NATIONAL OPEN UNIVERSITY OF NIGERIA

SLM 303

Introduction to Pedology and Soil Physics

Module 3

SLM 303 (Introduction to Pedology and Soil Physics) Module 3

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Module 3 Properties and Management of Nigerian Soils
Unit 1 Nigerian Soils

1.0 Introduction

Nigeria is situated entirely within the tropical zone and is located between latitudes 4° and 14° North of the Equator and longitudes 3° and 15° East. It is bounded on the west by the Republic of Benin, to the north by the Republic of Niger, to the east by the Republic of Cameroon and to the south is bathed by the Atlantic Ocean.

2.0 Objectives

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

- list the types of Nigerian soils
- state the nature of Nigerian soils.

3.0 Main Content

3.1 Nigerian Soils

It has a total land mass of about 924,000km^2 and a population of 88.5 million (Anon., 1992). Physiographically the country consists of several extensive plateaux. The major plateaux surfaces are the Jos Plateau, Udi Plateau and the north central high plains. The coastal areas are usually covered by soft rocks which are prominent along the Niger Delta, Niger-Benue trough and Lake Chad Basin. The high plateau is underlain by basement complex and volcanic rocks. Examples of the volcanic hills are the remains of extinct volcanoes as seen in Jos, Biu plateaux and the Eastern borderlands. The craters created by these volcanoes are well preserved and several of them contain crater lakes. The Mount Cameroon volcano is still active on the eastern border of Nigeria; activity during which several lives were lost was recorded in 1989. The lowland areas are composed of sedimentary rock and cover the Sokoto plains, Chad Basin, Niger-Benue trough, western areas of Nigeria, south-eastern Nigeria and coastal margins and swamps. The major rivers of Nigeria are found in these lowland areas.
Nigeria has two major rivers, the Niger, after which the country is named, and the Benue. They meet at the Lokoja confluence and enter the Gulf of Guinea through a network of creeks and distributaries which form the Niger Delta. There are, however, a few other tributary rivers which drain into the Niger-Benue trough and Lake Chad. These include the Sokoto-Rima, Kaduna, Anambra, Gongola, Hadejia, Jama'are and Yobe rivers. The basins of these major rivers and their tributaries constitute the drainage pattern of the entire country. Other major rivers e.g. Cross, Imo, Ogun, Osun, Benin, Qua Iboe etc. empty directly into the Atlantic Ocean. The majority of small rivers are seasonal.

3.2 Climate

The climate, determining the different ecological zones, is influenced by two wind systems, the south-westerly that brings rain and the north-westerly from the Sahara Desert that brings the dry and dusty harmattan wind. According to Garnier (1967) and Iloeje (1980), Nigeria, and indeed all the West African countries which experience similar weather conditions, can be said to have four main climatic zones.

a. The Equatorial Climate which extends from the coast to about 150km inland. Rainfall is between 1500 and 3000mm per annum, with an average temperature range of 17–24°C and relative humidity ranges between 60–90%. It has two seasons, the wet season March to October, and dry season November to March. Both Port-Harcourt and Lagos are in this zone.
b. Tropical Hinterland, about 150–240km northwards from the coast, with 1000 to 1500mm rainfall, temperature range of 21–25°C and relative humidity range of 50–80%. It has a longer dry season, of 4–5 months, compared with the equatorial zone which lasts from October to April. Examples are Ibadan and Enugu.
c. Tropical Continental which falls into the Sudano-Sahelian vegetation zone with rainfall of 250–1000mm, temperature of 25–30°C (but with lower night temperatures especially during the harmattan) and low relative humidity of 20–40%. The characteristic dry hot, harmattan wind may last from October to May. Examples are Sokoto, Kano, Maiduguri and Yola.
d. Montane or Plateau type climate is limited to the highland areas, with a high annual rainfall of 1400–4000mm, relatively low temperatures of 5–20°C and high humidity of 30–90%. Example is Jos.

In general, rainfall, temperature and humidity have the following trends. The temperature is usually high, with an average of about 25°C and increases as one moves northwards although variations are influenced by season and latitude, while the rainfall and humidity increase towards the coastal areas.

Recent years have seen a general trend of increasing drought conditions compared with the weather conditions of the 1930s to late 1940s (Oguntoyinbo, 1983). There was a notable drought period between 1968–1973 and this led to an upsurge of water conservation strategies. These included the construction of several dams, boreholes, irrigation projects and the formation of small water bodies both for domestic use and for migrating animals (Illiasu & Alsop, 1987; Satia, 1990) plus the creation of several River Basin Authorities.

Another change is in the harmattan which has now extended its frontiers into the tropical hinterland, and sometimes as far as the equatorial climatic areas. This is readily observed by obvious harmattan hazes and dry dusty winds.

The severity of the harmattan has been attributed to the encroaching desert due to deforestation as a result of human activities, bush burning, human settlement and development, logging and felling for firewood. There is also usually a drop in humidity causing dryness, coldness, and a dusty and hazy atmosphere. The unpleasant experiences which result from a severe harmattan include thick deposits of dust on buildings and furniture and increased incidence of conjunctivitis and cracking of human lips due to dryness.

3.3 Vegetation, Land Use and Population

Climate (particularly rainfall) has an important influence on the distribution of vegetation in Nigeria. There are ten main vegetation zones (Udo, 1970): the Sahel, Sudan and Northern Guinea zones. Jos Plateau, Montane forest and grassland, Rain forest, Oil palm bush, Southern Guinea zone, Swamp and Mangrove forest.

