construction, and several other uses. Thus, mining occupied a highly respected position in the traditional economics of a large part of Nigeria. It contributed greatly to inter-and intra-tribal commerce and conflict.

The arrival of the British led to the increase and variety of minerals mined, and large-scale commercial mining commenced. Other minerals found in Nigeria are petroleum,

natural gas, coal, limestone, lead, zinc, sand, feldspar, diamonds, sapphire, gemstone, tantalite, marble, columbite, zircon, and uranium

The minerals may be classified, for convenience, into three broad groups namely:

1. Fuel minerals: coal, lignite, petroleum, natural gas, and uranium;
2. Metallic minerals: cassiterite; columbite, tantalite, gold, and iron; and Out Finite Reserves
3. Industrial minerals: limestone, marble, gypsum, gravel, feldspar, and sand.

The location of each mineral depends partly on the nature of the rocks in which it is found and partly on the past geological history of the area. For instance, alluvial deposit is found in the valleys of rivers flowing over the hard ancient rocks, called basement complex rocks of Oyo and Sokoto states. The newer and softer sedimentary rocks, on the other hand, contain such minerals as petroleum, natural gas, coal, lead, zinc, and galena.

3.1.1 Coal

Coal was first found in Enugu in 1909. Excaration started in 1915. Later, coal was discovered in other parts of Anambra State and also in Benue and Plateau States. Nigeria has well over 1.5 billion tones of coal, out of which only 25 million tones or less than two percent has been mined. At a production rate of five million tones per annum, the present proven reserve of 639 million tones will last the next 128 years while the nearly one billion tones (from inferred calculations may last the next 200 years. Neither the gas nor the oil resources of this Nation, it appears, can last for so long (NEST, 1991).

In addition to coal, which is mostly of the bituminous variety, large quantities of lignite, sometimes referred to as brown coal, exist in Anambra, Edo, Delta, Benue and Imo States. The exploitation of the lignite has not yet commenced. Its reserves may well parallel those of coal.

The production of coal in Nigeria has fluctuated widely, varying from over one million tones per annum in the best of years to near zero tonnage in the worst of years. Among the many causes of these fluctuations have been the rise of petroleum and natural gas both as foreign exchange earners and as sources for domestically utilized fuel, disruption by the civil war; the “dieselization” of the Nigerian railway system; drastically reduced international demand for the country's coal; obsolescence of equipment; the shortage of operating capital; and weakness of government policy. However, the domestic and external demand for coal seems recently to have started to pick up. Greater and steadier production has began since the 1990s, to meet both the export demand, the needs of Nigeria's carbonization plants, cement factories, thermal power stations, and the Ajaokuta iron and steel industry.

3.1.2 Tin

Tin ore was mined and smelted in local furnaces by native Nigerians before the British arrived in the country. However, large-scale mining commenced in 1905; on the Jos

Plateau. From an annual output of approximately 1,300 tones of tin ore in 1910, the figure rose to 8,800 tones in 1920 and dropped to 5,000 tonnes per annum in the early 1930s, leading to mass retrenchments of tin mining workers. Production rose again under the pressure of World War II demands, ultimately reaching an all-time high of nearly 17,000 tones in 1962. Since then the output has decline. The fall has been so drastic that in 1987 less than 5,000 tones of tin ore was produced.

Nigeria exported the highest quantity of tin in 1962. In that year, however, a smelting plant capable of handling 1,500 tones of ore a month was constructed at Jos and in that same year 7,600 tones of tin metal, worth N13.2 million, was exported. The highest export figure was recorded in 1970, netting about N33.1 million.

The quantity of Nigerian tin utilized within Nigeria is insignificant. It is less than 100 tones per annum. The major uses of tin include the manufacture of tin plates, foils, and tubes, and the design of bronze and soldering materials.

3.1.3 Iron

Majority of the iron ore found in Nigeria occurs in Kogi, Benue, Kaduna, and Enugu States. The reserves are estimated at over 130 million tones. They have been considered large enough to warrant the establishment of a major iron and steel works in the country. The survey was conducted for in 1972 foriron ore deposits at Itakpe, less than l0km from Ajaokuta in Kogi State. In 1979, the contract for the construction of the Ajaokuta steel complex was awarded to a Russian firm, with the expectation that the project would be commissioned in 1987. Till date and despite an expenditure of billions of Naira it is still uncompleted (NEST, 1991).

The reasons for non-completion range from ideological conflicts to mismanagement and from massive thefts to blatant nepotism as liberally reported at various times by Nigeria's media houses.

3.1.3 Limestone

Limestone mineral exists in almost every state of Nigeria. Several of these deposits are being used for the production of cement Nkalagu, Ewekoro, Okpella, and Sokoto. Limestone production has been on the increase since its inception in 1957 because of the high demand for cement in the Nigerian market. The highest output of 4,777,000 tonnes was recorded in 1985, up from 1.4 million in 1981. It fell to 2.68 million in 1987. Apart from cement production, limestone is used in the production of industrial lime, whitewash, and fertilizer, and also a fluxing agent in the smelting of tin.

3.2 Impact of Mining in Nigeria

For fossil fuels, these problems have been summarized in Table below. Coal, for instance, is the dirtiest of these fossils fuels. As an illustration, the area occupied by the small coal-fired power station at Oji River in Enugu state, the average fallout rate of particles from

the burning of this fuel has been estimated two tonnes per square kilometre per month. For every 10 tonnes of bituminous coal burnt, over one tonne of sulphur dioxide is poured into the atmosphere. Sulphur dioxide is a major air pollutant, which is now gradually being controlled in the industrially advanced countries through cleaner forms of coal utilization.

Land degradation is pronounced in mining regions, and this is typified by the large stretches of the Jos Plateau, where open cast mining of tin has been going on for several decades. Also in many areas in which limestone is quarried. On the Jos Plateau, in particular, there is a tremendous amount of degradation of the land surface, resulting in the existence of numerous mine pits of various sizes. Some of these pits, now abandoned, are more than 10 metres deep and are over 50 metres wide. Many of them contain permanent water bodies which are a veritable breeding ground for mosquitoes that cause malaria and yellow fever. All of them constitute a permanent physical danger for both human beings and livestock.

Alongside the pits and ponds are hills formed by the material excavated during mining operations. These hills greatly disturb the movement of people and livestock and, more important, make the places where they occur unsuitable for agriculture, settlement, industrial development, and similar uses.

Smaller, but nevertheless, locally significant and very numerous, examples of land scarification occur in many parts of Nigeria as a result of quarrying of building materials. In Lagos alone, there are more than eight major sites for the quarrying of sand for building.

Mud quarries are a very common sight in and around towns and in villages all over the Federation. Many construction firms have opened up their own quarries, in Ado-Ekiti, Minna, Okigwe, Abuja and Kaduna. Each road and dam construction project leads to the opening up of new quarries for rock, laterite, sand, and gravel. Even at small scales and apart form the spoiling of the appearance of the land surface, very critical problems occasionally occur, as when a mine or quarry pit caves in and some people get killed (NEST, 1991).

Table 16.1

Environmental Impact of Fossil Fuel Resources

Mining Activity	General Effects	Specific Impacts
Exploration	Landscape disturbance	Aesthetic deterioration of the landscape.
Mineral Extraction	Land degradation and Ecosystem destabilization	Land surface devastation (including land subsidence, disruption of drainage systems, deforestation, excessive water draw-down, and lowering and contamination of the water table
Processing, Transportation storage and consumption	Gas. leaks, oil spills, noise, and pollution of the air, soil, and water.	Thermal loading of waterways, increase in C02 and CO, ozone layer depletion, acidification of air, soil and water, weather modification, toxicity hazard to plants and animals, death of terrestrial and marine life, loss of crops and livestock, impairment of atmospheric visibility, vehicular accidents, damage to buildings and machinery, nervous disorders, respiratory diseases, cardio vascular illnesses, cancers and food.

Development of Commercial Tin Mining

The first major mining camp was established early this century at Naraguta, north of the modern town of Jos. This has remained the focus of the early European tin mining on the Plateau until the development of the "Bauchi" light-railway from Zaria in 1915. From Naraguta, mining spread rapidly south to concentrate in two areas centred on the two principal sources of the alluvial tin, the Bukuru dome and the Roop Dome.

With the rapid expansion of mining activities, conflicts arose between the mining companies and the local population. The problem stemmed largely from the loss of agricultural land to mining since the areas of richest alluvial deposits also coincide with some of the better agricultural land. Eventually, the government passed legislation whereby mining companies paid compensation for crop damage but not for the destruction of the land.

