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UNIT 1: DEFINITION, NATURE AND FUNCTIONS OF SOIL

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1.0 Introduction

Now that you have read through the course guide, you would have acquired a general overview of what this unit is all about and how it introduces the subject matter of this course. In this unit, you will learn what soil is in and the functions it performs.

2.0 Objectives

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

- define soil in relation to some disciplines,
- identify the nature of soil and
- know the various functions of soil.

3.1 Definition of Soil

Various definitions of soil have emerged depending upon the point of view of soil users. Perhaps the first and the most popular definition is that given by agriculturists that soil is a medium or a stuff in which plants grow.

- The soil chemist sees the soil either as a chemical laboratory where various chemical processes and reactions take place or as a test tube into which plant nutrient can be introduced for the benefit of plant.
- Both the soil physicist and geologist conceive soil as a collection of matter, solid, liquid and recognizable mechanical properties associated with the rock from which they are formed.
- The engineers see the soil either as a material for civil engineering constructions or in terms of its suitability for foundation laying.

- To the geographer, the term "soil" means the uppermost superficial layer of loose or unconsolidated material overlying the crustal rock in which plants may grow.

5.2 The Science of Pedology

We now turn to looking at the soil, as the pre-occupation of the science of pedology. Pedology is the science of soils. It studies the origins, characteristics and uses of soils. Let us now consider the interests of the penologist.

- The pedologist is interested in the appearance of the soil.
- The pedologist wants to know the mode of formation of such a soil.
- The physical, chemical and biological compositions also interest the pedologist.
- Besides all these, the pedologist wants to classify the soil types of the world and how they are distributed over the surface of the earth.
- The pedologist is also interested in how soils are managed and conserved.

Do you know that for the pedologist to achieve his/her interests in the study of soils he/she makes use of a larger number of branches of scientific knowledge? These fields are many. They include biology, chemistry, physics, agriculture, forestry, geology, geography archaeology and history.

3.3 Functions of Soil

- Soil has many functions it performs. Out of these we will consider five of them.
- Soil acts as a medium in which seeds, spores and corm may germinate. This is because most seeds, spores corm need the protection; warmth and moisture of the soil to enable them commence their life cycles.
- Soil provides support for many growing plants, that is, soil is essential as an anchorage for plants.
- Soil is the main medium whereby water is brought to the roots of plants. This is so because soil is capable of holding moisture and air, both of which are necessary for plant life.
- It is through soil that nitrogen, potash, phosphorus, potassium, iron and other numerous mineral substances essential to plant life are supplied.
- Lastly, soil functions as a habitat for organisms whose biological activities are responsible for the recycling of mineral nutrients derived from organic matter.

4.0 Conclusion

In the first unit of this course, you have learnt some of the various definitions of soil as perceived by different disciplines. You have also seen the key role pedologist plays in the study of soil and how he has to fall back on other disciplines in order to make him/her achieve the set objectives. Finally, you have learnt, in this unit, five functions of soil.

5.0 Summary

This unit has made it possible for you to define soil in many ways. However, the definition that appears to be most popular considers the soil as a medium or stuff in which plants grow. Similarly, you have considered five interest of the pedologist and five functions of soil. The next unit will make you know what a lump of soil is made of.

6.0 Tutor Marked Assignments

1. Give four definitions of soil and state their origin.
2. Enumerate the functions of soi.

7.0 References and Other Resources

Brady, N. C. (1996). *The Nature and Properties of Soils.* Macmillan, New York.

Faniran, A. and Areola, O. (1978). *Essentials of Soil Study.* Heinemann, Ibadan.

Jeje, L. K.; Ekanade, O. and Osunde, M.A.A. (1996). *Man's Environmental Relations.* Macmillan Nigeria Publisher Ltd., Lagos and Ibadan.

UNIT 2: CONSTITUENTS OF SOIL

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1.0 Introduction

You can easily recall what definitions and functions of soil are. But you are yet to know what constituents the soil contains. That is what this unit will do. That is, if you hold a lump of soil you will know what it is made of. Do you know that soil contains air and water at any point in time? You also have a realize that the soil lump has mineral matter and organic matter. In essence, in Unit 2, you will learn of the four constituents of soil which are mineral matter, organic matter, soil air and soil water.

2.0 Objectives

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

- name the components of soil,
- know the percentage of each of them,
- learn that while two of them are variable, the other two are invariable, and
- know the constituents and functions of each component.

3.0 Main Contents

3.1 General Background

Most soils have four main constituents. They are mineral matter, organic matter, soil air and soil water. The percentage of mineral matter in the soil in 45% while that of organic matter is

5%. However, soil air and soil water each has ± 25%. Do you notice the percentages of soil air and soil water having ± signs? This is an indication that they vary according to seasons of the year. This is the reasons why they are regarded as variable constituents, whereas mineral matter and organic matter are *invariable* constituents. Fig. 2.1 illustrates the constituents of soil.

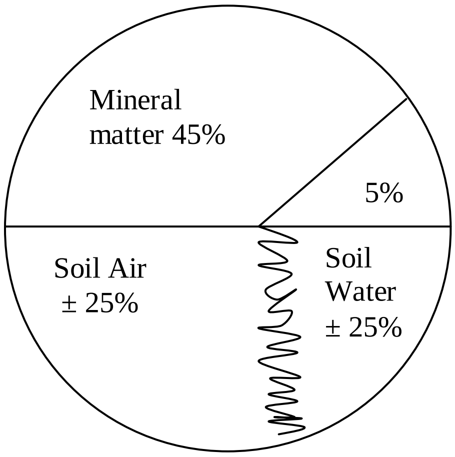

Fig. 2.1: Constituents of Soil

3.2 Mineral Matter

Mineral matter includes all inorganic substances in the soil. These include the rock fragments made up of sand, silt and clay fractions and the primary and secondary minerals.

Sand, silt and clay fractions form the texture of the soil. Of all these, clay fractions are the most important. This is because they consist of very small platy-structure mineral fragments which can only be identified by the use of electron microscope. You should also note that clay particles are also chemically active.

The primary and secondary minerals in the mineral matter of the soil are regarded as silicate minerals divided into macro and micro nutrients.

<u>Macro-nutrients</u> are made of metallic cautions such as calcium, magnesium, potassium and sodium, and the non-metallic elements such as nitrogen and phosphorus.

<u>Micro-nutrients</u> are also known as trace elements because they are usually present in the soil in only minutes quantities. Examples of micro-nutrients are boron, copper, zinc, manganese, cobalt, chlorine, molybdenum and vanadium.

3.3 Organic Matter

You will recall that organic matter is said to be 5% of the soil by weight. It is an accumulation of partially decayed and partially synthesized organic residues. Therefore, the material making up organic matter is continually being broken down by soil micro-organisms.
Although the organic matter of a soil is small, its influence on other soil properties is far greater than the low percentage would indicate. The beneficial effects of soil organic matter include.

- Functioning as a granulator of the mineral particles and contributes to soil aggregation thus improving physical properties and reducing erosion process;
- Modifying water retention properties especially in sandy soils thereby increasing the amount of water a soil can hold;
- Supplying most of the nitrogen and sulphur and a major source of phosophorus.
- Supplying most of the cation exchange capacity of acidic and highly weathered soils;
- Forming complexes with micro-nutrients which prevent the leaching and
- Being the main source of energy for soil mirco-organisms.

From the above, you could see that we can conclude that without organic matter constituents, biochemical activities would practically come to a standstill in any soil.

3.4 Soil Air

Now we can now turn to considering the variable constituents of soil. The first we will consider is soil air.

Soil air is regarded as the soil atmosphere from where organisms obtain oxygen for metabolism their and for the disposal of carbon dioxide and other obnoxious gases.

Soil air varies in accordance with the rate at which organisms take up oxygen and deposit carbon dioxide; and the rate it is replenished from the atmosphere.