These major zones have different vegetation types which can be further subdivided into coastal forest and mangrove, deltaic swamp forest, swamp forest and wooded savanna, secondary forest, mixed leguminous wooded savanna. *Isoberlinia* savanna, *Afzelia* savanna and semi-deciduous forest, plateau grass savanna, mixed Combretaceous woodland, wooded savanna, mixed wooded savanna, floodplain complex, *Sorghum* grass savanna, *Burkeo africana* savanna, wooded tropical steppe and moist lowland forest.

An estimated 68 million hectares of land is utilised for farming with an average of two hectares per farming family. Because of the differing vegetation and climatic conditions and

socio-cultural base, each ecological zone has some degree of specialisation in farming system, type of crops and animals reared.
The crop farming system is mainly the traditional rain fed agriculture, contributing about 95% of the farming activity, while mechanised and irrigated agriculture uses only 5% of the cultivated land. There are six main farming patterns: shifting cultivation, sedentary and permanent cultivation, terrace agriculture, irrigated agriculture and mixed farming. In animal husbandry, there are four main systems, free range, sedentary, migratory and intensive animal husbandry.
In the forest zone more tubers, such as cassava, yam, cocoyam and forest related crops such as cocoa, palm tree, coconut, banana, pineapple, orange and mango, are grown while in the savanna and arid zones of the Sahel, Sudan and Guinea vegetation more cereals such as sorghum, maize, rice, beans, soyabean, guineacorn and vegetables (including pepper, carrots, garden eggs, potatoes and some other vegetables) are grown. A higher population of livestock is raised in the savanna region because of the limiting effects of livestock diseases and the high humidity of the southern vegetation zones. Dwarf goats, sheep and Ndama cattle are more abundant under sedentary conditions in the southern vegetation zones.
The recent population figures from the National Population Commission indicate that Nigeria is a highly populated nation and as might be expected, the use of resources depends on the population and socio-economic structure. Areas with a high population have greater pressures on the utilisation of both terrestrial and aquatic resources. The available resource commodities that are utilised would in turn influence the economic activities of such communities.

3.4 Soil and Soil Erosion

The abundance of water in a given area under natural conditions is partly a function of soil, types of geological formation, vegetation and other environmental factors. This is because the ability of any soil to retain moisture and its water-holding capacity determine the extent and formation of pools of available surface water.