Mining Techniques and landscape Devastation

The landscape features of the mined areas are by no means uniform. The degree of landscape degradation depends entirely on the methods employed in mining the ores which are in turn controlled by the depth below ground surface at which the mineral-bearing alluvium is to be found.

The earliest techniques of mining simply involved panning the alluvium of rivers. This later extended to pick-and-shovel working of floodplain deposits and again separating the tin by panning. These techniques (although still employed by individuals) are capable of exploiting only the shallowest deposits, that is, within about 5m of the surface. Such exploitation was essentially small-scale and hence much localized. Nevertheless, a distinct landscape of small mounds of spoil, irregular canyons, and isolated pillars of un-worked sediment has been created along sections of the contemporary river channels for instance, along Curly Creek in Tudun Wada, Jos.

Although these were the methods initially adopted by the European mining companies in the early years of commercial mining, the pick, shovel, and pan were replaced by the bulldozer, water monitor, and sluice box as technology improved. The thin layer was removed by bulldozer and scraper to reveal the tin-bearing strata. High-powered water jets (monitors) were then used to turn the tin-bearing sediment into a slurry which was then pumped by gravel pump to sets of sluice boxes in which the metal ore was separated from the dross. This technique is still used today wherever the mineral-bearing alluvium is close to the surface, e.g at New Delimi between Jos and Rayfield. The resultant landscape is one of shallow (10-15m deep) paddocks (hollows) which are invariably filled with water; long low, isolated mounds of spoil; and low angle tailing cones spreading out from sluice box sites. These tail cones often terminate in flooded pad-docks.

In few localities, the extent and depth of the tin-bearing sediments and the configuration of the surface topography have lent themselves to the economic use of a dredge. Some overburden is removed from the tinbearing beds and used to construct a dam across the natural watercourse. This produces a flooded paddock on which the dredge floats. The dredge digs or sucks up the tin-bearing alluvium, which is then pumped through a series of dredge borne sluice boxes for sorting.As dredge moves across the tin-bearing areas, new dams are created and the old dredged paddock infilled with tailings from the sluice boxes. Dredging began in 1932.

The only remaining area of tin bearing on the Plateau is along the Ropp and Tseri rivers at Darowa. These areas have a distinctive landscape of low earth dams, shallow rectangular ponds, and unfilled paddocks surrounded by scattered, long and low mounds of overburden.

As the mining companies increased their prospecting activities during and just after the First World War, tin-bearing alluvium was found to occur not only along contemporary river courses but also along an extensive network of buried river courses dating from the Pliocene period to about 500,000 years ago. The change in the drainage network on the Plateau was related to the outpouring of the "Older" and "Newer" basalts. Initially,

these potentially rich tin deposits were beyond the depth at which the available techniques could economically and effectively operate. However, in 1924, the first draggling, a converted steam shovel running on a system of railway tracks, which continued in operation until 1981, was introduced. This immediately enabled deeper deposits to be worked and was the forerunner of a major change to the use of draglines to remove the overburden. It also heralded major landscape changes. With tinbearing alluvium being concentrated in the narrow, sinuous channels of former river courses, the normal cut-and-fill procedures usually adopted by dragline mining operations were impracticable. Consequently, a landscape of steep-sided, multi-coloured, and conical spoil mounds, surrounding very deep, often vertical-sided, and flooded paddocks, has developed.

The impact on the landscape has been exacerbated by the fact that many of these former river courses now run along or across present watersheds. Thus, although the mounds cannot (by law) exceed half the depth of excavation in height, they still stand well above the surrounding areas. As the shallower tin deposits become worked out excavations have become deeper and deeper. At Sabon Gida Cell paddock NG8, tin is being mined depths in excess of 36m. Once the tin-bearing sediments have been exposed, they are washed to a slurry put by water monitors and pumped to sluice boxes in the usual way. The tailings are used partially to infill previously worked paddocks.

Thus, the various mining techniques employed on the Plateau have produced a variety of landscape features, highlighted by the multicoloured conical spoil mounds and variably-coloured conical spoil mounds and variably coloured waters of the flooded mining paddocks.

Adapted from:

M. J. Alexander, "An Historical Introduction to the Reclamation of Mineland on the Jos Plateau", Interim Report No. 4, Jos Plateau Environmental Resources Development Programme, Department of Geography, University of Durham and Department of Geography, University of Jos, 1985.

3.3 OIL EXPLOITATION

Without doubt, petroleum is at present Nigeria's and the world's most important derived energy supplier. Apart from petroleum, other fossil fuels are natural gas, coal, tar sands, and oil shale. But clearly, oil and coal are far ahead of the others in the country in terms of level of exploitation and utilization.

3.3.1 Crude Oil Reserves

Nigeria's proven oil reserves are close to 3 billion tonnes or over 19 billion barrels of "flowing" oil. Notice should also be taken of "trapped" or non- flowing oil. The latter comprises the vast quantities of petroleum left over after the more readily accessible oil has been pumped out. Trapped in rock pores and cracks, the amount of oil involved may range up to 50 or 60 percent of the original gross oil deposit estimates. As oil

recovery technology improves, Nigeria is certain to succeed in extracting more and more of this trapped oil.

Intimately associated with oil in Nigeria is natural gas. As a former Managing Director of Shell Petroleum Development Company, Nigeria's oldest and largest petroleum producer, put it in 1980, the country is "a gas province with a bit of oil in it... In oil equivalent terms we have discovered more gas than oil".

The nation's proven natural gas reserves are over 2,600 billion cubic metres. Of this tremendous quantity, only 20 billion cubic metres is produced annually. A mere ten percent of this yearly production figure is utilized, the remaining percentage being deliberately flared as constituting a nuisance in oil exploitation operations.

So far, much more serious attention has been paid to oil producing than to the production of natural gas in Nigeria. From the late 1950s, when oil production started in the country, the output has risen very remarkably. In 1958, when the first shipment of oil was made from Nigeria, the total production was only 1.9 million barrels. Subsequently, it reached peaks of 823 million and 841 million barrels in 1974 and 1979, respectively. However, it declined to 547 million barrels in 1985 (See Table below:

Table 16.2: Petroleum Production in Nigeria

Year	Quantity (Barrels)
1960	6,367,188
1965	99,353,794
1970	395,835,825
1975	651,509,039
1980	752,223,285
1985	547,089,595

Source: Various

Petroleum has become overwhelmingly dominant in the Nigerian economy and over 90% of her foreign exchange earnings has accrued from it annually for over fifteen years now. Inevitably, agriculture, which had been the country's primary income earner, became grossly neglected in the euphoria over the newfound petroleum wealth. Aside from the very obvious, dangers inherent in this mono-product economy (e.g gluts in the world oil market), there are difficulties associated with oil exploitation in Nigeria. Of these, the environmental problems are among the most widespread, intractable, and disturbing (NEST, 1991)

3.3.2 Our finite Reserves

Although we like to remain a major producer and exporter of petroleum for at least the next three decades, then we should be reminded that all is a finite asset.. It is, like coal and natural gas, a non-renewable resource.

Indeed, one authoritative estimate puts the duration of Nigeria's proven oil reserves at 30 years, given a yearly production rate of 90 million tonnes or 630 million barrels. For natural gas, incidentally, the picture is rosier, being 138 years.

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Two issues may be raised at this point. What will happen to the Nigerian economy when Nigeria's fossil fuels run out? Is today not the appropriate time to use part of the oil-generated money to develop alternative energy resources which will replace the oil, coal, and natural gas when they begin to run out? Even if by a stroke of fortune, the nation's reserves do not run out as fast as anticipated, it is still valid to call for heavy investments now in alternative and renewable energy, of which solar power is a good example. This is because predictions regarding new oil discoveries are no more than guesses. Moreover, it is clear that new deposits cannot restore what has been pumped or dug out. In addition, will the exhaustion of petroleum not lead to the cutting down of forests at a much faster rate than is going on at present?

And will such accelerated deforestation not cause even worse problems of soil erosions, and desertification than Nigeria is currently experiencing? These are serious questions indeed. What are your thoughts about these issues and questions.

4.0 Conclusion

This unit has exposed you to mining and oil exploitation in Nigeria. The solid mineral discussed in the unit include coal, tin, iron and limestone. The mining of these minerals for commercial purposes has resulted into serious devastation of the Nigerian environment.