It is, however, necessary to note that the content and composition of soil air is determined, to a large extent, by the soil-water relationships.

Finally, the tendency for rapid changes in soil air has marked effect not only on the growth of economic plants but also on other organisms that live in the soils.

3.5 Soil Water

Soil water is the second soil constituent that is variable. Do you know the main source of soil water? It is water from precipitation i.e. rain, snowfall, and hail.

There are three types of soil water. These are:

(i) hygroscopic or absorbed water,
(ii) percolation or gravitational water, and
(iii) capillary water.

Let us now consider what each of these types stand for in soil.

Hygroscopic water is inn from of ions held by soil particles through the process of adsorption. This type of water is very small in quantity and is not usually available to plant roots.

Percolation water is only available in soil when there is a surplus water. It moves through the soil as a result of gravitational attraction. This type of water moves very fast in the soil and because of this it is not available to plants. Hence, it is hardly of any important to plants.

Capillary water is that soil drawn up through the fine interstices which from capillaries between soil particles. Capillary water is better imagined as being analogous to the spreading of water in a blotting paper. Hence, the interconnecting soil vesicles make the water spread easily through the pores. It is the only soil water that is readily available to plants.

You need to also know that the rate at which water sinks through the soil, known as infiltration capacity and permeability depends on the texture, structure and the initial moisture content in the soil.

4.0 Conclusion

In this second unit of our course, you have learnt the constituents of soil. You now know that when you hold a lump of soil, it has four constituents. These are mineral matter, organic matter, soil air and soil water. You also know that the first two are invariable while the last two are variable, depending on the season. Among these constituents, organic matter has the least percentage (5%) but from what we have learnt, we know that it is very important as its affects other soil constituents and properties in no small way.

We also learnt that mineral matter consists of the inorganic substances in the soil such as rock fragments (texture) and the primary (macro-nutrients) and secondary mineral (micro-nutrients). This unit also shows the importance soil air and soil water.

5.0 Summary

This unit has clearly indicated to you that mineral matter, organic matter, soil air and soil water are the constituents of soil. While mineral matter is 45% of the soil, organic matter is 5% while soil air and soil water are ±25% each. Mineral matter is made up mainly of texture and nutrients while organic matter is the synthesized plant and animal tissues. You are also made to know that soil air is the soil atmosphere where metabolism of soil organisms occurs. It is also shown in this unit that soil water are of three types of hygroscopic, percolation and capillary water.

6.0 Tutor Marked Assignments

(i) with a well-labelled diagram, show the constituents of soil
(ii) what is soil organic matter? What are its benefits in the soil?
(iii) List and discuss soil water type.

7.0 References and Other Resources

Brady, N. C. (1996). *The Nature and Properties of Soils.* Macmillan, New York.

Cruickshank, J.G. (1972). *Soil Geography.* David and Charles, Newton Abbot.

Faniran, A. and Areola, O. (1978). *Essentials of Soil Study*. Heinemann, Ibadan.

UNIT 3: PHYSICAL PROPERTIES OF SOIL

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1.0 Introduction

Now that we have known the general constituents of soil, we need to go into greater details as to what properties those constituents are made of. The properties of soil can be broadly divided into physical and chemical domains. In this unit, you will learn about the physical properties of soil. Soil physical properties are those you can see with your eyes and feel with your fingers. You are going to learn about soil texture, soil structure, soil colour, soil depth, soil temperature and the profile.

2.0 Objectives

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

- Know what the textural properties of soil are,
- Identify different types of soil structure,
- Distinguish soils of different colours,
- Appreciate the role of temperature in soil bio-chemical processes,
- Recognize different layers of a soil profile.

3.0 Main Contents

3.1 General Background

There are many properties of soil that are usually considered in the scientific study of soil. You will recollect that we mentioned that those and soil properties are either physical or chemical. We will now consider the most common soil physical properties in this unit. These will include texture, structure, colour, depth, profile and temperature.

3.2 Soil Texture

Soil texture refers to the degree of coarseness and fineness of the soil material. In some textbooks and publications, it is also referred to as particle size composition of the soil. The soil texture is commonly described in terms of percentages of sand, silt and clay grades. Soil texture can be roughly determined by the ‘feel’ of the finger. It is usually represented as a triangle in which 22 textural grades are identified using combinations of sand, silt and clay grades (fig….) Note that the soil structure is very important because it influences soil properties such as porosity, permeability, structure and consistence.

3.3 Soil Structure

You can consider soil structure
Either: as the various arrangements of the primary and secondary soil particles.
Or: as the aggregation of the units of the soil mass into various shapes and sizes.
Note that individual aggregates or structures are called peds. When aggregation is absent , as in loose sand, soil is said to be structureless.

Soil is structure is usually described in these three ways:

- types of ped,
- size of ped, and
- strength or resistance of ped.

The types of structure are defined by their shape. They are granular, crumbly, platy, columnar, prismatic and blocky (Fig….). Soil structures are described as fine, medium or coarse depending on their sizes. Soil structures may also be graded as structureless, weak, moderate or strong, depending on how well formed and how resistant to pressure they are.

You remember it was said that textural classes are quantifiable. In the case of structure it is not so. Although soil structure is difficult to determine quantitatively, it has significant implication on soil fertility. A good soil structure is depicted by high water holding and aeration capacities. In essence having good structure will facilitate the activities of micro-organisms and make soils to be loose, friable and easy to cultivate.

3.4 Soil Colour

Colour is the most conspicuous property of soil that has been used widely to describe and classify it. In identifying soil colour, the terms used are **dark, bright and light.**

You need to know that two main substances produce colour in soils. These are the organic matter and mineral matter. In general, organic matter, especially humus, produces the dark colour while mineral matter produces the light and bright colours depending on their states of weathering.

Soil colour is usually determined in the field by using some kind of colour system. The most widely used colour system is that of **Munsell Colour Chart.** Soil colour charts are indicated in hue, value and chroma.

The advantage of colour charts is mainly to bring about some objectivity into soil colour determination and enhance comparability.

3.5 Soil Temperature

Soil temperature is the degree of coldness or hotness of the soil. It is another important property of the soil as it regulates, to a larger extent, the rate and intensity of the biochemical processes of soil formation. Therefore, when temperature is high biochemical processes will be rapid but when the temperature is low, biochemical processes will be slow. Similarly, when soil temperature is high micro-organic activities are very active whereas when soil temperature is very low, micro-organic activities are almost non-existent. The result of the latter is that soil organic matter is hardly broken down to become humus such as in the cold regions of the world.

It is also necessary to know that the nature of the soil surface considerably affects the amount of solar energy absorbed by the soil. Dark soils generally absorbs more solar energy than light-coloured soils, while sols with a smooth surface reflect more radiation than those with a rough surface.

3.6 Soil Profile

Soil profile is the arrangement of soil in different layers right from the top to the base where the parent rock or parent material is found. Each layer of the soil profile is called horizon. How do we distinguish one soil horizon from another? It is by noting the characteristics of each horizon. These are indicated through varying texture, structure, colour and constituents.

The ideal soil profile consists of three major horizons viz: A, B, and C. The A horizon is the topmost layer, where leaching or eluviations of substances takes place. This is followed by B horizon which is a one of accumulation or illuviation of substances. It is, therefore, referred to as a zone of enrichment. The last horizon is the C horizon. It is a zone that is not so much affected by soil forming processes. It is the soil parent material. (see Fig…..)

It is necessary to indicate that not all soils have well developed horizons such as soils that are developing on young parent materials like alluvial and glacial deposits. Some of them may not have any horizon at all.

3.7 Soil Depth

Soil depth refers to how deep a soil profile is. It is mainly dependent on the nature of soil parent material, rate of weathering processes and the majority of the soil-forming or pedological processes. Soil depth may also depend on the nature of topography and slope. For example, soils of flat surfaces especially with easily weatherable materials will be quite deep whereas soils on sleep slopes will be shallow.