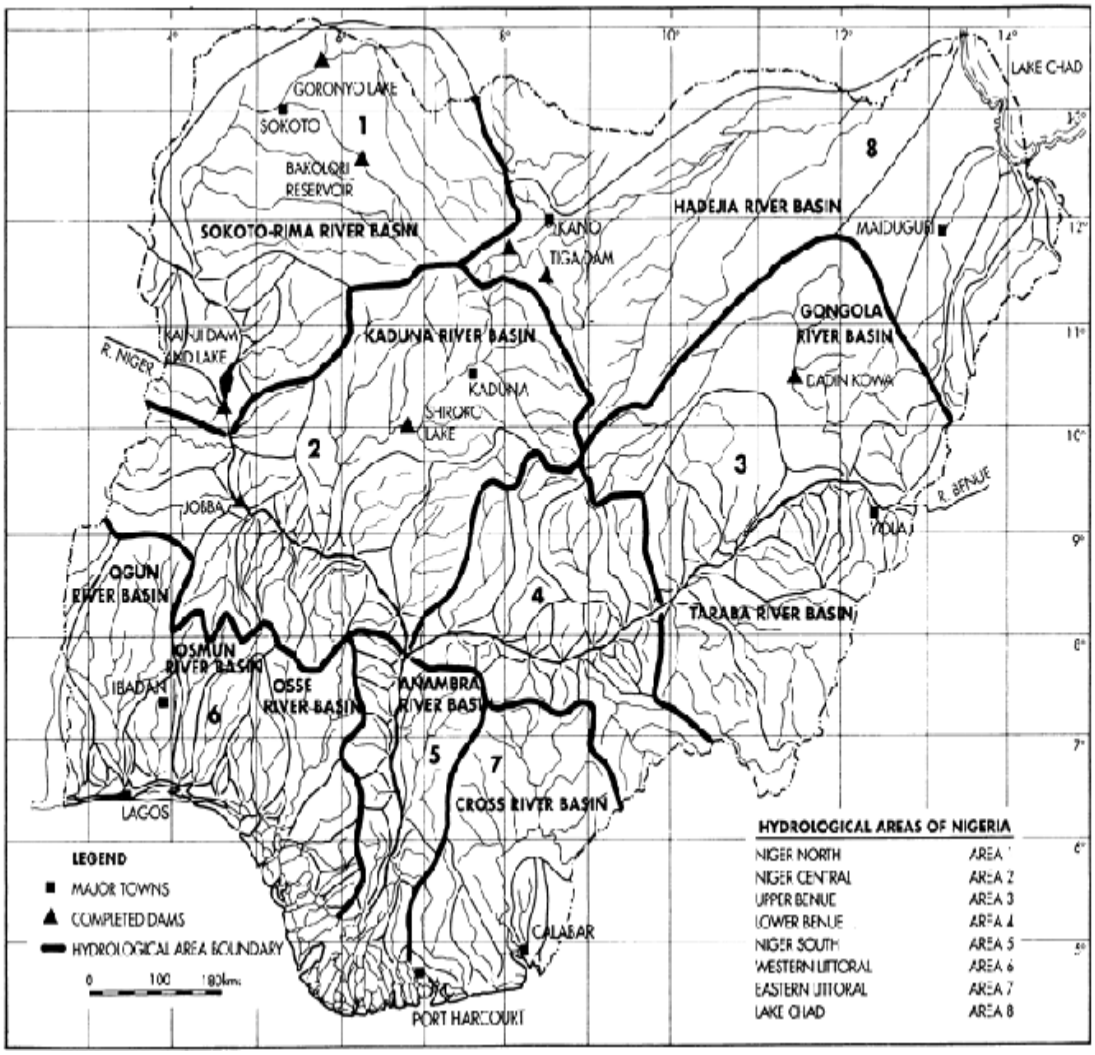

Fig. 1: Hydrological Map of Nigeria

Nigeria's fragile soils are susceptible to erosion, the various causes of which are both natural, and man-made due to abuse of the environment. However, the natural phenomena are over-shadowed by the effects of human activities. While some of the causes of erosion are limited most have very wide distribution. Depending on the type, soil erosion is of concern because it can devastate human settlements, agricultural grounds and recreational development, can disrupt and destroy industrial structures and facilities and severely upset the hydrological regime. The deformation of hydrological regimes usually leads to increased rates of siltation. Hydrological disruption may also affect the pattern of water discharges, hence affecting the normal pattern of aquatic life

3.5 The Soils of Nigeria

The purpose of this section is to show the sketch map of the major soils in Nigeria with an illustration of how the distribution of soils follows the rainfall and vegetation patterns.

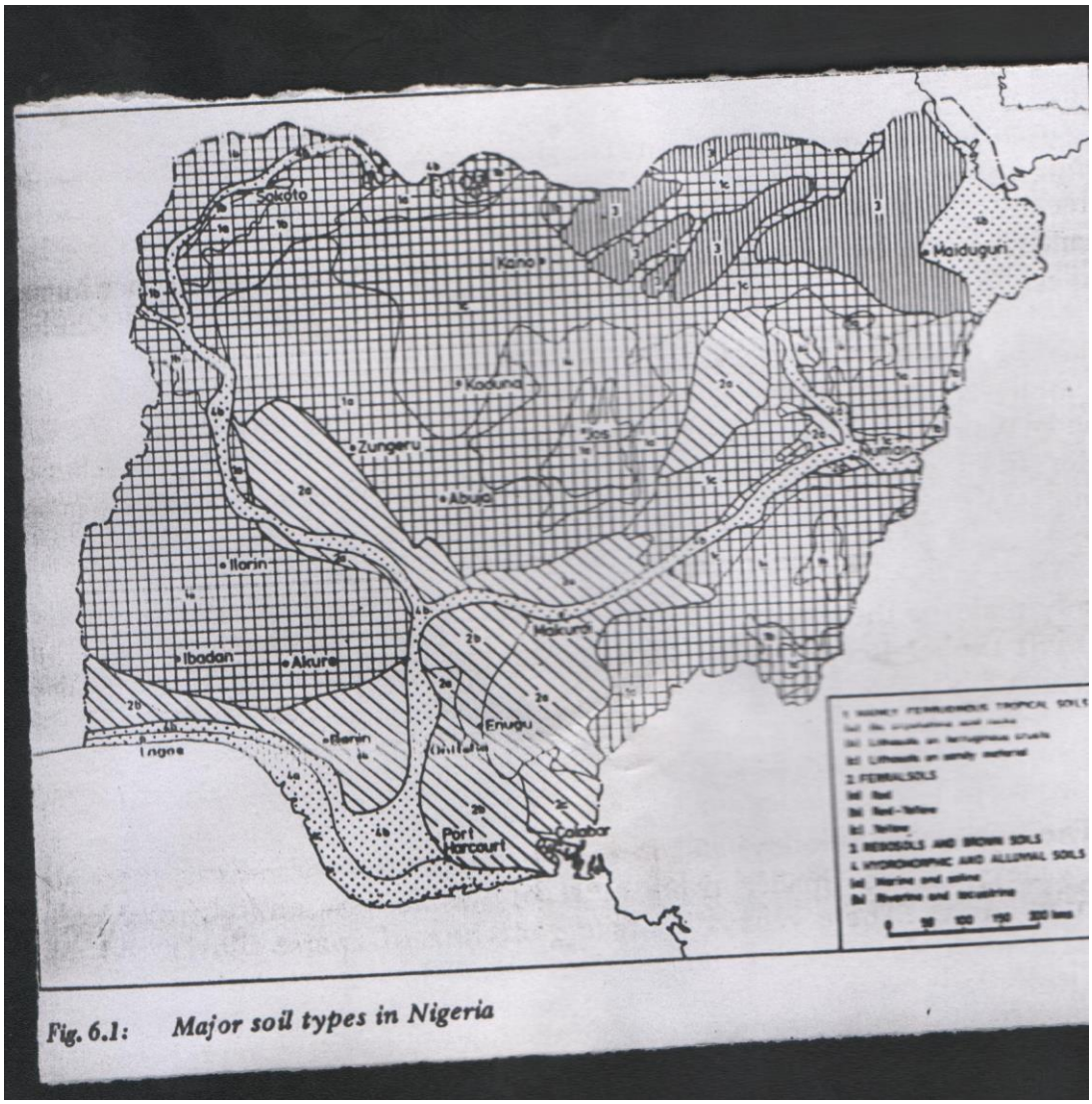

Fig. 6.1: Major soil types in Nigeria

Based on the FAO generic classification system, the four major groups of soils in Nigeria are shown in fig. 6.1 above. They are:

- The hydromorphic and organic soils developed on alluvial, marine and fluvio-marine deposits of variable texture, notably along the coast and river flood plains
- The regosols and brown soils developed on drift and continental sedimentary deposits in the north-eastern parts of the country,
- The ferrasols, some (the ochrosols) with iron concretions and some (the oxysols) without, developed essentially on sedimentary rocks and
- The highly ferruginous tropical red and brown soils of the Basement omplex rocks areas.

Fig.6.2: Climate Map of Nigeria

4.0 Conclusion

In Nigeria, the distribution of soils follows the rainfall and vegetation patterns as shown in Figure 6.2 above. Nigeria has two broad belts of vegetation types, namely, the forest and savannah types. There is, however, also the mountain vegetation of the isolated high plateau regions in the central and far eastern parts of the country.

5.0 Summary

Nigeria's soil is rated from low to medium in productivity. However, the Food and Agriculture Organisation of the United Nations (FAO) concluded that most of the country's soil would have medium to good productivity if this resource were managed properly.

6.0 Tutor-Marked Assignment

1. What is a Soil, briefly describe the nature of Nigerian soil
2. State the importance of Nigerian soil to agriculture
3. What is soil erosion? Describe the factors contributing to soil erosion in Nigeria

7.0 References/Further Reading

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Unit 2 Properties of Nigerian Soils

1.0 Introduction

Nigerian soils are a mixture of different things; rocks, minerals, and dead, decaying plants and animals. Soil can be very different from one location to another, but generally consists of organic and inorganic materials, water and air. Together with physiography, it constitutes the most observable element of the landscape. Soil characteristics express and reflect environmental conditions, particularly climate. A fertile soil must supply adequate nutrients, be of good physical condition and hold enough water so that the nutrients in the soil will be available for plant uptake.

2.0 Objectives

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

- identify physical and chemical properties of the Nigerian soil
- mention the components of Nigerian soil.

3.0 Main Content

3.1Properties of Nigerian Soils

Broadly speaking, the natural vegetation over a geographical area is essentially a response to the climate in that area. Nigeria's vegetation belts reflect this very close link between vegetation and climate. Hence, the similarity in the west-to-east zonation of both climate and vegetation. With the south to north progressive decline in total rainfall and length of wet season, vegetation belts are demarcated on west-to-east zonation pattern characterised by transitional zones from one belt to another are influenced by soil type.
Nigeria has two broad belts of vegetation types, namely, the forest and savannah types. There is, however, also the mountain vegetation of the isolated high plateau regions in the central and far eastern parts of the country. Generally speaking, the properties of Nigerian soil deteriorate while the chemical properties follow a reverse pattern.

3.2 Soil is

- A layer of natural materials on the earth's surface containing both organic and inorganic materials and capable of supporting plant life.
- The material covers the earth's surface in a thin layer.
- It may be covered by water, or it may be exposed to the atmosphere.
- Soil contains four main components: inorganic material, organic matter, water, and air.
- Ideal soil should contain about 50% solid material and 50% pore space.
- About half of the pore space should contain water and half of the space should contain air.
- Inorganic material consists of rock slowly broken down into small particles.
- The organic material is made up of dead plants and animals in varying stages of decay.
- The percentages of the four main soil components vary depending on the kind of vegetation, amount of mechanical compaction, and the amount of soil water present.

4.0 Conclusion

A fertile soil must supply adequate nutrients, be of good physical condition and hold enough water so that the nutrients in the soil will be available for plant uptake.

5.0 Summary

The chief factors contributing to soil fertility are:

- Adequate supply of soil nutrients
- Organic matter content
- Soil reaction or pH
- Absence of injurious substances
- The physical characteristics of texture, structure, consistency, depth and
- Nature of the soil profile.

6.0 Tutor-Marked Assignment

1. Describe the properties of Nigerian soil.
2. State the types of Nigerian soil.
3. What is soil erosion? Describe the factors contributing to soil erosion in Nigeria.

7.0 Reference/Further Reading

Butler, B. E. (1980). *Soil Classification for Soil Survey*. Oxford: Oxford Science Publications. *Science,* 96.
Cline, M. G. (1949). *Basic Principles of Soil Classification*. *Soil Science*, 67(2), 81-91.
Cline, M. G. (1963). *Logic of the New System of Soil Classification. Soil,* 17-22.

Unit 3 Profile Description of Nigerian Soils

1.0 Introduction

Soils are structural and functional elements of terrestrial ecosystems, which are formed in a historical process of development through the interaction of geological, climatic and biotic factors at the respective site. Soil is the fundamental source of life for all living beings. As the physical and chemical properties of soils exert great influence in the distribution and development of vegetation, it needs to be studied and evaluated from time to time. The soil forming process is very slow and time taking. It takes normally thousands of years for the soil formation. Therefore, we are studying the past activities while analysing the soil profile at present. The parent material, topography, geological processes, climatic conditions, vegetation and human interferences play major roles in formation and development of soil profiles in particular area. Similarly, our activities at present will certainly influence the soil profiles in far future.