The oil mineral is also being exploited till date. This has resulted into several environmental problems which has affected the flora and fauna of the states where these exploitation has continued and human habitat cum survival are currently under threat. Bitumen is another mineral (in Ondo State) that may soon face similar problem if authorities don't pay quick attention to it.

So far we have discussed interactively on mining and oil exploitation in Nigeria yet there are more areas to discuss on. These will come up in other courses as you progress in this programme.

5.0 Summary

This unit began by mentioning some minerals that are mined in Nigeria which consequently has led to the destruction of our environment especially the land and air. These minerals include: tin, iron and limestone. People have lost their life to mined pits, others their farms while some had to relocate their habitat.

Our oil is finite, hopefully will lead us not more than 30 years. Have we put the funds generated from this major resource to help build other alternative energy? Is this generation selfish? “Afterall, I must have gone when the crude oil might be spent.” What do you think of this last statement? Will you have gone 30 years from now? If you were in position of authority in Nigeria in 30 years time, what kind of picture will you have of the past generations between 1956 to date?

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UNIT 3: OIL SPILLAGE IN NIGERIA ENVIRONMENT

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1.0 Introduction

Oil spillage is one of the greatest environmental problem Nigeria is currently battling with especially in the Niger Delta zone. Oil communities have been at the receiving end of this environmental problem. The problems has generated a lot of concern within of the three tiers of government especially in oil producing states.

This unit stems from the previous one. It will relate with you the evil of oil spillage facing the Nigeria environment. The causes, consequences and control mechanisms will be some of the major focus of this unit.

2.0 Objectives.

At the end of this unit you should be able to:
- Discuss on at least two causes oil spillage in Nigeria
- List five consequences of oil spillage
- Recommend strategies of controlling oil spillage in Nigeria.

3.1 Causes of Oil Spillage in Nigeria

Without doubt, the greatest single environmental problem associated with petroleum exploitation in Nigeria is oil spillage, both onshore and offshore. The rate of spill has been rising with the increasing tempo of petroleum production. Whereas in 1970 only one oil spill (of 150 barrels) was reported, a year later the number shot to 14 (involving 15,110 barrels). In 1974 there were 105 oil spills; another 154 in 1978; 241 in 1980; and 216 in 1982. In the 13-year period from 1970 to 1982, a total of 1,581 oil spills, involving nearly two million barrels of oil, were reported in Nigeria. It is anybody's guess how many cases went unreported either they were not considered big eNTIgh to enter the records or because, (as all too often happens even today), the relevant firms and authorities simply refused to report them. It is also anybody's guess the accuracy of the volumes of spillage reported.

The causes of oil spillage may be summarized as:

- Break-down, or damage to oil tankers or storage vessels;
- Damage to or leakage of oil pipelines,
- Oil tank overflow;
- Rupture or failure of loading, floating, or under-buoy hoses; and
- Broken flange connections or flowlines.

Among the remote, less immediate or other causes are:

- Nigeria's low technological capability;
- The weakness of our laws and their feeble enforcement;
- The callousness of foreigners participating in the oil business;
- The carelessness of various personnel inside and outside the oil industry (including highway construction workers); and
- Sabotage by aggrieved people

Sabotage by aggrieved people, despite the vast claims made against it by the offending oil companies, is in fact the least cause. Research indicates that less than two percent of all the oil spillages in Nigeria stems from sabotage.

3.2 Consequences of Oil Spillage in Nigeria

The impact of oil spillage has ranged from the barely tolerable to the utterly disastrous.

The impact of oil spills includes:

- Loss of fish,. crustaceans, and other aquatic animals (fauna);
- Eutrophication of water bodies;
- Abandonment of fishing grounds and associated livelihood pursuits;
- Devegetation and other forms of ecological damage (flora),
- Emigration of wildlife and the consequent decline of hunting;
- Loss of drinking and industrial water and its consequent importation or derivation at extra cost;
- Destruction or reduction of agricultural and related activities;
- Loss of recreational and aesthetic value of water bodies;
- Increase in economic and other burdens entailed in pollution cleanup, population resettlement, and other aspects of rehabilitation;
- Impairment of human health;
- Forced population migration;
- Worsened rural underdevelopment; and
- Embitterment of the affected individuals and communities.

The reality of these impacts where oil spillage has already taken place, their anticipation in areas still lucky not to have experienced any significant spillage, the inadequacy of clean-up measures and of proffered compensation are more than enough to make some Nigerian communities anything but enthusiastic about having oil drilling take place within their territory. Hence, it is not surprising that in October 1989 protesting villages raided the premises of a major oil company, reportedly destroyed equipment worth N10 million, and injured a number of the company's workers, all in a spirited protest against the drilling of an oil well on their land.

3.3 Oil spillage and Environmental Pollution

Nigeria today is faced with increasing environmental problem and unless laws guiding the environment are properly implemented more serious problem will arise. The basic disasters linked with oil spills have lead to the need to protect the environment while conducting oil operations. However, an oil pollution incident of a high magnitude can cause damage to the environment. especially where there is an existing environmetal degradation from oil prospecting .and transportation.

The Mobil Oil spillage in 1998 resulted to a loss of some 40,000 barrels of crude oil and it affected not only marine life in Akwa Ibom State but also in all the communities in the Niger Delta region. According to Clark (1982) some substances that are toxic to aquatic fauna and flora are released and they are chronically lethal in concentrations of a few ppm (parts per million) and lethal to sublethal in concentrations of ppb (parts per billion). These susbstances pollute the water bodies by depressing phytoplankton's photosynthesis, respiration and growth, kill or cause developmental abnormalities in zooplankton and the young stages of many aquatic organism.Oil spill in water kill shelfish and finfish by its smothering action and also ingested oil may interfere with fish nutrition (Odiete, 1999). In shallow inshore sites contamination may persist for years and also surface organisms are killed by oil on the surface of water, which limit gaseous exchange and entangle the organisms.

The NNPC spillage at Owa and Abudu in Delta State in 1982 resulted in oil- logged farmlands and the death of economic crops such as seedlings of yam and cassava. This kept the farmlands barrens for some months.

Igbo (2000) mentioned that, in Abonnema, Rivers State the result of a spillage as reported by the Environmental Rights Association (ERA) resulted in thick layers of crude oil polluting the water in the centre stretch of the River and Creeks in the various communities affected. The spill has severely affected aquatic creatures in the area, including snails for sale which is one of the major sources of income for the people. All that has gone because the mangrove swamp has been thickly covered with crude oil, (Newswatch November 8, 1999). Defoliation and death of Rhizophora, racemosa occurred 2 - 3 months after the spill in mangrove swamps (Ekekwe 1981, Ekweozor and Snowden, 1985). Damage was due to smothering of the pueumatophores of mangroves. Prop roots and attached fauna were killed. Amagor (1985) observed that when oil spillages occur on land, such as the Ejamah-Ebuubu oil spill incident near Eleme Rivers State in 1970 which was not cleaned, farmlands and swamps are heavily impacted, the

soils were no longer fit for farming and streams were no longer being used for fishing. He also observed that the higher and low molecular weight hydrocarbons had evaporated and intermediate and heavier fractions had permeated into the soil.

The table below reveals oil spill incidents in Nigeria from 1976-1997

Table 18.1

Year	No. of Spills	Vol. Of Spills bbls
1976	128	21157
1977	104	32879
1978	154	489294
1979	157	694117
1980	241	600511
1981	28	42722
1982	257	42841
1983	173	48351.3
1984	151	40209
1985-	187	11876
1986	155	12905
1987	129	31866
1988	208	9172
1989	195	7928.161
1990 -	160	14940.816
1991	201	106827.98
1992	367	51141.91
1993	428	9752.22
1994	515	30282.67
1995	417	63677.174
1996	430	46353.12
1997	339	59272.3
Total	5334	2.8 million

Finally, when there is a case of oil spillage, the cost of the impacts are much felt in the environment so it is better prevented than allowed to occur. The cost of cleanup activities, ecosystem restoration and legal settlements of oil spills are so high that the best strategy is prevention.

3.1.1 Causes of Oil Spillage in Nigeria

Odiete (1999) stated that crude oil spillage occurs daily in Nigeria from drilling and production operations, pipelines, manifolds, hoses, oil tankers barges, oil terminals and depots.