5.0 Summary

Unit 3 has looked at some important physical properties of soil namely soil texture, soil structure, soil colour, soil temperature, soil profile and soil depth. While soil texture is the degree of coarseness and fineness of the soil material, soil structure refers to the aggregation of the units of the soil mass into various shapes and sizes known as peds. Soil structure could be granular, crumbly, platy, columnar, prismatic and blocky while soil texture is usually described in terms of sand, silt and clay percentages. The latter are combined to give 12 textural grades of soils in the soil textural triangle. You have to remember that the most conspicuous property of soil is colour and that the Munsell Colour Chart is mostly used to identify soil colours usually indicated in hue, value and chroma. Soil temperature largely regulates the rate and the intensity of the bio-chemical processes of soil formation and also controls micro-organic activities in the soils.

Since soil is formed over time, it is observed that different layers are seen as we dig the soil down the surface. This is called soil profile or horizon. You should not forget that there are A, B, and C soil horizons. Remember also that the A horizon is the elluviation layer while the B horizon is the layer of illuviation. That is, while substances are removed in the A horizon, they are deposited in the B horizon. The C horizon is the parent materials. Quite related to the soil profile is soil depth. It is defined in terms of how deep or shallow a soil profile is. While soils found on flat surfaces are usually deep, those on sleep slopes are usually shallow.

6.0 Tutor Marked Assignments

- List two important attributes of soil texture and three of soil structure.
- With a well annotated diagram, describe and ideal soil profile.

7.0 References and Other Resources

Brady, N. C. (1996). *The Nature and Properties of Soils.* Macmillan, New York.

Cruickshank, J. G. (1972). *Soil Geography*. David and Charles, Newton Abbot.

Jeje, L. K.; Ekanade, O. and Osunde, M.A.A. (1996). *Man's Environmental Relations.* Macmillan Nigeria Publisher Ltd., Lagos and Ibadan.

UNIT 4: CHEMICAL PROPERTIES OF SOIL

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1.0 Introduction

In unit 3, we considered the general characteristics of soil physical properties. It is just in order for us to look at the chemical properties of soil in this unit. We can say that this unit will look at the chemistry of soil. In contrast to soil physical properties, soil chemical properties cannot be seen with our eyes neither can we feel them without fingers. Therefore in unit 4, you will know about those soil properties that cannot be physically seen or felt but can be determined mainly in the laboratory from soil samples collected from the field.

2.0 Objectives

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

- Identify major and minor chemical properties of soil,
- Know the function(s) of identified soil chemical properties,
- Appreciate their usefulness to plants; and
- Learn that some of them are useful as components of chemical fertilizers.

3.1 Nature of Soil Chemical Properties

Soil chemical properties are sometimes referred to as the soil nutrients. These are nutrients absorbed in solution by roots of plants. You need to know that soil chemical properties can be broadly divided into two groups. The first group consists of those properties which are required by plants in large amounts. They include essentially soil reaction nitrogen, phosphorus, sodium, potassium, magnesium and calcium. These are generally known as macro-nutrients. The second group is made of nutrients required by plants in only small quantities, and comprises a wide range of elements such as born copper, iron, zinc manganese aluminium and molybdenum. This group is generally referred to as micro-nutrients or as trace elements.

3.2 Soil Reaction

One of the most important chemical properties of the soil is its reaction. Soil reaction refers to the acidity or alkalinity of the soil. Do you know why soil reaction is so important? It is because

- It influences many of the other chemical properties.
- It largely determines the chemical environment in which plants and soil micro-organisms live.

Soil acidity refers to a situation in which soil solution possesses a lot of hydrogen ions (H+) more than hydroxyl ions (0H-).

Soil alkalinity, on the other hand, is when hydroxyl ions are more than the hydrogen ions in soil solution.

A third situation arises when soil solution has an equal concentration of H+ and 0H- ions. In such a case we talk of *soil neutrality*.

The exact relationship in any particular case is ordinarily evaluated in terms of hydrogen ion concentration which is usually expressed in terms of pH. The pH value of a solution is defined as the logarithm of the reciprocal of the hydrogen ion concentration.

The pH value ranges from 1 – 14. A soil is said to be acidic when its pH is less than 7, alkaline when it is above 7 and neutral when it is 7.

3.3 Nitrogen

Do you know that nitrogen was discovered by a Scottish physician named Daniel Rutherford in 1772? Nitrogen is known to be the fifth most abundant element in the universe and makes up about 78% of the earth’s atmosphere it is largely an inert gas. Nitrogen is obtained from liquefied air through the process known as fractional distillation.

Soil nitrogen is a very useful element for crop production. Its absence results in yellowish colour of plants. However, nitrogen is a major component of NPK fertilizer. It is to be noted that the largest use of nitrogen is for the production of ammonia (NH3). Usually large of amounts of nitrogen are combined with hydrogen to produce ammonia.

3.4 Phosphorus

Do you know that phosphorus was discovered before nitrogen? While nitrogen was discovered in 1772, phosphorus was discovered in 1669 by Hennig brand who prepared it from urine.

Phosphorus is never found free in nature but widely distributed in combination with minerals. Hence it has a geologic pool. The presence of phosphorus in adequate amount in soil is also crucial to crop production. It also forms a major component of NPK fertilizers.

Phosphorus is also important in the production of steels, phosphor bronze and many other products. Finally, is an essential ingredient of all cell protoplasm, nervous tissues and bones.

3.5 Exchangeable Cations

Exchangeable cations are also referred to as metallic cations. They are derived from the rocks and they include calcium, magnesium, potassium and sodium.

Calcium is the chief exchangeable base in the soil. It is derived mainly from calcium carbonate and to some extent from calcium sulphate. Its abundance in the soil appears to be the main determinant of soil reaction and nutrient status. However, the major problem of calcium is that it is easily leached and washed away by drainage water.

Magnesium follows calcium in its abundance as an exchangeable base in the soil. It is an essential element for plant growth. It is derived mainly from forromagnesian rock-forming minerals such as olivine, hornblende and pyroxene.

Potassium is formed from silicate minerals such as orthoclase and potash micas. Potassium exists in two forms in the soil viz, the readily available another relatively unavailable forms. The readily available potassium is found in the soil solution. Potassium is an important of the NPK fertilizer.

Sodium is in the family of exchangeable base but not a major cation. This is because it is the least common of the metallic cations in soils. However, it is quite an important element in alkali soils found in arid areas of the world.

3.6 Micro-nutrients

Can you remember what we said about micro-nutrients? Do you remember that they are soil elements required in small quantities but crucial to crop production? They are many but let us briefly see three of them.

Boron is one of the simplest of atoms found in a variety of minerals related to borax. It is a relatively rare element in the earth's crust representing only 0.001%. It was discovered by Davy, Gay-Lassac and Thenard in 1808.

Boron is necessary in small amounts for plant growth. In larger amounts it is poisonous to plants and the range can be small. If the signs of boron deficiency supplement can be applied.

Copper as a micro-nutrient in the soil is strongly attached to organic matter. As a result it does not travel very far after release into the soil and it hardly enters groundwater. Too much of copper causes toxity which is dangerous to both soil flora and fauna lives. Copper can interrupt the activity of micro-organisms and earthworms in soil negatively. This may seriously slow down the decomposition of organic matter.

Zinc is another one of the most common elements in the earth's crust and is soil micro-nutrient. The level of zinc in soil increases mainly from disposal of zinc wastes from metal manufacturing industries and coal ash from electric utilities. If there is zinc deficiency in soil, a supplement is usually applied.

4.0 Conclusion

This unit has briefly shown the important characteristics and functions of soil chemical properties. These soil chemical properties include pH or soil reaction, nitrogen, phosphorus, exchangeable cations (i.e. calcium, magnesium, potassium and sodium) and micro-nutrients (e.g. boron, copper, zinc, iron, molybdenum, manganese). You have seen that all these chemical properties of soil serve on purpose or the other to make the soil what it is. Note that soil pH influences other soil chemical properties while nitrogen, phosphorus and potassium are components of chemical fertilizers that revitalize the soil.