2.0 Objectives

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

- describe the methods and techniques of identification
- analyse and evaluate Nigerian soils.

3.0 Main Content

3.1 Profile Description of Nigerian Soils

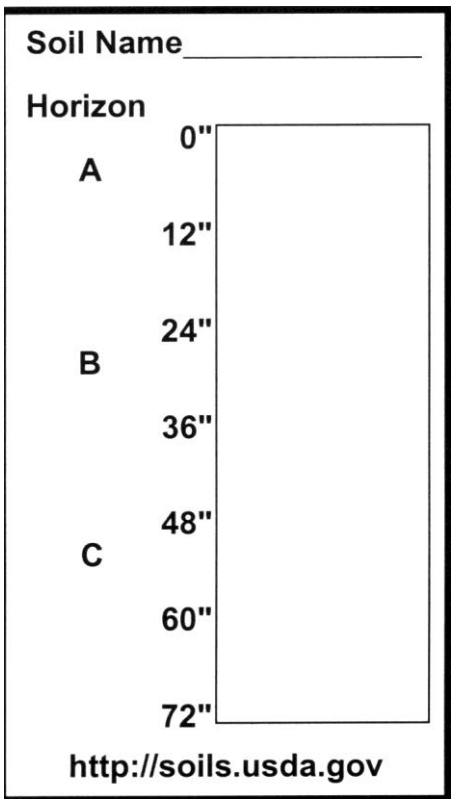
Nigeria can be divided into the 7 major ecological regions (Fig. 1):

(1) The Coastal Swamp Region which includes the coastal forest and mangroves as well as the deltaic swamp forest
(2) The Moist Lowland Region
(3) The Southern Guinea Savanna Region
(4) The Montane Region
(5) The Northern Guinea Savanna Region
(6) The Sudan Savanna Region
(7) The Sahel Savanna Region

The location and extent of most of the regions coincide with the vegetation zones of the country as described by Keay (1953), Areola (1978) and Areola *et al.* (1982). The 12 reference soils (NG 15 to NG 29) are located in the southern part of the country in the Coastal Swamp (Region 1), the Moist Lowland (Region 2), and the

The *Coastal Swamp Region* includes creeks, lagoons, the Niger delta and the coastal plain. The mean altitude of the creeks and lagoons area is about 40 m a.s.l. while along the coastal plain the elevation is about 160 m a.s.l. Total annual precipitation ranges from 429 mm at Bonny in the east to 1755 mm at Lagos in the west. The rainy season lasts for about 10 months. The soils are mainly hydromorphic and derived from marine and lacustrine parent materials. The vegetation consists of coastal forest, mangroves and deltaic swamp forest. The mangrove forest is dominated by varieties of red mangrove *(Rhizophera racemosa),* the

swamp forest consist solely of slender trees. Reference Soils NG 19 and NG 20 are found in this region and described in Soil Brief Nigeria. The Moist Lowland Region is underlain by rocks of the System. The landscape is undulating and marked by numerous domed or sugar-loaf hills and by occasional flat-topped ridges. The summits of the hills range between 300 and 600 m a.s.l. Temperature is high throughout the year with an annual average between 28°C and 32°C. The rainy season lasts for 8 months and total annual rainfall is higher than 1100 mm. The region is covered with lowland forest consisting of evergreen hydrophytic plants with a large diversity. The forest is characteristically stratified. At the forest margins or in areas disturbed by man, woody lianas form an almost impenetrable tangle. The original or high forest is no longer as extensive as it used to be and is now restricted to a few forest reserves in Ondo, Benin and in the Cross River Basin along the border with Cameroon.



4.0 Conclusion

Soil profiles look different in different areas of the world. They are affected by climate, vegetation and other factors.

5.0 Summary

Soil Profile refers to the layers of soil; horizon A, B, and C. Horizon A refers to the upper layer of soil, nearest the surface. It is commonly known as topsoil. In the woods or other areas that have not been plowed or tilled, this layer would probably include organic litter, such as fallen leaves and twigs. The litter helps prevent erosion, holds moisture, and decays to form a very rich soil known as humus. Horizon A provides plants with nutrients they need for a great life.

The layer below horizon A, of course, has to be horizon B. Litter is not present in horizon B and therefore there is much less humus. Horizon B does contain some elements from

horizon A because of the process of leaching. Leaching resembles what happens in a coffee pot as the water drips through the coffee grounds. Leaching may also bring some minerals from horizon B down to horizon C. If horizon B is below horizon A, then horizon C must be below horizon B. Horizon C consists mostly of weatherised big rocks. This solid rock, as you discovered in Soil Formation, gave rise to the horizons above it.

6.0 Tutor-Marked Assignment

1. What is soil profile?
2. Discuss the various levels of soil profile you studied.
3. Explain the effects of climate on soil profile.

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Unit 4 Classification of Nigerian Soils

1.0 Introduction

Soil classification deals with the systematic categorisation of soils based on distinguishing characteristics as well as criteria that dictate choices in use. Soil classification is a dynamic subject, from the structure of the system itself, to the definitions of classes, and finally in the application in the field. Soil classification can be approached from the perspective of soil as a material and soil as a resource. Development of sustainable agricultural systems such as alley farming is an attempt to reduce degradation of natural resources and to find environmentally compatible ways of increasing production and promoting broad-scale development.