About 2330 cubic meters of crude oil spilled every year into the environment but statistics from the Department of Petroleum Resources (DPR) from 1976 to 1996 showed that 4836 incidents resulting in the spillage of about 2.44 million barrels of oil into the

environment occurred. These are mostly linkable to oil well blowouts, corrosion of pipelines, equipment malfunctions, and human error during operations, lack of proper maintenance of the equipment and sabotage.

In 1980 the largest spillage in the country was the Funiwa offshore blowout where about 400,000 barrels of crude oil spewed into the Atlantic Ocean from a Texaco facility and destroyed 340 hectares of mangroves. This was as a result of well blowout (Odiete 1999).

Ekakpemre community in Ugheli south local government area of Delta State experienced leakage from pipeline, which resulted to a devastating spill and made over 3,000 women to take to the streets to protest what they described "as the careless handling of the spillage by shell petroleum Development Company, SPDC". Also at Abonnema in Akutu Toru Local Government Area of Rivers State, a spill occurred as a result of Shell's rusty pressure pipeline. A report by Environment Rights Association (ERA) said, "Shell did not make adequate effort to detect the source of the pollution or to stop it".

According to ERA, the high water current and tidal waves have combined to worsen the pollution. The Abonema spillage spread to Idama, Kola and Elem Kelabani creeks. It also spread to Abuloma, Elem, Sagama; Krakrama, old Bakama, and Ifoko in Asani Tori local government in Rivers State. (Igbo, 2000).

A Mobil oil spill in 1998 in Akwa Ibom State, occurred on a pipelines conveying crude oil from the company's Idoho production platforms to the Qua Iboe terminal led to a spill of about 400,000 barrels of crude oil spreading from the coast of Akwa Ibom State to as far as Lagos. Can you imagine the distance the spillage covered? This spill- was as a result of a drop on the company's pipelines and also as a result of corrosion due to old age of the pipelines (National Concord, May 6, 1999).

Shell Petroleum Development Company, SPDC reported an oil spillage estimated at 1500 barrels from a 24 inch pigging manifold at Chanomi creek in Warri South local government Area of Delta State (The Punch December, 31, 1999). This spill was master-minded by Saboteurs from different communities.

A spill due to rupturing of crude oil pipeline carrying crude oil from offshore Idoho platform to its terminals was recorded by Mobil (Vanguard May 6, 1999).

Sometimes spillages that result from sabotages are due to the fact that oil mineral producing communities have suffered unbelievable injustice. They are denied of any entitlement to their land by the Land Use Act, deprived of adequate revenue accruing to the federation from the export of oil and gas extracted from native community land. Some areas were also completely excluded from all Federal Government developments while certain parts are well developed and unfortunately with the open looting of the federal treasury in recent times the host communities have continued to resort to sporadic sabotage of pipelines and kidnapping as a means of forcing oil companies cum government to release money. Unfortunately, sometimes these funds are mismanaged within these communities.

According to an Environmental report published by Shell Petroleum Development Company (SPDC Annual Report, 1997) sabotage was by far the most serious cause of oil spillage in SPDC's operations in 1997. It went further to say that almost all oil spills from SPDC facilities were due to 80% sabotage. The most common methods used were sawing or drilling holes in pipelines and flowlines. In all cases of suspected sabotage a team comprising representatives of the community, SPDC, the police and the Department of Petroleum Resources investigate the cause of the spill and sign a joint investigation report.

Finally from annual report (1997), the number of spills caused by corrosion also decreased but the volume spilled increased considerably compared to 1996.

Two major incidents accounted for the increase, a leak at Ebubu manifold in Ogoni land spilling 3,000 barrels and another corrosion incident on Nembe creek 11 - delivery line, spilling 1500 barrels.

3.4 Control and Management of Oil spillage

Oil spills both large and small are inevitable. Thus, effective scientific and technological curative and preventive techniques must be researched into for sustainable development. All nations that are involved in the transport of oil or that exist in a coastal location must be prepared to deal with oil spills.

Ideally, preventive measures such as better tanker construction, expert navigation and pilotage on all tankers carrying petroleum products and proper maintenance on tankers and pipeline would minimize the chances of an oil spill ever occurring. But these measures are not always carried out and often oil is spilled in situations beyond the control of those transporting it.

Igbo (2000) outlined the findings of an oil spill response task force on seven most significant recommendations for control of oil spillage, which are mentioned below:

(1) Strengthen programs to monitor and control corrosion and erosion in hydrocarbon handling equipment. Corrosion/erosion was identified as the most likely cause of a major oil spill. We should review all of our oil pipelines, associated structures and offshore storage tanks.

(2) Implement processes or procedures to, reduce human error

(3) Reinforce planned preventive maintenance (PPM) programs on hydrocarbon handling equipment. Mechanical failure has been cited as the most common cause of offshore spills. There is PPM programs being used in several of our operations with different degrees of success. We need to extend these programs to all of our major offshore installation.

(4) Enhance environmental awareness by training top and middle management on environmental issues.

(5) Generate an environmental design guideline. There is inconsistency in the application and selection of spill prevention equipment such as flare scrubbers. Efforts should be made to get this equipment installed.

(6) Develop better methods of transferring information between the

communities involved and the oil companies. Communicating information about suspected cases is of high importance.

(7) Direct our research and development efforts to work on new as well as existing technology on the control and prevention of oil spills. Recommended topics of research are monitoring pipeline integrity; economical leak detection and cleaning water for injection and disposal.

In addition to the above recommendations, oil companies should make plans which include guideline for various aspects of their activities and operation including risk assessment, operational procedure or limits,access to information, advance notification, reporting documentation and training.

The plan should take into account that an essential prerequisite for the safe production and handling of oil products containing hazardous substances is to properly identify their piping system, loading, discharging, transportation and storage. For safety and environmental protection, all oil companies should realize that it is necessary that every care is taken and that all necessary information concerning oil products are passed to all members of staff. Also an oil' company should realise that to remain profitable, competitive and viable in this millennium it should develop and implement safety policies and practice in agreement to the safety objectives of the company. Managers of each section of the company should strive to ensure that the intent of the safety policy is understood and appreciated by member of the staff.

To ensure that oil spills are not repeated, it is necessary to take a quick and close look at their pipelines to ascertain their life span. This is necessary to ensure rehabilitation and replacement where necessary. Areas affected by oil spills should be continuously monitored until the slick is completely eliminated. The job of the oil companies should go beyond cleaning up the mess occasioned by the spill. The team of environmentalists, marine biologists and chemist should also seek to ascertain the return of normalcy to ecological and aquatic life in the endangered areas.

The existence of oil spills in the oceans creates unpleasant sight and odour as, well as actual harm to marine life. The need for early detection and initiate clean-up procedures is brought out by the cost of clean-up in some recent oil spill cases.

The oil companies should as a matter of urgency begin to compensate adequately the affected oil communities. The exercise should be based on the extent of damage done at present as well as what that community is likely to lose overtime. International safety standard must be adhered to in matters of such.

In response to the problems of environmental neglect done by the oil companies the government has issued new environmental conditions to be met by oil companies in their areas of operation. The federal government in November 1999 read the riot act to the oil companies the first time in many years, (Newswatch November 8, 1999) according to the act, they are to hasten the provision of poverty alleviation and community based project.

The Minister of State, Ministry of Environment at the inauguration of the forum on "cleaning up of the Niger Delta" in Abuja, accused the oil companies of igniting the crisis in the Niger Delta by rebuffing the community demands and other anti-social behaviours.

The government has therefore directed the oil companies to find a lasting solution to the problem in the Niger Delta. The directive is coming on the heels of the submission of the Environmental Remediation Action Plan for notification to the National Assembly by the President. The thrust of the action plan is to attain a 100 percent remediation of all identified past impacted' sites by the year 2002 and zero discharge by the year 2003.

The oil companies and the government are to contribute money for a special clean-up fund, which is to be established.

Also to combat some of the environmental hazards witnessed the Federal Government Protection Agency (FEPA) and some other leading oil companies have organised series of lectures and symposia to see possible ways of handling the issue of oil spillage. According to the Minister of State for Environment, Ime Okopido the federal government spends $5 million annually on Niger Delta environmental survey and $3 million on environmental index mapping. All the efforts are part of efforts by the federal government to remediate the hazards caused by oil spillage in Nigeria.

Table 18.2
Potential Sources of Oil Spills in Order of Magnitude

.	No. of Source	Potential spill volume barrels
Tanker	80	300,000
Floating storage	3	300,000
Well blowout	50	25,000
(Drilling/work over.wireline) transport	10	10,000
Pipeline	5,000	5,5000
Platform oil tank	200	3,000
Production it	20 .	2,000
Production	500	1,000
Flare carry over	500	50

Depends on the type of well, and pipeline size/length.