Remember that exchangeable cations of calcium, magnesium, potassium and sodium act as nutrient bases for soil. Finally, micro-nutrients are trace elements that are needed by plants in small quantities.

5.0 Summary

In unit 4, we have studied the soil chemical properties. Those properties considered include pH, nitrogen, phosphorus, exchangeable cations (calcium, magnesium, potassium and sodium) and micro-nutrients such as boron, copper and zinc.

Soil pH measures how acidic or alkaline a soil is. When pH value is less than 7, it is said to be acidic, when it is more than 7 it is alkaline but neutral when it is 7, the pH range is 1 to 14.

You remember it is Rutherford who discovered nitrogen in 1772!!! Nitrogen makes up 78% of the grasses in the atmosphere. It determines the greenness of plants and it is a major component of NPK fertilizer.

Could you recollect that phosphorus was discovered before nitrogen and that was in 1669 by Hennig Brand? Phosphorus is of geologic pool and also an important component of NPK fertilizer.

Exchangeable cations are also known as metallic cations. These are calcium, magnesium, potassium and sodium. Generally, they act as nutrient asses in soil. Calcium is easily leached and washed away by water while readily available potassium is found in soil solution. Magnesium is next in abundance to calcium while sodium is the least common of all the metallic cations. Potassium is also important for its inclusion in the NPK fertilizer.

Micro-nutrients are also known as trace elements and they are needed in minute qualities by plants. If they are absent, plants may suffer but their supplements are available. Exampels of these are boron, copper and zinc. One common feature of micro-nutrients is that they are found mainly in earth's crust.

6.0 Tutor Marked Assignments

1. List five important characteristics of soil pH.
2. What do you know about exchangeable cations.

7.0 References and Other Resources

Brady, N. C. (1996). *The Nature and Properties of Soils*. Macmillan, New York.

Faniran, A. and Areola, O. (1978). *Essentials of Soil Study*. Heinemann, Ibadan.

UNIT 5: FACTORS OF SOIL FORMATION

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1.0 Introduction

Do you know that the lump of soil you hold does not result from weather rocks alone? In this unit, you will find out that five factors have been identified as being crucial to soil formation. These factors play different roles to make it possible for us to have soil. As you will see later, to get a mature soil takes time and it is also depends on the type of parent material and the relief. Furthermore, the organic matter of the soil environment and the climatic conditions are all important. Can you recognize the five factors none? If you can, you have done well, if you cannot, just go on and you will soon master them.

2.0 Objectives

At the end of this unit you will be expected to:

- Identify the active and passive factors of soil formation,
- Solve the soil forming equation;
- Appreciate the overriding role of climate in soil formation,
- Learn about how organisms affect soil formation,
- Learn about the passive factors and their contributions in soil formation.

3.1 The Make-up of Soil Forming Factors

You probably have the idea that soil derived from the residual inorganic material resulting from the physical disintegration and chemical decomposition of the crust. However, not all weathered rocks become soil. It is therefore, necessary to know that certain factors act together to make soil formation possible.

The soil forming factors are classified into active and passive factors. Those active factors are climate and organisms while the passive ones are relief, parent material and time. Do you know that an American soil scientist, Jenny (1941), functionally related the soil forming factors into an equation? Here is it:

S = f(U, O, R, P, T)…………………………………….(1)
where S is soil property
0 is organisms
R is relief
P is parent material
T is time

3.2 Climate

Climate is an active factor of soil formation. Through its component elements of temperature, precipitation, humidity and wind, climate is generally regarded as the most important factor in soil formation. This is because climate plays both a direct and an indirect role in soil formation. What are those functions that make climate a major foremost soil forming factor? Some of these are:

- Promotion of the production of soil water and soil warmth which constitute the most important agents of soil formation;
- Association of world's soil types in broad terms with climate types
- Determination of the rate of organic matter decomposition,
- Responsibility for the richness, sparseness or absence of vegetative cover which, in turn, affects the total nature of soil.

Indeed, we can seen that climate is almost everything for soil. This is why it is termed an active factor as it supplies the energy that the deed rock material needs to come alive.

3.3 Organisms

Organisms or biological activities are made up of both plants and animals. These also contribute to the formation of soils actively. However, plants play a greater role.

The role of organisms in soil formation is both direct and indirect. When organic materials decompose in the soil it produces organic acids which directly intensify pedogenic processes. Soil fauna (animals) especially bacteria, worms, termites and man also participate directly in many ways in soil formation.

The indirect role of organisms takes many former. For example, tree roots extend the depth of soil profile while vegetation influences the operation of climatic elements particularly precipitation and temperature by creating a micro-environment. It is also known that most processes of soil formation such as humification and mineralization are all closely linked with biological activities.

3.4 Relief

Relief affects soil formation through altitude, slope and aspect.

Altitude usually creates microclimate e.g. where altitude is high temperature is low thereby encouraging physical weathering to predominate. In this case soil will be coarse and stony and may remain immature and skeletal for a very long time. Altitude may also cause orog raphic rainfall whereby the windward side is weather with deeper soil than the leeward side with shallower soil.

Slope affects depth of soil. The higher the relief, the steeper the slop is likely to be. This affects the rate of materials movement from the slope. Usually depth of soil is thin where slope is steep and deep where slope is gentle.

Aspect is a facet of relief that influences soil formation in higher latitudes. Usually, slope facing the sun receives more isolation and are therefore warmer and drier than the slope not facing the sun. It should be noted that aspect is especially important in high-latitude regions. It is therefore found in the northern hemisphere that the south-facing slopes receive greater isolation leading to the formation of deeper soils on such slopes than on their north-facing counterparts. Invariably, this explains why vegetation on the south-facing slopes is luxuriant while that of the north-facing slope is sparse in the northern hemisphere.

3.5 Parent Material

Parent material may be regarded as rocks from which soils are formed. There are two categories. *In situ* materials are those on the original spot. That is, they are not moved, such as igneous, sedimentary and metamorphic rocks.

Deposited materials are those that have been eroded transported to where they become soils. Examples include alluvial, colluvial, aeolian, morrainic and littoral materials.

Most of the inorganic fractions of the soil are obtained from the parent material which are always released by weathering. Parent materials mostly determine the textural classes and also that the type of inorganic fractions found in any soil depends on its character. In essence, acid rocks often yield a large amount of quartz fragments whereas basic rocks often yield clayey substances. In the cases of deposited materials soils developed on them are usually sandy with the exception of alluvial materials. However, the influence of parent material may no longer be visible on very mature soils.

3.6 Time

Time is a factor soil formation occupies a special position. This is because not only do the processes of soil formation operate in a temporal framework but that the other factors also change through time both in themselves and in their relationships. Therefore, it is known that the formation of a mature soil requires a lot of time which also depends on the type of rocks on which such a soil is being formed. For example, it may take over 1000 years for 3cm of granitic rock to become soil whereas a 3cm soil depth has been known to have been formed on a volcanic eruption made up of ash in less than 30 years.

4.0 Conclusion

The factors of soil formation are considered in this unit. These factors are climate, organisms, relief, parent material and time. These soil forming factors are usually grouped into active and passive factors. Climate and organisms constitute the active factors while relief, parent material and time are the passive factors.

The major climate element influencing soil formation are temperature and rainfall. Studies have show a high correspondence between soil and climate maps of the world. Organisms include plants and animals i.e. living things. These are actually responsible for the living entity of the soil.

The location of soil is also important and is depicted by relief in respect of altitude, slope and aspect. Parent material is the rock from which soil mineral matter is formed after it has been weathered. The formation of soil is a long and complex process so it could take a long time before a weathered material becomes soil. This is why time is also a crucial factor of soil formation.