Intensification of agriculture on land currently used for traditional farming requires a thorough knowledge of the soil as a resource and attributes of the land. Information on distribution, potential and constraints of major soils is needed, so that the most appropriate soil management systems can be designed. In addition knowledge on land capability and suitability is also essential to determine the best land use for sustained crop production. This unit reviews current systems used to classify Nigerian soils and land capabilities.

2.0 Objectives

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

- describe the advantages of soil classification and list classification systems in Nigeria
- discuss the hierarchy of categories in the Soil Taxonomy classification
- explain the topographical regions of Nigeria
- classification of Nigerian soil both as a material and soil as a resource.

3.0 Main Content

3.1 Classification of Nigerian Soil

Soil is the thin layer covering the entire earth's surface, except for open water surfaces and rock outcrops. The properties of soil are determined by environmental factors. Five dominant factors are often considered in the development of the various soils: (a) the climate, (b) parent materials (rocks and physical and chemical derivatives of same), (c) relief, (d) organisms (fauna and flora), and (e) the time factor. There are a large number of different soils, reflecting different kinds and degrees of soil- forming factors and their combinations.

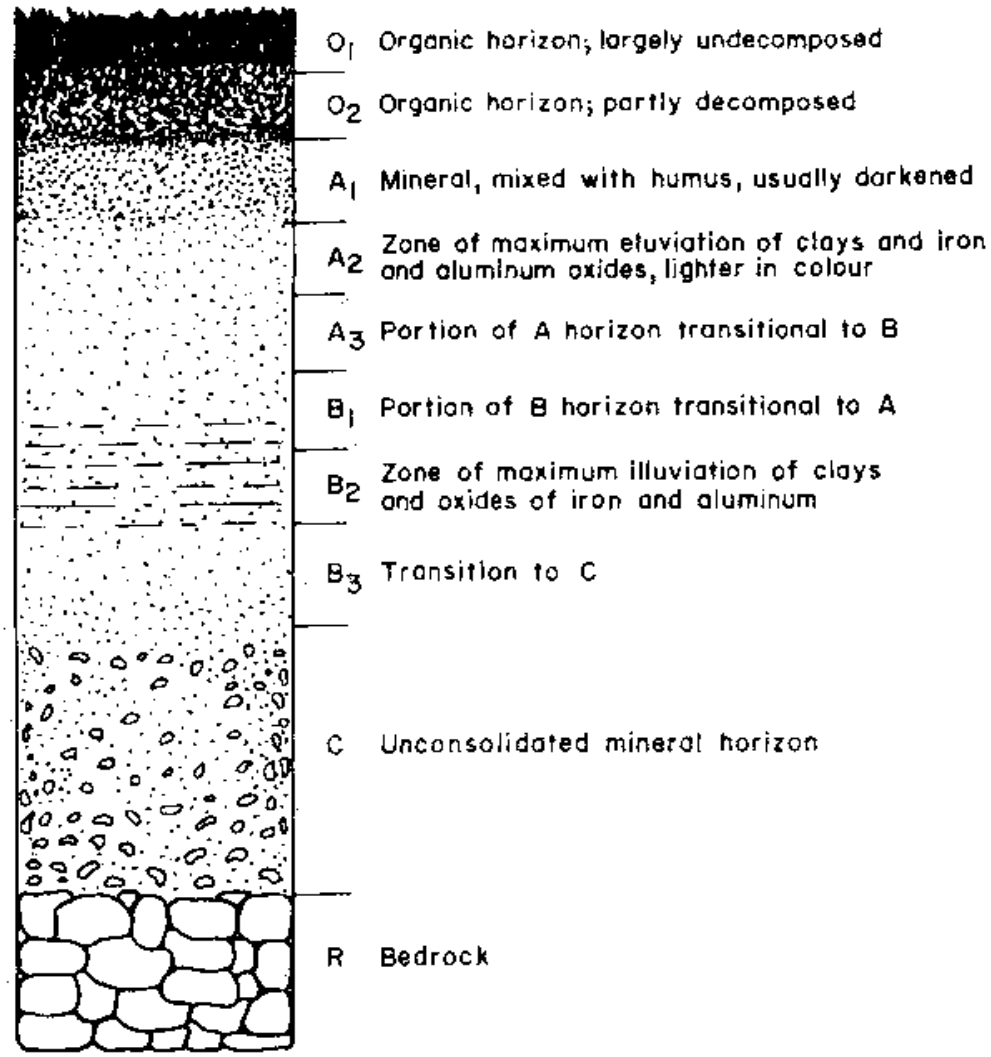

Fig. 1: A Hypothetical Soil Profile

Scientists have developed different systems of soil classification to group soils of similar properties in one class, allowing them to exchange information on soils found in different areas. Soil classification also helps in determining the best possible use and management of soils. Soil classification is however a controversial subject at both national and international levels. There is lack of agreement for a common classification system, because soil scientists do not agree on the characteristics for differentiating and classifying soils.