Sources: As prepared by oil spill response task force on the prevention of oil spills from off shore production facilities.

4.0 Conclusion

This unit has exposed you to another major environmental problem in your country. I hope by now you can appreciate this problem. Oil spillage is a reality in Nigeria oil rich states and people from these areas bear the burden of the consequences of this problem while others like you and I bear the "bread" with the burden. Government must therefore put in more effort in ensuring that oil companies control and manage this problem curatively and prevent its occurrence. We must recall that the environment must not be destroyed to the detriment of on coming generations. After 100 years, when perhaps the oil exploitation would have been over, how will the oil producing communities look like? You may wish to write a creative literature piece on this.

5.0 Summary

The focus of this unit has been on oil spillage in the Nigerian environment. Being an oil rich state oil spillage will definitely occur, but the management and control of its consequences on flora, fauna and human is very critical to oil communities.

This unit traced the causes of oil spillage to include, corrosion of pipelines due to oil age, mechanical and human error during oil exploration and in few causes sabotage. Oil spillage poses a very serious environmental problem in oil communities and its consequences for many years remain irredeemable.

Several control and management techniques were articulated to ameliorate this problem and assist oil communities.

6.0 Tutor Marked Assignment

1. Discuss on two causes of oil spillage in Nigeria.
2. State five consequences of oil spillage in the Niger Delta
3. Mention five control and management techniques of oil spillage.

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UNIT 4: GAS FLARING PROBLEMS IN NIGERIA

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1.0 Introduction

Apparently, there has been little concern for the environmental hazard consequential from the process of openly flaring natural gas from oil wells and flow stations in Nigeria except until very recently.

Gas flaring may be explained as a means of safely disposing waste gases by combustion. Usually an elevated flare is employed where the combustion takes place at the top of a pipe bearing a burner and an igniter.

This unit intends to take you through a contemporary discussion on the problem of gas flaring in the Nigerian environment. We shall highlight its implication on our resource, economy, and government's position on flaring and the feasibility of eliminating gas flaring.

2.0 Objectives

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

- Evaluate the quantity of gas that is flared in Nigeria within a particular period
- Mention government's position on gas glaring.

3.1 Gas Flaring in Nigeria: Burning Valuable Resources

Nigeria is so blessed with natural gas that it ranks number 10 in the world and number two in Africa in its reserves. Contrary to what operates in other parts of the world, Nigeria's gas is wasted generously through flaring with little care. Flared gas releases hazardous substances into the environment that increases the problem of global warming. The attendant "greenhouse effect" phenomenon is one of the most frightening environmental problems facing humanity currently. Do you share the same view? In spite of advances in technology and the potential to convert the flared gas into a source of enormous national revenue, the practice has continued in Nigeria, ostensibly underscoring the problems of

our national development.

The earth seemingly infinite capacity and resilience should not be taken for granted. We have no habitat other than, the earth, Mars is still inhabitable.Beyond the lip service of oil industry executives and 'government officials, a sincere commitment to the discontinuation of gas flaring is desirable. (Odilison, 1999).

You will agree with me that Nigeria ranks first among nations wasting a finite valuable resource - GAS. This is because each day almost 2 million cubic feet of natural gas is burnt during crude oil production. According to World Bank, gas flared in Nigeria is equivalent to total annual, power generation in subSaharan Africa.

Exercise 19.1

What is the quantity of gas that might have been burnt between 1990 and 2000? Gas flaring at a Nigerian oil well: waste of a valuable resource and cause of environmental pollution.

Gas flaring not only a wastes valuable resources, but is also a major cause of environmental pollution'in the Niger Delta, where most of Nigeria's oil output is produced. There is growing anger among local inhabitants at the damage caused to their health and ecosystem by the production activities, especially gas flaring and crude oil spillage. As at November 1998, there were about 100 gas flaring sites. Some of them have been burning ceaselessly for 40 years.

The extent of human damage attributable to gas flaring is unclear but doctors have found an usually high incidence of asthma, bronchitis, skin and breathing problems in communities of oil-producing areas. Moreover, flaring is a global source of greenhouse gas emissions, contributing to global warming. The World bank estimates that gas flaring in the Niger Delta releases some 35 million tonnes of carbon dioxide annually into the air. (Ekanmen, 2001).

3.1 Gas Flaring and Local Poverty

Oil companies contend that oil community activists and environmentalists grossly exaggerate the negative impact of oil production in Nigeria, and thus reject the charge that gas flaring is a major contributor to acid rain in the Niger Delta. They also point out that although the figure for carbon dioxide emission by Nigeria's oil industry seems high, it is minute on a global scale. Increased frequency of crude oil spills in the Delta in recent years, oil operators explain, is mainly caused by sabotage carried out mostly by aggrieved communities hoping to extract compensation payments. According to Shell, which accounts for about half of Nigeria's 2.2million barrels per day oil output, almost 80 per cent of all spilled from the company's facilities in 1997 was due to sabotage, addition up to more than 60,000 barrels. Other causes of oil spills include equipment failure, accidents and corrosion of aging pipes.

Oil companies believe that the root cause of the growing unrest and discontent in the Niger Delta is the poverty of inhabitants who feel cheated of what they consider their rightful share of the wealth extracted from their land. Beleaguered oil multinationals have in the 1990s increased their spending on community development but argue that they cannot assume the state's role as the prime provider of social amenities.

The government and its joint venture oil partners acknowledge the need to clean up oil production activities, including substantially reducing the proportion of associated gas that is flared. Most of Nigeria's oil comes from reservoir containing gas; so associated gas is produced with the oil. Though current levels of gas flaring remain unhealthily high, Nigeria has made some progress in reducing flaring since the early 1970s, when less than 2 percent of the country's gas production was utilized. (Obadina, 2000).

3.1 Effect of Gas Flaring on the Nigerian Economy

Nigeria is believed to be losing about $6 billion every year to gas flaring. The Minister of State for Environment, Dr. Umeh Okopido, said that the Federal'Government was not happy with the ugly development and would enforce the flare reduction deadline by 2004.
"I have now got the support of the National Assembly as far as the issue of 2004 deadline is concerned (Ekanem, 2001).

He said: the issue of gas has gained acceptance since President Olusegun Obasanjo's administration came in expressing displeasure about gas flare.

Okopido said at a recent meeting, Obasanjo "brought a memo to council which has been approved for networking on the issues of gas pipeline of the entire country.
It is a cleaner source of energy and a lot of fertilizer companies are going to be revitalized". He said he was scheduled to meet with all the operators on June 28 at which we are going to discuss the way forward".

He said in his capacity as the chairman of a monitoring forum for all gas- related projects, he had visited all the petroleum oil installations and "I put across to the council what we saw when I visited the places and what asked what need be done".

Besides the economic aspect he explained it was equally very important for Nigeria to stop gas flare, "because as far as the Kyoto Protocol is concerned, global warming is of serious concern and we want to cut down as much as possible on the gas we flare"

He said the Niger Delta region "is a gas surplus province, we know that we still have up to 182 trillion cubic feet of gas, and after exploiting 33 percent of that we will still have about 159 trillion that we still have between 45 - 100 trillion cubic feet not yet discovered".

The United Nations Environmental Programme (UNEP) and the Global Programme of Action (GPA) for the Protection of the Marine Environment from land-based activities have promised "to contribute and assist in any way to realise the great vision of Obasanjo" on the Zero Gas Flare Initiative being implemented in the Nigr Delta.

The coordinator, UNEP/GPA Coordination Office, Keerle Vandeweard said in the letter to Okopido that the implementation of the initiative would significantly improve the environmental quality in the Niger Delta and "is an outstanding example of the practical implementation of the FPA".

UNEP/GPA thus requested that the "Zero Gas Flare Initiative" be used "as a laudable example in the run-up to the First Intergovernmental Review Meeting of GPA and the meeting itself'. The group also requested that an extract of Okopido's speech be used at the James Callaghan lecture 2001, as a document for the World Bank/UNEP Workshop on financing the GPA, scheduled to be conducted in The Hague from July 9-11, 2001. (Oghifo, 2001).

3.2 Government's Position on Gas flaring

The Nigerian Government has warned oil companies operating in the country to take urgent steps to end gas flaring else the nation will 'initiate legislation that would impose drastic penalties against them President Obasanjo mentioned that the three tiers of government in Nigeria and the oil companies operating within the country must jointly accept responsibility for the current crises in the Niger Delta and must work together to provide urgent solutions to the problems.