5.0 Summary

In unit 5, we consider the factors of soil formation. There are five factors which Jenny (1941) has put into an equation thus:

S = f(U, O, R, P, T)
where S is soil property
U is cliamate
0 is organisms
R is relief
P is parent material
T is time

These factors are grouped into active and passive. The first two, climate and organisms are regarded as active factors while relief, parent material and time are passive factors. We can call the active factors as the life wire of soil. They give it the living entity. While climate especially through its elements of temperature and rainfall, provides warmth and moisture, water organisms i.e. directly influence decomposition of organic matter apart from their indirect influence on soil processes. The latter may include, for example, the extension of the depth of soil profile by three roots. It is also noted that the influence of climate on soil formation is so high to the extent that world's soil types are closely associated with world's climate types e.g. lateritic soils are found mostly in the tropics irrespective of their location.

Relief affects soil formation through altitude which creates microclimate which can affect the soil e.g. where altitude is high soil may be coarse and stony. Another way relief affects soil formation is through slope whereby soil depth is affected e.g. where slope is steep, there is thin soil whereas where slope is gentle, there is deep soil. Aspect is the third way relief affects soil formation. It is all about areas facing or backing the sun.

Parent materials are of two types viz *in situ* and deposited materials, and most of the inorganic fractions of the soil are derived from these. The character of the parent material determines whether a soil is acidic or basic.

Time is important in soil formation because the formation of a mature soil requires a long time. Besides, the, type of rock on which soil is being formed also has temporal dimension. While granitic rock may take a very long time to form soil volcanic materials may take a short time.

6.0 Tutor Marked Assignments

1. List and group the soil forming factors.
2. Discuss climate and parent material as factors of soil formation.

7.0 References and Other Resources

Jeje, L. K.; Ekanade, O. and Osunade, M.A.A., (19960. *Man's Environmental Relations.* Macmillan Nigeria Publisher Ltd., Lagos and Ibadan.

Jenny, H. (1941). *Factors of Soil Formation*. McGraw-Hill, New York.

Paton, T.R. (1978). *The Formation of Soil Material.* George Allen & Unwin, London.

UNIT 6: SIMPLE PROCESSES OF SOIL FORMATION

Table of Contents

1.0 Introduction

The factors of soil formation were considered in Unit 5. However, apart from these factors there are certain processes of soil formation that take place before we can talk of soil. These processes act both singly and collectively together to modify the inorganic rock debris in order to produce soil. There are two types of processes of soil formation. They are the simple and the complex types. In this unit, we will consider simple processes of soil formation. These simple processes are noted not only for their simplicity, but also for operating in specific parts of the soil profile. They refer to the physical, chemical and biological processes which make the soil. A number of the physical and chemical reactions pertain mainly to rock weathering and the synthesis of new, secondary minerals such as solution, hydration and reduction. A number of others also pertain specifically to soil formation and horizon differentiation e.g. leaching, eluviations, illuviation and precipitation. Besides all these, biological processes, such as humification, mineralization, ammonification, nitrification and denitrification are crucial to the pedogenic process.

2.0 Objectives

At the end of Unit 6, you will be expected to:

- Know the types of simple processes of soil formation,
- Differentiate the different types of the simple processes of soil formation and
- Identify different components of simple processes of soil formation.

3.1 Types of Soil Forming Processes

Soil forming processes are processes which act both singly and collectively to modify saprolite i.e. the inorganic rock debris, to produce the living soil. There are two types of soil forming processes. They are

- Simple processes of soil formation, and
- Complex processes of soil formation.

While simple processes of soil formation involve a single process, complex processes of soil formation involve a number of combined simple processes. Some simple soil forming processes include leaching, eluviations, illuviation, humification and mineralization, while examples of complex processes of soil formation are lateritisation, podsolization, calcification, salinisation and gleisation.

Simple processes – Physical and Chemical

Three processes will be discussed here. They are leaching, eluviations and illuviation. Leaching is the removal, in solution, of constituents from the soil. Hence, it operates mainly in humid environments but least affective in dry areas. It is fundamental to all the more complex soil forming processes such as lateritisation, podsolisation and calcification. The materials involved in the leaching process are mainly salts and carbonates that are the readily soluble minerals. Leaching may involve the complete loss of nutrients and other soil materials from the soil profile. Excessive leaching robs many soils of essential nutrients which can only be extracted by plants in soluble forms i.e. the very form in which they are leached from the soil. Do you know that leaching is both beneficial and destructive to soul? For example, toxic substances to plants such as sodium chloride are leached. Leaching is known to be the most important process of soil formation especially with respect to horizon differentiation.

Eluviation and Illuviation are closely related to leaching but not identical to it. Both processes refer to the movement of soil material in solution or in suspension from one place to another within the soil. There two processes operate mainly in areas where these is an excess of precipitation over evaporation.

Eluviation refers to translocation of mineral particles colloids and soluble salts within the soil. It may be vertical or lateral depending on the direction of soil water movement. In effect, horizons that lose materials through eluviations is referred to as eluvial horizons.

In relation to the soil profile, eluviations takes place in the A horizon while illuviation takes place in the B horizon.

3.3 Simple Processes – Biological

As stated earlier biological processes of soil formation include humification, mineralization, ammonification, nitrification and denitrification. While humification and mineralisation will be considered separately, the processes of ammonification, nitrification and denitrification will be considered together. Since they are all connected with the process of nitrogen fixation and nitrogen cycling in the atmosphere.

3.4 Biological processes – Humification

Is the process by which organic matter is decomposed and new organic complexes are synthesized to form humus or the organic component of the soil.

Humification is believed to be the most important process of soil formation since without it there cannot be any soil because it makes soil a living entity.

The major factor controlling humification is climate. This is because it has been observed that as climate changes from one type into another, the intensity of humification changes. Therefore, while humification process is rapid in the humid tropics and sub-humid tropics, it is of less intensity in the temperature regions and it is almost nil in the cold areas of the world.

Apart from climate, the type of vegetation also affects the humification process. Generally, woody plants contain large quantities of lignins, waxes and resins which are highly resistant to decomposition. They are also rich in tannins and other acid-producing substances which tend to subdue the activities of bacteria but stimulate fungus development. By contrast, in the grasslands, humification process in intense at the expense of mineralization process. The result is the accumulation or organic matter.

3.5 Biological Process - Mineralisation

Is the process whereby organic mineral elements in the soil organic matter are released and converted into organic minerals. The process involves the decomposition of organic matter to its fundamental components i.e. oxygen and other gases, water and minerals.

The process takes place simultaneously with humification mainly in the Ao layer but also at any other part of the soil profile where organic matter is present. However, unlike humification, which tends to increase the acid content of the humus complex, mineralization tends to decrease the acid and increase the base content of the soil, thus tending to make the soil alkaline.

3.6 Biological Processes – Other

Biological processes, is indicated earlier, relate to the processes of nitrogen fixation and nitrogen cycling in the biosphere. These related processes *are ammonification, nitrification and denitrification.*

It is known that the nitrogen content of most soils ranges from 0.2 to 0.4 percent. It is also known that the major part of this content is insoluble organic combination that is inaccessible to plants.

You need to also know that the most important aspect of the biological process, especially in relation to soil fertility, is perhaps nitrogen fixation by legumes. Nitrogen fixation is also known as *symbiotic fixation*. In this situation, some legumes are able to extract nitrogen from the soil atmosphere and incorporate it into their systems. This nitrogen is made available to other plants when the host plant dies and is ploughed back into the soil.

4.0 Conclusion

The simple processes of soil formation are examined in this Unit. As the name implies, simple processes of soil involve simple processes which may be physical, chemical or biological. Because of the close interaction between the physical and chemical forms of simple processes of soil formation, they are usually considered together. Their components are *leaching, eluviations and illuviation*. Leaching is the removal of soil constituents in solution. However, while eluviations is the translocation of mineral particles, colloids and soluble salts within the soil, illuviation refers to the deposition of colloids, soluble salts and small mineral particles in the soil layer.