Although many soil classification systems exist; however, two systems are widely used: The USDA Soil Taxonomy and the FAO/UNESCO legend. The classification of soils starts with examination of soil profiles. Morphologically, soils are composed of a series of horizons. Soil horizons are layers of different appearance, thickness, and properties which have arisen by the action of various soil-forming processes. The horizons are normally parallel to the surface. Collectively, the horizons make up what is called the soil profile or soil "pedon". A soil profile is defined as a vertical section of the soil to expose layering. Figure 1 sketches a hypothetical soil profile having all the principal horizons, with a brief description of the characteristics of each horizon. Individual soils have one or more of these horizons. Very young soils may not yet have started the soil horizonisation process.

3.2 Hierarchy of Categories in the Soil Taxonomy

There are six levels in the hierarchy of categories: Orders (the highest category), suborders, great groups, subgroups, families and series (the lowest category) (USDA, 1978).

Orders
There are ten orders, differentiated on gross morphological features by the presence or absence of diagnostic horizons or features which show the dominant set of soil-forming processes that have taken place. The ten orders and their major characteristics are shown in Table 1. The occurrence of the major soils in the humid and subhumid tropics.

Suborders
It is the next level of generalisation. It permits more statements to be made about a given soil. In addition to morphological characteristics other soil properties are used to classify the soil. The suborder focusses on genetic homogeneity like wetness or other climatic factors. There are 47 suborders within the 10 orders. The names of the suborders consist of two syllables. The first connotes the diagnostics properties; the second is the formative element from the soil order name. For example, an Ustalf is an alfisol with an ustic moisture regime (associated with subhumid climates).

Great groups
The great group permits more specific statements about a given soil as it notes the arrangement of the soil horizons. A total of 230 great groups (140 of which occur in the tropics) have been defined for the 47 suborders. The name of a great group consists of the name of the suborder and a prefix suggesting diagnostic properties. For example, a Plinthustalf is an ustalf that has developed plinthite in the profile. Plinthite development is selected as the important property and so forms the prefix for the great group name.

Table 1: Brief Descriptions of the Ten Soil Orders according to Soil Taxonomy

SOIL ORDERS	DESCRIPTION
ALFISOLS	- Soils with a clayey B horizon and exchangeable cation (Ca + Mg + K + Na) saturation greater than 50% calculated from NH_4OAc-CEC at p^H7.
ULTISOLS	- Soils with a clayey B horizon and base saturation less than 50%. They are acidic, leached soils from humid areas of the tropics and subtropics.
OXISOLS	- Oxisols are strongly weathered soils but have very little variation in texture with depth. Some strongly weathered, red, deep, porous oxisols contain large amounts of clay-sized Fe and Al oxides.
VERTISOLS	- Dark clay soils containing large amounts of swelling clay minerals (smectite). The soils crack widely during the dry season and become very sticky in the wet season.
MOLLISOLS	- Prairie soils formed from colluvial materials with dark surface horizon and base saturation greater than 50%, dominating in exchangeable Ca.
INCEPTISOLS	- Young soils with limited profile development. They are mostly formed from colluvial and alluvial materials. Soils derived from volcanic ash are considered a special group of Inceptisols, presently classified under the Andept suborder (also known as

	Andosols).
ENTISOLS	- Soils with little or no horizon development in the profile. They are mostly derived from alluvial materials.
ARIDISOLS	- Soils of arid region, such as desert soils. Some are saline.
SPODOSOLS	- Soils with a bleached surface layer (A2 horizon) and an alluvial accumulation of sesquioxides and organic matter in the B horizon. These soils are mostly formed under humid conditions and coniferous forest in the temperate region.
HISTOSOLS	- Soils rich in organic matter such as peat and muck.

4.0 Conclusion

Soil classification deals with the systematic categorisation of soils based on distinguishing characteristics as well as criteria that dictate choices in use. Topography, geological processes, climatic conditions, vegetation and human interferences play major roles in determination of soil types.

5.0 Summary

In soil classification, the item to be classified is the soil profile. The classification or study of the entire profile consists of recognising and naming the horizons which make up the profile. In the study of soil profiles, sub-soil horizons are given greater emphasis than surface horizons which are frequently changed by human activity to such an extent that they bear hardly any relationship with genetic process.

6.0 Tutor-Marked Assignment

1. Briefly Describe the system of soil classification
2. State the major orders in soil classification
3. Explain the importance of soil classification.

7.0 References/Further Reading

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Unit 5 Management of Nigerian Soils

1.0 Introduction

A fertile soil must supply adequate nutrients, be of good physical condition and hold enough water so that the nutrients in the soil will be available for plant uptake in this unit we shall discuss the various ways of soil management in Nigeria.

2.0 Objectives

At the end of this unit, you be able to:

- analyse soil management methods in Nigeria

3.0 Main Content

3.1 Management of Nigerian Soils

Maintenance of Soil Fertility
In maintaining soil fertility, the farmer is mainly concerned with keeping the soil at a satisfactory physical condition and maintaining the nutrient supply at a desired level. A fertile soil must be in a physical condition that is favourable for root growth. Thus, cultivation to break down the soil aggregates must be done. This important practice will accelerate the decomposition of organic matter which when present, aids in promoting the porosity and granulation of the soil. Maintaining good soil structure and providing good vegetative cover or mulching, together with minimal, timely and systematic cultivation also help to maintain soil fertility.

However, under annual cropping, it is not practicable to keep the soil covered throughout the whole year or to avoid some structure-destroying tillage. Nevertheless, the fertility of the soil must be maintained and this could be done effectively by crop rotation, cover cropping, green manuring, application of compost and farmyard manure as well as proper land use.