On gas flaring, Obasanjo expressed displeasure that 21 years after he, as Head of State, signed a decree imposing penalties against gas flaring it has continued in the Niger Delta. Apart from damaging the environment, gas flaring, he said, was tantamount to burning money, which Nigeria could ill- afford to waste.

He, however, expressed concern on the state of affairs in the Niger Delta, saying that while his administration would be at the forefront of efforts to address the many problems of the area, it would encourage the states and local government authorities to take a lead in areas where direct action by them could achieve better result.

Government expects the oil companies to do much better for their host communities by way of community development assistance, pointing out that frustration among the youth as a result of lack of opportunities for self- actualization and the absence of the basic necessities of life was one of the major causes of current agitation in the Niger Delta. Companies must be prepared to create more jobs for qualified youths in their areas of operations.

The Nigerian government and people are far from being satisfied with the current levels of indigenisation at key managerial levels of the domestic oil industry, thus government would no longer accept more tokenism from the oil companies on the matter but would expect them to take urgent and visible action to train and integrate more local personnel into critical decision- making positions in the oil industry.

Without necessarily reducing current levels of investment in Nigeria's oil industry, government had a vision of developing the domestic gas industry to such an extent that at least equal levels of revenue will accrue to the nation from it and from the oil industry (Emerole, 1999).

Through the policy put together by the previous military regimes, it was cheaper for the oil companies to flare gas into the atmosphere and pay a fine of about 10 American cents per 1,000 standard cubic than $10 required in developed countries which has discouraged the companies from flaring gas in such developed regions of the world.

The Minister of State for Environment, Dr. Okopido noted that although foreign companies have been discouraged to utilize the gas in the past. because of population density, the distance from foreign markets, geological conditions that preclude re-injection and marginal 'economics based on prevailing gas prices which discourage expensive infrastructural development, the present government is committed to stop the burning of gas into the atmosphere and utilize it because apart from the environmental benefits, Nigeria's oil has limited life span of about 50 years.

He said that Nigeria does not want to be caught napping when the oil wells are drying up and as such the gas industry which has no environmental implication has to be developed.

The Minister said that meetings have been held with the Italian Oil Company, AGIP, and the company has promised to stop 89 percent of gas flaringin June 2001. Another Oil Company, Mobil it was learnt has been working on the reduction of its flares.

Dr. Okopido said that he had visited a company called ENI, 60 kilometres from Milan, in Italy to study their gas storage and how Nigeria can benefit from doing the same thing. The minister said that Nigeria lias over 182 trillion tons of gas reserve that will last the .country for over 450 years adding that this was why under the Kyoto Protocol, Nigeria can use the assistance from advanced countries to build more energy efficient industries.

He regretted that there must be an.atmosphere of peace in the region to achieve the reduction of gas flaring (Akingbade, 2001).

3.5 Feasibility of 2004 Zero Gas Flaring Target

Nigeria is no doubt, a country with surplus gas.Statistics reveal that within the last forty years, about 23 trillion cubic feet (TCF) of gas has been produced from an ultimate recoverable gas of about 182 TCF. This leaves a total of about 159 TCF as recoverable reserve.

Conversely, additional undiscovered natural gas potential is estimated at about 45 - 100 TCF. Given these statistics, Nigeria's reserve life for gas spans about 450 years when streamlined with the current commercial demand of about 0.33 TFC per year. This is indeed a large figure and so all necessary measures should be put in place to ensure maximum utilization of gas reserves (Ekanmen, 2001).

It is in the light of this fact that present administration led by President Olusegun Obasanjo has initiated the current fast track zero flare initiative. Its main objective is to encourage gas gathering and maximum utilization which aims at extinguishing the nation’s gas flares by the year 2004.

Given the enormity of the programme some are hopeful while other sees this target as a mirage. However, considering the huge waste of this depleting natural resource and the increasing concern about the impact of gas flaring on the global, regional and local environment, it is only proper that the major players heed this clarion call by the present administration. One smart way to go about this is for all players involved to redouble their present efforts.

To this effect gas exploration and production activities have been brought to the forefront of the nation's agenda hence the shifts in deadline from 2010 to 2008 and now 2004, it has given rise to major policy moves aimed at giving the gas sector its deserved prominence.

Minister of State for Environment, Dr. Imeh Okopido, has said at various times through various media that the 2003 deadline can be met. He reiterated this at the five Petroleum Policy Roundtable (PPR) organized by The Centre for Petroleum Information (CPI). He emphasized that-for this to be possible, there is an urgent and important need for the timely development and consolidation of a national master plan as well as a fast-tracking of the various phases of gas utilization projects in the country.

Below is the status of some of the nation's natural gas key utilization projects.

1. Shell Petroleum Development Company (SPDC) has the Soku Gas Plant and is scheduled to supply more than 53% of the total nominal gas requirements of the Bonny NLNG Plant. The Akakiri Gas Plant is currently awaiting the rehabilitation of both NAFCON fertilizer plant at Onne, Rivers State and ALSCON Aluminium plant in Ikot Abasi, Akwa Ibom State, for uptake of the gas. South Forcados Associated Gas Project is scheduled to be on stream by mid-2004 and will gather about 20% of gas produced by SPDC West for delivery to NLNG Train 3 in Bonny. It is pertinent to note that SPDC's gas utilization master plan, though notable, needs to be fast-tracked in order to meet the year 2004 deadline for termination of gas. flaring in the nation.

2 Gas Utilization facilities of Chevron Nigeria Limited (CNL) Chevron's gas initiatives comprise Escravos Gas Projects (EGP) Phases 1, 2 and 3.

EGP Phase 1 gathers gas from Okan/Mefa Field and involves the process of 130 million standard cubic feet of gas per day (MMSCFD) for domestic sales, EGP Phase 2 collects gas from CNL Swamp Area Operations and involves the gathering of 100 MMSCFD of gas for regional sales including the West African Gas Pipeline (WAGP) for EGP Phase 3 the master plan involves the gathering of 300MMSFD of natural gas from offshore operations for Gas to Liquids (GTL) production for the international market.

Note:
MMSCFD means Million Standard Cubic Feet of gas per Day

Chevron's gas utilization programme is tailored towards the achievement of 75% reduction in gas flaring by year 2004.

3. Gas utilization facilities of the Nigerian Agip Oil Company (NAOC) Obiaku/Obrikom Plant has a capacity of more than 20ON MSCFD of gas. The plant was constructed in 1984 for gas re-injection to optimize oil recovery.

Kwale Gas Plant, built in 1987, is further programmed to catalyze gas uptake for implementation of the Kwale Area Independent Power Provision 9450M2).

Natural Gas Liquids (NGL) Plant to supply feedstock to Eleme etrochemical Company Limited in Port Harcourt, Rivers State.

4. Gas utilization facilities of TOTAL/FINA/ELF
Elf's gas utilization master plan is geared towards the achievement of two key objectives. First, is the sup-ply of 250 MMSCFD (million standard cubic feet of gas per day) maximum daily contracted quantity from onshore fields to NLG
Trains 1 .& 2. The full achievement of this objective will ensure the termination of Elf's onshore flares by March 2002.

Secondly, the supply of 350MMSCFD 'maximum daily contracted quantity from offshore fields to NLNG Trains 4 %.

5. The full achievement of this objective would ensure the termination of Elf's offshore flares by 2005. However, alternative plans are being considered for dialogue towards fast-tracking Elf's offshore gas utilization master plan to meet the Federal Government's wish of year 2004 as the terminal date for gas flaring. Through Federal government deliberations, the gathering of Elf s associated gas for delivery to NLNG Trains 4 & 5 is a move to ensure that the goal of meeting this deadline is enhanced, (Ibhade, 2001).

4.0 Conclusion

Natural gas, which is the lightest fraction of crude oil, emanates under pressure from oil wells. It is this gas coming out during crude oil exploration that is flared and contains very volatile parts of the liquid crude. The major composition of this flared natural gas are methane, ethane, some hydrogen sulfide. The principal products of the_flared gas are carbondioxide, carbon monoxide, sulphurdioxide and aldehydes and .oxides of nitrogen. These are gases that have serious negative effects on human health and life, vegetation, wildlife, water and air quality, especially at high concentration. This is often experienced few kilometres radius of a gas flaring point.