The biological form of simple processes of soil formation deals with many processes that are brought together under three healings of humification, mineralization and those processes that fix nitrogen and make for its cycling. Humification refers to the process by which organic matter is decomposed and new organic complexes are synthesized to form humus whereas mineralization is that process whereby organic mineral elements in the soil organic matter are released and converted into organic minerals. The third type of biological process relates to nitrogen fixation and cycling in the biosphere. The related processes in this regard are ammonification, nitrification and denitrification.

5.0 Summary

Unit 6 of this course treats the simple processes of soil formation. It consists of physical, chemical and biological forms.

The physical and chemical forms are treated under leaching eluviations and illuviation processes. *Leaching* is the removal, in solution of constituents from the soil. Therefore, it operates mainly in the humid environments. Leaching is fundamental to the complex processes of soil formation like lateritisation and podsolisation. Salts and carbonates are mainly involved in the leaching process. It is known that leaching is both beneficial and destructive. While leaching removes toxic substance to plants, and is responsible for horizon differentiation, it robs many soils of essential nutrients needed by plants.

Eluviation is about the translocation of mineral particles, colloids and soluble salts within the soil either vertically or laterally depending on the direction of soil water movement. But *illuviation* is the deposition of materials removed in the eluvial horizon in another soil layer. It is important to note that eluviations normally takes place in the A horizon while illuviation is found in the B horizon.

The biological process of soil formation is made up of humification, mineralisation and the related nitrogen fixation and cycling processes in the biosphere. *Humification* is the process whereby organic matter is decomposed and new organic complexes are synthesized to form humus. It is believed that without humification process there will not be soil because humification maeks soil a living entity. Climate and the nature of vegetation are important determining factors of the intensity of humification. Humification process tends to increase acidity level of soil. *Mineralisation* is defined as the process whereby organic mineral elements in the soil organic matter are released and converted into organic minerals. The process involves the decomposition of organic matter to its fundamental components such as oxygen, and other gases, water and minerals. Mineralisation however, tends to decrease acidity level of soil thereby tending to make the soil alkaline.

The processes of ammonification, nitrification and denitrification are processes of nitrogen fixation and cycling in the biosphere. Generally, the nitrogen content of soil ranges from 0.2 to 0.4 percent. This aspect of nitrogen fixation by legumes is important to soil fertility and it is known as *symbiotic fixation.*

6.0 Tutor Marked Assignments

1. Describe the process of leaching in the soil horizon
2. Compare and contrast humification and mineralization processes as forms of soil forming processes.

7.0 References and Other Resources

Gerrard, A.J. (1981). *Soils and Landforms.* George Allen & Unwin, London.

Paton, T.R. (1978). *The Formation of Soil Material.* George Allen & Unwin, London.

UNIT 7: complex Processes of Soil Formation

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1.0 Introduction

You will recall that there are two types of processes of soil formation. These are the simple and complex processes of soil formation. In unit 6, the simple processes of soil formation were considered. Therefore, in this unit, we will consider the complex processes of soil formation.

Complex processes of soil formation are all distinguished mainly on climatic basis but they are by means mutually exclusive. It is necessary to point out that boundaries of these processes are not easy to established hence boundaries are arbitrary.

2.0 Objectives

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

- Identify the complex processes of soil formation;
- Know the different climatic regions and environments associated with complex processes of soil formation;
- Distinguish the basic characteristics of the complex processes of soil formation.

3.0 Main Contents

3.1 Forms of Complex Processes of Soil Formation

Do you remember that simple processes of soil formation involve single processes as discussed in unit 6? This idea will lead us to the fact that complex processes of soil formation involve a combination of a number of simple processes. The complex processes of soil formation include lateritisation, podsolisation, calcification, gleisation, salinisation and solodisation. As pointed out either these processes are not mutually exclusive.

3.2 Lateritisation Process

This is the process which forms laterites and lateritic soils. They are also known as latosols, oxisols and ferruginous tropical soils.

Lateritisation process operates mainly in the warm to hot humid regions particularly in the equatorial, tropical and monsoon climates of the world. In these hot climates, vegetation is luxuriant and this also helps lateritisation process. Another factor is topography. This is particularly important in relation to the groundwater situation as well as to the depth of the effective soil.

Some characteristics of lateritisation process are:

- Long and uninterrupted period of rock weathering and soil formation result in deep and intensely weathered parent material;
- Leaf fall from the luxuriant forest and its rapid decay keeps the basis in rapid circulation between soil and vegetation;
- Mineralization of organic matter is complete and rapid while the intense chemical weathering of rocks releases bases from the mineral fragments still remaining in the soil;
- Alteration of the high-silicate clays (montmorilonite and illite) into low-silicate days such as kaolinite to a point where only a residue of kaolin, iron and aluminium sesquioxides, in various degrees of hydration possess small inclusions or impurities;
- Formation of a stratified or an unstratified soil profile.

3.3 Podsolisation Process

Unlike lateritisation, *podsolisation* process is prevalent in the cool humid areas of Koppen's C and D climates. The word podsolisation is derived from the Russian term "podsol" meaning "ash underneath". The process produces the podsols and the podsolic soils. In these soils the profiles are distinct both in appearance and in their physical and chemical properties. It is for these reasons that the typical ideal soil profile is the podsol because of the clear-cut development of the horizons and parts thereof. It should also be noted that because of the high acid content of the soil solution with a pH level of between 3 and 4, the leaching, especially of the bases and soil colloids is much more intense than in any other soil.

Some other characteristics of podsolisation are the

- Presence of soluble bases (i.e. metallic cations) which are displaced from the soil colloidal interfaces and removed from the solum by groundwater;
- Availability of aluminium and iron sesquioxides that become mobile and susbsequently transported downward in the soil thus making the A_2 horizon somewhat lighter in colour than it was previously;
- Tendency of inorganic clays to be peptised and making it to be susceptible to dispersion and downward movement; and
- Tendency of an illuvial B horizon to develop at depth, as a result of the deposition of the susquioxides, lags, bases and humus which primarily results from reduction in soil acidity.

3.4 Calcification Process

This process is characteristics of low-rainfall areas, especially in the continental interiors. As such it is characteristic of the grassland regions, including the savannas, but especially the temperate grassland areas.

Other characteristics of calcification process include:

- The formation of a calcic horizon usually within the B or C horizon, and a mollic horizon or a soft friable surface horizon containing a high percentage of organic colloids, well saturated with calcium ions.
- The prevalence of lime in the soils thereby they are collectively called pedocals or soils of calcium;
- Some downward movement of solutions and materials takes place even though leaching is not prominent;
- The net loss of soil water because evapotranspiration exceeds precipitation;
- The precipitation of ions in the order calcium and magnesium bicarbonates followed by calcium sulphates, and
- The formation of a crust known as calcrete.

3.5 Gleisation Process

This process occurs in areas with impeded drainage conditions. In effect gleying can occur in any climate environment, i.e. within zonal soils. The presence of this process may be due to.

- topographic effects e.g. valley bottoms and swampy low-relief areas;
- geological influence e.g. poorly drained, clayey soils, and
- climate e.g. in the permafrost areas of the cold regions.

The soils formed under these conditions are grouped together as hydromorphic soils. The major characteristics of gleisation process are:

- mottling of soils especially where periodic drying takes place;
- the formation of an impervious horizon within the soil profile causing surface-water gleying;
- the formation of an impervious horizon beneath the soil profile causing groundwater gleying;

- the formation of homogeneously grey or grayish-white soils, and
- the production of mottles of rust-coloured ferric oxide making mottling a prominent feature of most hydromorphic soils.

4.0 Conclusion

In this unit, you would have noticed that complex processes of soil formation relate very much to climatic conditions especially with the element of rainfall. Hence, while *lateritisation* is found in warm to hot humid tropical areas, podsolisation process takes place in cool humid areas of temperate regions. In the case of calcification process, it is found in areas where rainfall is low especially in the continental interiors. Although, gleisation process could take place in any climatic environment the role of rainfall is important before we can have impeded drainage conditions.