3.2 Crop Rotation in Soil Fertility Maintenance

A proper rotation programme of crops can be used effectively to maintain soil fertility. The alternation of legumes and non-legumes or the use of legumes in rotation helps to maintain soil fertility. This is because the residues of such crops as groundnuts and soya beans improve the nitrogen content of the soil through their ability to fix nitrogen in their roots. Moreover, with the incorporation of the plant residues left on the field into the soil, improves aeration, soil structure and water-holding capacity of the soil.

A good rotation can also benefit by minimising exposure of the soil to the risk of erosion. It reduces weed infestation of the land and checks the build-up of pests and diseases on the land.

3.3 Maintaining Fertility with Green Manures

Crop rotation is an intensive system of farming; as such the soil nutrients get depleted and exhausted at certain stages of the land use. So, green manure crops have to be planted to replenish the organic matter and nutrient content of the soil when ploughed into the soil. Growing annual legumes as green manure crops in rotation with other crops is likely to be of value where sufficient moisture is available. Moisture promotes vigorous growth of the crop and causes rapid decomposition during the period between ploughing the green manure crop with the soil, and planting of the next crop. This means that the green manure crop should be ploughed into the soil to decompose before the new crop is planted. This practice is therefore usually ineffective in drier areas because of moisture limitations. Thus, under fairly good rainfall conditions, it can be a useful aid in soil fertility maintenance. The beneficial effects of green manures are short-lived; consequently, they must be grown rather frequently in the rotation programme to maintain crop yields at reasonable levels.

The effects of green manuring in increasing the soil organic matter as well as the total and available nitrogen levels are very important and significant. These effects may even be more important than any increase in the availability of mineral nutrients that it may bring about. However, it is not practicable to maintain fertility alone with green manure crops since its effects are short-lived. Hence, other methods have to be employed too.

It is important to note that the green manure crop should:

(1) be able to grow rapidly
(2) have abundant and succulent tops since it will decay quicker,
(3) be able to grow even on poor soils, and
(4) not have the chance to persist and thus become a weed, competing with the crops.

3.4 Maintaining Soil Fertility with Farmyard Manure

Farmyard manure is unquestionably a most useful aid in maintaining soil fertility and should be used wherever it is economical and practical to do so. Farmyard manure or pen manure consists of a rotted mixture of the excreta of farm animals and the straw provided for their bedding, which should be sufficient to absorb the dung and the urine. Well rotted farmyard manure is usually best applied just before planting a crop. Applying it earlier in the dry season, especially if it is left partly exposed, may lead to some loss of nitrogen and possibly some soluble nutrients by leaching at the beginning of the rains.

Large yields of crops, especially root crops, are usually obtained. Also many experiments in various parts of the tropics have shown that the majority of annual crops respond well to the application of farmyard manure.

The value of farmyard manure is due to the nutrients it contains rather than from any special characteristics associated with its organic matter content.

3.5 Composting and the Maintenance of Soil Fertility

Compositing is a term used for the application of decomposed heaps of plant and animal remains to the soil. The decomposed mixture could include crop residues, household refuse,

weeds and other waste vegetable material, either with or without additions of some animal or human excreta.

Compost preparation may be done in heaps or in pits depending on the climatic conditions. Heaps compost are better in wet climates and pit composts in dry areas. The compost is commonly made of alternate layers of vegetable matter or crop residues and manure. The manure or soil which is very high in organic matter supplies active decay organisms which start the decomposition process. The compost heap should be turned three times at intervals of 2-4 weeks to get all the material well rotted. The heap should, however, be kept moist to reduce the loss of ammonia and elemental nitrogen and also to encourage vigorous bacterial action. The soil pH should be suitable for the microbes to function efficiently.

The advantage of applying compost as opposed to burying raw crop residues and weeds is that it enables partially decomposed organic matter to be applied to the land at the proper time so that available plant nutrients are rapidly released for plant growth. Burying the undecomposed materials would mean taking nutrients away from soil (and the crop plants) until they are well rotted. Composting, therefore, is a worthwhile practice because of the nutrients it supplies to crops. Thus, it must be encouraged as a measure for maintaining soil fertility wherever it is practicable.

4.0 Conclusion

Soil management can be defined as the process of managing the use and development (in both urban and suburban settings) of land resources in a sustainable way. Land resources are used for a variety of purposes which interact and may compete with one another; therefore, it is desirable to plan and manage all uses in an integrated manner.

Soils are affected by human activities, such as industrial, municipal and agriculture, that often result in soil degradation and loss or reduction in soil functions. In order to prevent soil degradation and to rehabilitate the potential of degraded soils, reliable soil data are the most important prerequisite for the design of appropriate land-use systems and soil management practices as well as for a better understanding of the environment. This is the main objective of soil science.

5.0 Summary

Soils are important to our ecosystem for six main reasons: first, soils are a place for plants to grow; second, soils control the speed and the purity of water that moves through them; third, soils recycle nutrients from dead animals and plants; fourth, soils change the air that surrounds the earth, called the atmosphere; fifth, soils are a place to live for animals, insects and very small living things called microorganisms; sixth, soils are the oldest and the most used building materials

6.0 Tutor-Marked Assignment

1. What do you understand by the term soil fertility?
2. How can the nutrient resources of a soil be depleted?
3. Explain methods that can be used to conserve and improve the nutrient status of the soil.

7.0 References/Further Reading

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