Based on these issues the Nigerian government has taken a position to stop gas flaring by 2004. The question is, how feasible is this? You may have to answer the question yourself and except you come along with me to the last unit in this course this task may not be too easy.

5.0 Summary

This unit focused on the environmental of gas flaring in Nigeria especially as it affect our economy. Gas flaring is evidently a waste of finite natural resource and economic loss. This act has been for 40 years. This gas flaring has thus made the government of the Olusegun Obasanjo to take more decisive steps towards the halt of the flaring especially because of environmental consequences on human and biodiversity and the economic implication of the loss.. The question therefore is how feasible is government's decision to stop gas flaring by 2004. The key players in this respect are the oil companies, they are best in proving answers to this question. The next unit will discuss on this.

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UNIT 5: GAS FLARING IN NIGERIA: TOWARDS EFFECTIVE CONTROL

Table of Content

1.0 Introduction

The inhabitants of the ecological zone of the riverine areas of Nigeria where crude oil is produced are the most obvious victims of the environmental and socioeconomic hardships that gas flaring has produced in the country.

When will these people have clean air to breathe? When shall Nigeria adequately save her gas to earn more dollars to alleviate the poverty line of millions of Nigeria?, What are the views and plans of some of the big names flaring Nigeria gas come 2004? Do we have to fold our hands and watch the consequences of gas flaring consuming our people? These questions will be treated in this unit.

2.0 Objectives

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

- Outline the positions of two major oil companies on when gas flaring will cease in Nigeria.
- Discuss briefly two major obstacles to zero gas flaring initiative come 2004.
- State seven direct and indirect consequences of gas flaring.

3.1 When Will Gas flaring be Actually Eliminated?

3.1.1 Chevron, says 2004

Chevron believes gas flaring in Western Niger Delta oil fields can be fully eliminated by year 2004.

Mr. Joe Anyigbo, an executive director of Chevron Nigeria Limited, said the measure was achievable as a result of the unique and robust incentives offered by the Federal Government and the `state or projects' currently being pursued by Chevron.

Mr. Anyigbo said that going by the Chevron experience. `we can safely say that natural gas projects are technically and economically viable in Nigeria. It was confirmed that natural gas development in Nigeria was still at a very low level, adding, "more gas exists than oil on an energy equivalent basis in Nigeria and 78% of the gas produced is flared". Chevron's 620 miles, $400 million pipeline is expected to move 100150 million cubic feet a day, eventually rising to 4 or 5 times that volume. The executive director also identified some of the current challenges to the development of the gas sector in Nigeria as low domestic consumption level and low domestic price of the product. Other challenges, he added, were limited pipeline network transmission stem, which makes it difficult to meet local demand growth, and the high cost of gathering.

3.1.2 Shell Says 2008

Shell Petroleum Development Corporation, SPDC, operator of the NNPC/Shell/El/Agip Joint Venture, believes that the proposition of a zero gas flare target date of 2004 is unrealistic. Saying it cannot meet that target, it reiterated its readiness to put an end to its gas flares by 2008.

Reacting to the recent call by the Ministry of Environment on the Federal Government to fast track the zero flare target date by four years (i.e from 2008) to 2004, the company said the date is unachievable.

Some companies have said it is possible but for Shell, it says this date is not achievable. Today, Shell produces 900,000 barrels per-day (bpd). By 2003/2004, the company hoped for a total production of about 1.4 million bpd. With new fields, it is expected that there will be new gas flares, which is not allowed by the government. It follows that by 2004, what we will have is more gas volumes being utilized but certainly not a flare out date.

The company believes that the inconsistency in the actual date for the zero flare target arose from the different "factions and voices" of the government. Oil and gas are commodities. Whereas oil can be stored, gas cannot be stored or hawked. It must go through pipelines and be bought by contract in a ready market. Gas gathering projects are very technical and expensive and Nigeria as a country has problems militating against it like the difficult terrain of the Niger Delta and inadequate fiscal and gas pricing policies, amongst others. This makes 2008 a more attainable date compared to 2004. Thus the spokesman of Shell Mr. Omiyi explained that Shell has invested large sums of money in gas gathering projects in order to actualize its goal of gas utilization from over 52 of the company's 88 flow stations. These include the Soku Gas Project already delivering gas to the NLNG plant, the Cawthrorne Channel Project, SPDC's largest gas gathering project expected to supply 200 million scfd of associated gas from four oil fields to the NLNG plant as well as local market and the Forcados Yokri Project also for the NLNG Bonny/plant.

On going gas gathering projects being executed by the company include the Greater Ugbhelli Project expected to gather about 60 million standard cubic feet per day (scf/d0 between 2001 and 2002 to be supplied to the Delta Power Station, and the Otumara and the Oguta Gas Gathering Project.

He however assured that SPDC is committed to ending all routine gas flaring by 2008 through effective economic utilization of gas for the benefit of the country. He also stated that SPDC has been very concerned about its gas flares since the inception of its oil production, adding that it supplies ovef 87% of the country's commercial gas. Omiyi stated that it is currently actively involved in the development of the Nigeria NLNG Project, supplying more than half the gas requirements of the plant.

Shell has since provide the technical leadership for the Nigeria LBG plant. In 1999, it supplied an average of about 374 mmscf/d of gas to the plant, which represents 53% of its total feedstock. The current expansion of the project is in part to be funded from the $8.5 billion investment of Shell and its Join- Venture partners. It will enable the delivery of 800 million standard cubic feet of gas per day to the other LNG trains that will come on stream in 2000, bringing SPDC gas supply to the NLNG to a total of about 1,5000 mmscf The expansion is expected to increase Nigeria's share of the world LNG market to about 8%. The NLNG is presently planning additional two trains by year 2005, being projects that will be sufficient to convert all associated gas produced by SPDC and its Joint Venture Partners to economic use. (Ibhade, 2001)

3.2 Obstacles to Zero Gas Flaring

l. Lack of Facilities and Markets

Nigeria faces a number of difficulties in harnessing its abundant gas reserves which are estimated at 120 trillion cubic feet, but could total 300 trillion cubic feet. It lacks gas utilization infrastructure. When most of its oil facilities were built in the 1960s and 1970s, at a time when gas was not a popular energy source in the world, little thought was given to gas collection facilities.

Associated gas, which is produced at low pressure and must be compressed and treated in facilities specifically built for the purpose, is one of the most difficult and expensive gas sources to harness. In Nigeria, it requires an expensive network of compression facilities and pipelines to link scattered fields that do not produce sufficient quantities of gas to be commercially viable on their own.

Apparently, the biggest constraint and challenge to gas development in Nigeria is the lack of ready markets for the commodity. Domestic gas demand is a meager 300 million cubic feet per day, in a country with few households employing modern cooking appliances and most still use traditional, cheaper forms of energy. Exports of Nigerian gas involve high transport costs because of the distance to the major international gas markets of Europe and Asia (Obadina, 2000)

2. Influential interest groups hinder Nigeria's progress in achieving zero gas flaring Level

In may 1995, the World Bank published its extensive two-volume report, Defining An Environmental Strategy for the Niger Delta. While identifying a litany of deleterious forces currently and dynamically reshaping the profoundly unique ecological and social systems of the Niger River Delta, the Bank does not sufficiently articulate the underpinning causes, many the legacy of the World Bank itself. Key problems are

ignored, others marginalized. Downplayed or dismissed are the unfortunate consequences'of a half- century free-for-all for oil (Ekanem, 2001).

Shielding the multinationals responsible for the rapid and myopic plunder of Nigeria's economic and natural -resources, the Bank nonetheless details in strong language many of the daunting issues critical to the ecological/social health of this 20,000 kMZ wetlands. The report offers significant insight and, at times, harsh criticism, of various destructive environmental activities and mal-development policies. Declining agricultural productivity; land degradation; disease; erosion; fisheries depletion' illegal logging; deforestation' proliferation of exotic species, toxic and hazardous substance pollution' vehicular emissions; sewage; resource ownership; population; municipal wastes; oil pollution; institutional collapse and corruption, for example, are all flagged as critical issues.

Forgotten are the multinational controls over the Nigerian economy; the complete abrogation of all basic human rights and freedoms; the lingering maladies of colonialism; 'state terror; the elite Nigerian oligarchy; the national and regional militarization and hegemony; the pharmaceutical profiteering; the legislation of gender; the entrenchment of successive military regimes, the ongoing charade of "democracy"; and government by. dictator's whim and decree. Such inconvenient realities are ignored, as if inconsequential to environmental or social woes, policy interventions, or regulatory and institutional reforms.