5.0 Summary

You have been able to distinguish the simple and complex processes of soil formation. Specially, unit 7 deals with the complex processes of soil formation that involve a combination of a number of simple processes. In this unit four important soil formation processes are considered. They are lateritisation, podsolisation, calcification and gleisation. It is also important to note that these processes have certain distinguishing characteristics. Some of the important ones include.

- A long period of uninterrupted rock weathering with soil having deep weathered parent material; mineralization of organic matter and a formation of a stratified or unstratified soil profile in the case of *lateritisation* process;
- A high aid content; leaching of the bases and soil colloids more than in any other soil; availability of mobile aluminium and iron sesquioxides in the A_2 horizon which are subsequently transported and a clear-cut development of the soil horizons in the case of podsolisation process;
- The formation of a calcic and mollic horizons; prevalence of line in the soils bringing about pedocals; net loss of soil water; the precipitation of ions and the formation of calcrete in the case of calcification process;
- The mottling of soils due to periodic drying; formation of impervious horizon beneath the soil profile; formation of uniform grayish-white soils and production of rust-coloured ferric oxide mottles denoting hydromorphic conditions in the case of *gleisation* process.

6.0 Tutor's Marked Assignment

1. In a tabular form compare five characteristics of lateritisation and podsolisation processes of soil formation.

2. Discuss a soil formation process that is not necessarily depend on climate.

7.0 References and Other Resources

Gerrard, A. J. (1981). *Soils and Landforms.* George Allen & Unwin, London.

Paton, T.R. (1978). *The Formation of Soil Material.* George Allen & Unwin, London.

UNIT 8: MAJOR SOIL TYPES OF THE WORLD

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1.0 Introduction

Now that we are familiar with the factor and processes of soil formation, we can now go onto consider some major soil types of the world. It is important to know that we cannot discuss all the various soil types of the world. We can only attempt to know some key ones. In that respect we will consider soil types of the world under three broad groups. These are *zonal intra-zonal* and *azonal* soil types of the world. The recognization of these soil types was based on genetic classification which we will discuss fully in the next unit.

2.0 Objectives

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

- List the major three soil types of the world based on genetic classification;
- Distinguish some soils of the zonal types;
- Identify the causes of intra-zonal soil types and
- Locate topographic conditions that bring about azonal soil types.

3.0 Main Contents

3.1 Main Types of Soils

Three main types of soils have been recognized using the genetic approach. These soils include the azonal, intrazonal and azonal types.

Since climate exerts a lot of influence on weathering, water content and plant cover, the basis of a broad analysis of major zonal soil types is climatological. Naturally, these soils occur most commonly on latitudinal zones. Zonal soils occur most commonly on gently undulating land where drainage is relatively free and where the parent materials exerts little or no influence on soil formation.

Intrazonal soil types occur where special conditions of relief or parent material exert a stronger influence on the soil than climate or vegetation. These soil types depend on a specific kind of parent rock; on the presence of much water; or on a coastal habitat.

Azonal soil types are without well-developed characteristics either because they are relatively young or because the parent material and relief conditions have prevented the development of more definite characteristics.

3.2 Some Types of Zonal Soils

The zonal soil types we will consider here are tundra podsol, chernozem tropical soils.

Tundra soils are found in very cold areas around the polar margin where the subsoil is under permafrost i.e. permanently frozen. The topsoil is frozen in winter but not in summer due to melting. In summer, some vegetation colonises the soil especially lichens, mosses, ferns and worths.

Podsols are found mainly in Eurasia and North America where they develop on glacial drifts where the land surface is covered by coniferous forests. Soil surface horizons contain pine needles and cones and these decompose very slowly because they are resinous. Leaching is severe and the soil is very acidic.

Chernozem soils underlie most of the temperate grasslands of the world in places like central Russia, Ukraine, Romania, Hungary, North American States of North Dakota and Texas, south eastern Australia and Argentina. Cherokee soils are very rich in humus and they occur over a variety of bedrocks. Hence, they are highly climate-dependent. Areas covered by chernozems constitute the great wheat lands of the world.

Tropical Soils are very complex because they comprise a variety of soils known as latosols. They are found within the tropics that experience, in most cases, alternate wet and dry conditions. Furthermore, rocks are known to be deeply weathered giving rise to deep soil. There are four main types of tropical soils. They are ferralitic and ferruginous soils, ferrisols and vertisols. *Ferralitic* soils are intensely weathered and leached due to exposure to pedological agencies over a long period of time. The soils are brilliantly red, porous and friable. They are associated with extremely old surfaces up to the Tertiary Age. *Ferruginous* soils are reddish brown and are found mostly in the savanna and areas of monsoon climate. Although weathering may not be quite deep, grass cover provides some amount of organic matter content with a fairly large amount of humus. This makes it more fertile than the ferralitic soils and the ferrisols. *Ferrisols* are also highly leached but weathered to great depths. They are commonly found where the surface is liable to constant erosion while weathering goes on below. *Vertisols* are associated with depression with fine clay sediments and organic matter content making the soil relatively fertile. Vertisols could expand and contract because of high content of clay minerals especially the montmorillonite group.

3.3 Some Types of Intra-zonal Soils

Here, we will consider the saline, peat and calcareous soils. *Saline soils* are those in which soluble salts are present in large quantity. They are widespread in areas of high evaporation especially in deserts and in the cooler continental interiors. The strong salt solution rises by capillarity and usually forms a grayish surface crust below which there is a granular salt-impregnated horizon. Typical saline soils are called *solonchaks*. However, solonetz soils occur when there is a rather higher rainfall that could leach some of the surface salts thereby making the B horizon highly saline.

Peat soils are formed when soils are waterlogged, air is virtually absent, fen organisms are found making bacteriological activity greatly reduced. Instead of the chemical processes of oxidation producing nitrates, carbon dioxide, sulphates and ferric oxides, reduction takes place forming ammonia, sulphates and ferrous oxides. When soil forming processes are allowed to act on an accumulation of peat, either by natural changes such as increasing aridity or by the work of man, notably drainage and deep-ploughing, peat may form a rich organic soil. Examples of peat soils are *fen-peat soils, meadow soils, bog-peat soils* and *dry-peat soils.*

3.4 Some Types of Azonal Soils

The major azonal soils that will be considered include alluvial, marine and volcanic soils.

Alluvial soils are derived from a mixture of sand, silt and clay, consisting of well-mixed rock wastes transported and re-deposited in beds by running water and replenished at times of floods. Alluvial sols are good agricultural soils. Some alluvial plains, especially those of south-eastern Asia, form great areas of intensive cultivation and of dense population.

Marine soils are derived from marine materials built up along low-lying coasts in the form of mud-banks, sand-banks and dunes by natural processes but sometimes stimulated by artificial reclamation. In countries like Belgium, the Netherlands and Germany dykes are used for draining the low-lying coasts producing various soils developed on marine clays. Such soils are known as polders.

Volcanic soils result from the deposits of lava and ash produced by volcanic activities. These volcanic materials weather easily and are usually transported lower than the slope of volcanoes by rain-wash and torrents. Around a volcanic site, the new higher lava forms bare grey sheets while the lower weathered materials are immensely fertile and are usually cultivated.

4.0 Conclusion

We have briefly looked at the major soil types of the world in this unit. You could have observed that zonal soil types are closely associated with climate. Hence, they are commonly found latitudinally i.e. whatever their parent materials may be, they are influenced by the prevailing climate within the latitudes they are found. In the case of intra-zonal soils, climate plays only a little role while special conditions of relief or parent material exert a stronger influence. Azonal soil types result from quite young parent material and under relief conditions that have not allowed the development of definite characteristics.