Equally critical to the environmental and social integrity of Nigeria, and all West Africa, are the debilitating $33 billion debt and debt service "obligations" accrued through years of indiscriminate exploitation. It is this debt that forever insures Nigeria's sovereign subservience to the elite benefactors of international finance capital, and the inevitable liquidation and sterilization of the natural environment. Couched in the ecospeak of "sustainable development," the report barely conceals what appears to be the Bank's ultimate agenda; Sustainable plunder (Ekanem, 2001).

Commenting on a government steel mill, for example, the report concludes "epidemiological studies on the surrounding communities would have to be conducted to determine the health effects from exposure to metals."There is no mention however, of the complete absence of epidemiological studies for communities in. the vicinity of oil installations, gas-flares or unlined waste pits, all of which have contaminated water and land. The report concludes that "particulate, including sulfur, contribute to chronic and potentially debilitating respiratory illnesses, while lead can cause mental dysfunction and potentially,. death.... And N02 may lead to increased susceptibility to respiratory pathogens." But these are the deadly benefits of an unregulated and opportunistic automobile industry, where gas lead content is the highest in the world. Curiously, the epidemiological effects of poisons spilled by the waste streams of pipelines, flow- stations and gas flares are dismissed without mention. Unlike other problems where data or research is lacking, here there is "little evidence" of disease, though "speculations are widespread." This is a region where Nitrogen oxides and S02 emissions are estimated at some 220,000 and 40,000 tons per year. Nor does the Bank find it necessary to consider that human moralities in the Niger Delta remain largely unreported due to

the geographical and institutional constraints of rural communities and the complete lack of health facilities. Of the limited studies of gas flaring, which have been performed, funded by Shell, the N02 and S02 concentrations, the Bank claims, "were not disturbing." All in all, the report says, "given the low environmehtal and health ranking, the actual future benefits of reducing oil pollution are low."

Gas flaring in the Niger Delta amounts to billions of cubic meters global warming methane and C02 flared into the atmosphere daily and while the report notes that this is probably the single greatest contributor to global warming, it also concludes that "there is no prospect indicating that gas flaring practices will be changed in the future." Given these conclusions, about the repercussions of Big Oil in the Delta, it is not surprising to read that the "social unrest" in oil- producing communities is perhaps due more to a crisis of "perception" (than to prolific oil contamination), since "local communities perceive oil activity problems and especially oil pollution to be greater than they actually are." In fact, it can be inferred from the report that a little persuasion and propaganda would go a long way toward alleviating "social unrest." As for the ongoing Niger Delta Environmental Survey, funded by Shell, the report boldly asserts that "critical to the legitimacy of the study is the fact that it will be strictly independent from Shell".

3.3 Environmental Groups and Gas Flaring

With the even-increasing environmental awareness various environmental groups are springing-up. One of the most active ones, The World Bank Group has set out objectives and projects towards finding a solution to the gas being flared wastefully today. They include the following: Increase investment in natural gas in client countries. Gas in developing countries accounts for 50% of world reserves, but less than 20% of production.

- Substitute natural gas for other fuels. Properly consumed, natural gas is a preferred fuel because of its benefits for local environments as well as producing far less COZ than other fossil fuels.
- Expand markets for LPG or bottled gas; which could go a long way in some areas towards addressing the energy 'needs of urban and rural poor.
- Reduce flaring of nati4ral gas through development of markets.
- Support application of new commercial technologies to natural gas development transport and consumption.

3.4 Consequences of Gas Flaring

The effects of sour gas on the environment are negative.The main impact that sour gas has on the environment comes in the form of acidic precipitation. The incineration of sour gas (Hydrogen sulfide) produces sulfur oxides, which are released into the atmosphere. The end result of these compounds when they combine with other atmospheric constituents, namely oxygen and water, is what we call acid rain or acid precipitation.

Water
Acid rain affects bodies of water by raising the pH of the water and potentially farming or. killing the aquatic life contained therein. In some sensitive lakes and streams, acidification has completely eradicated fish species such as brook trout, leaving the waters barren.

Vegetation and Soil
Acid rain has also been linked to the degradation of forests.Acid rain, as it moves through forest soils, strip away the essential nutrients, through various chemical reactions, required for continued healthy growth of vegetation.Acid rain is particularly a concern for areas in which the soil type has a low buffering capacity.

Other Materials
Acidic precipitation is also known to contribute to the corrosion of metals, stone, and painted structures. Considering that very few people actually live in densely forested area, this is probably the most visible effect of acid rain in most people's minds. (Microsoft Encarta .Encyclopedia, 1996).

Possibly the most important effect of sulfur oxides in our atmosphere comes about when these oxides form sulfate aerosols. These aerosols may be transported over long distance by atmospheric wind currents.

Human Health
Martha Kostuch, a veterinarian and acknowledged industry expert, says that people who live near flares report so'trie health effects similar to what farmers observe in cattle, respiratory problems, extreme fatigue and depression (Mostrom, 1999). Data also showed that there were more respiratory symptoms among children between 5 - 15 living down wind from gas processing plant relative to those who are not.

Flaring produces incomplete combustion with the release of carcinogens including benzopyrene, benzene, carbon di-sulfide, toluene and other toxins, thus predisposing humans to cancer of various sorts. Though there is a lack of research on the health effects on human populations, reports from areas where there is gas flaring, predominate cases of respiratory ailments have been noted.

Dr. Owens Wiwa, a medical doctor and brother of the executed man Ken Saro Wiwa, noted that these health problems were particularly noticeable within the Ogoni tribe of Rivers State with "very high rates of asthma, tuberculosis, bronchitis and ling cancer (Martin, 2000).

Animal Health

The Canadian Association of Petroleum Producers (CAPP) and Alberta government initiation a three-year program to conduct epidemiology investigations of cattle health problems where it's suspected that the oil and gas industry is involved.

The study shows a direct correlation between the volume of sour-gar flaring and an increased risk increased risk of non-pregnancy, abortion and twins. (This is bad news for dairy farmers because a female twin is almost always sterile).

Other adverse effects include abnormalities in pregnant and post parturient cows and (possible) abortions and increase risk of twins. Studies show that some polycylic aromatic hydrocarbons are endocrine disrupt that can behave as estrogen antagonists and modify the availability of estrogens in target tissues.

Possible related to the impact on reproductive endocrine systems is an association of exposure to flare type emissions and abnormal nervous system function. The effect reflect a highly lipid organ targeted by the xenobiotics. Potential effect include depressed animal productivity that may be reversible but which has an economically importance impact on cattle producers. Impact Includes: Depressed milk production, Prolonged feeding time in a feedlot, lowered weaning weight in calves sprayed by condense, and increase morbidity and mortality (Mostrom, 1999).

Ahove (2001) gave a summary of the consequence of acid precipitation induced by gas flaring these includes among others:

1. Damaging status, building, mental and car colours
2. Killing fish, acquatic plants, and mico-organisms in lakes and streams
3. Weakening or killing trees, especially conifers at high elevation, by leaching calcium, potassium and other plants nutrient from soil.
4. Damaging tree roots by releasing ions of aluminum, load, mercury and cadmium into the soil.
5. Making trees more susceptible to attacks by disease, drough and fungi and moss that thrive under acidic conditions.
6. Stunting the growth of crops such as tomatoes, soyabean carrot and cotton
7. Leaching toxic metals such as copper and lead from city and home water pipes into drinking water.
8. Causing and aggravation many human respiratory diseases and leading to premature death.

4.0 Conclusion

Will gas flaring cease come 2004? The government says YES, Chevron says Yes and Shell says NO. If we are to go by the amount of crude oil shell produce as a measure of the gas company flares then my people in the Niger Delta should expect to consume more of these flared gases and face its attendant consequences.

The government may not be able enforce its plans on Shell based on extreme pressures. But with Chevron and other Oil Companies if their plans come to reality then my people will have a sigh of relief

5.0 Summary

This unit traced the issue of gas flaring - when it actually ceases. The government has mandated oil industries to cease flaring by 2004 a four year shift of the previous 2008. Shell sticks to the old position - 2008 but Chevron wants us to believe they will cease flaring come 2004.

A visit by the author a Chevron flow station near Escravous shows that gas flaring has ceased.

6.0 Tutor Marked Assignment.

l. Outline the position of two oil companies on which gas flaring will cease in Nigeria .
2. State seven direct and indirect consequences of gas flaring.

7.0 References and Other Resources

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