5.0 Summary

By now you should be able to grasp the fact that there are three main soil types all over the world. These are called zonal, intra-zonal and azonal soils.

As earlier stated, zonal soils are influenced a lot by climate notwithstanding their types of parent materials. For instance, in very cold areas, we have tundra soils that are shallow with their subsoil horizons under permafrost. Indeed, tundra soils have frozen topsoils in winter. Podsols and chernozems are found in temperate regions. While the former occur under forest, the latter are found under temperate grasslands. Lastly, we have our own tropical soils which are very complex. Their various types include the ferralitic and ferruginous soils, ferrisols and vertisols.

For the intra-zonal soils there are saline, peat and calcareous types. Saline soils have plenty of soluble salts present in them and are mostly found in areas of high evaporation. Typical types of saline salts are solonchaks and solonetz. Peat soils include fen-peat, bog-peat, dry-peat and meadow soils. Calcareous soils are mainly rendzina and *terra rossa* types. They are formed on limestones and chalk as parent materials. Whiel rendzina soils are dark-colorued, *terra rossa* soils are reddish in colour.

The major types of azonal soils are alluvial, marine and volcanic soils. Both alluvial and volcanic soils could be quite fertile hereby supporting agricultural practices. However, marine soils, found along low-lying coasts, may only be made cultivable through artificial means such as dykes and reclamation.

6.0 Tutor's Marked Assignments

1. Describe the types of soils that are greatly affected by climate

2. Select any two examples each from intra-zonal and azonal soils and indicate their differences.

7.0 References and Other Resources

Ahm, P. M. (1970). *West African soils.* Oxford University Press, London.

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Faniran, A. and Ojo, O. (1980). Man's Physical Environment. Heinemann, Ibadan.

Jeje, L. K.; Ekanade, O. and Osunade, M.A.A. (1996). *Man's Environmental Relations*. Macmillan Nigeria Publisher Ltd., Lagos and Ibadan.

UNIT 9: TRADITIONAL SOIL CLASSIFICATION SYSTEMS

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1.0 Introduction

In the last unit, we briefly looked at the major soil types of the world. In the present unit, our focus will be the traditional soil classificatory systems. Do you know that soil classification is a way of organizing soils in order to understand their important attributes and the relationships between the various attributes of such soils? In fact, soil classification is an attempt to introduce order into a chaotic situation of complex and infinite variety of differences of soil types both in space and in time.

Generally, soil classification has been done by arranging them into assemblages according to selected characteristics properties. There are several ways of classifying soils which relate to each discipline such as agronomy, pedology, engineering, geography, geology etc. However, no classificatory system is mutually exclusive i.e. none stands alone.

2.0 Objectives

By the time you finish with this unit, you should be able to:

- define soil classification
- identify the three types of the traditional soil classificatory systems;
- distinguish the various methods used for the traditional classificatory systems of soils and
- differentiate the various types of the traditional soil classificatory systems.

3.1 Traditional Classification of Soils

As earlier indicate, soil classification could simple be defined as the arrangement of soils into assemblages according to certain inherent characteristic properties of such soils. Through these processes, their important attributes will not only be known, the relationships among the soil attributes will also be understood.

There are three main traditional classificatory approaches of soil worldwide. These are the empirical or generic system, the morphological system and the genetic system. In subsequently sub-sections, each of them will be considered in some details.

3.2 Empirical classification of Soils

Do you recollect that empirical classification of soils is also known as generic classification of soils? It is the oldest system of soil classification in which the properties that appear to be significant in the use of virgin soils for crop growths are used.

Two major soil properties have been used in the USA soil surveys. These are texture of the topsoil and the type of parent material. The texture of the topsoil has been used primarily because the general ease of cultivating a soil has been closely related to it. Soil texture is also perhaps the most important as far as soil fertility and productivity, including response to soil treatment, are concerned. As for the parent material, it is considered to be the determinant of soil texture and, even soil structure, and so invariably of the fertility of virgin soils.

In the empirical soil classificatory system, some other observable properties of soil like colour, depth, pH, nutrient content, base exchange capacity, clay fractions etc. could also be used for this system. For example, Australia has successfully used soil colour in this regard. It has been observed that empirical soil classification based on chemical properties of soils such as pH and base content are very common in the agronomic literature.

Note that this early system of soil classification is still being used particularly at the local level such as series and soil type levels. Soil serves are usually distinguished on account of profile characteristics. On the other hand, soil types are distinguished by the surface textual class such as silt, silt-loam, sandy loam and loam.

3.3 Morphological classification of Soils

Morphological classification of soils is the system in which the structure and development processes of soil profile are considered. These may be internal or external. The main aim of this system is to infer genesis from profile characteristics. Morphological classification of soils is mainly at the series level in which a number of similar soil types are grouped together. This system also utilizes properties such as colour and texture. It is for this reason that this system of soil classification is frequently mixed up with the empirical system of soil classification.

3.4 Genetic Classification of Soils

Genetic classification of soils is based on the relationship between soils and the climatic characteristics. This classificatory system is therefore based on the idea that each soil has a definite form and a structure that is relatable to a combination of soil forming factors which are found in certain climatic zones. Important among soil forming factors are the parent material, weathering processes, leaching and the organic matter supply. Indeed, apart from the parent material, at the other factors are more or less climate controlled.

Local parent materials is important to the extent of imparting certain soil characteristics like the texture and the inherent chemical minerals. However, climate determines the rate of weathering, leaching and the production of organic matter supply and its decay. For instance, it is known that leaching and eluviation processes, rock weathering and decay of organic matter are more pronounced under moist, warm humid climates than under dry climates. Therefore, given the same parent material under different climatic zones, different types of mature soils will likely evolve; and this is the basis and the sum total of zonal soil concept.

It is necessary to point out that the genetic soil classification was suggested by Dokuchaer, a Russian soil scientist as far back as 1880. Dockuchaev noticed that by moving from the polar area to the equatorial area, the soils in the different climatic zones vary, notwithstanding the nature of the parent material. However, this classificatory system has since been developed by the European and American soil scientists.

4.0 Conclusion

We have attempted to look at the traditional soil classificatory systems. Three traditional systems of soil classification are identified. They include the *empirical,* the *morphological* and the genetic systems. The oldest of these systems is the empirical or generic classificatory system of soil. This system makes use of the properties of soil that appear to be significant especially soil texture and parent material. In the case of morphological system, the structure and the development processes of soil profile are usually considered. Genetic classification of soils is mainly related to climate.

5.0 Summary

In this unit, we have been able to define what soil classification is, and can easily mention the three main traditional classificatory types i.e. empirical, morphological and genetic types. We have also identified the various methods used to identify these traditional soil classificatory systems.

Do you remember that empirical classification of soils is the oldest system of soil classification? Here, topsoil texture and parent material have been used mainly to achieve this soil classification. Some attempts have also been made to use some other observable properties of soil such as colour, depth, clay fractions and pH.

Genetic classificatory system of soils is based on soil-climate relationships. It is clear from this classification that soil related so closely to the climate and that even given similar prevent materials the evolving soil type will be shaped by climate. This brings about the idea of zonal soil concept. Note that it was Dockucheav, a Russian soil scientist that first suggested genetic soil classification.

6.0 Tutor's Marked Assignments

1. What do you understand by traditional soil classification? Name three of them.

2. Write very concise notes on empirical and genetic types of soil classification.

7.0 References and Other Resources

Brady, N. C. (1996). *The Nature and Properties of Soils.* Macmillan, New York.

Cruickshank, J. G. (1972). *Soil Geography.* David and Charles, Newton Abbot.

Faniran, A. and Areola, O. (1978). *Essentials of Soil Study.* Heinemann, Ibadan

Jeje, L. K.; Ekanade, O. and Osunade, M.A.A. (1996). *Man's Environmental Relations.* Macmillan Nigeria Publisher Ltd., Lagos and Ibadan.

UNIT 10: INTEGRATIVE SOIL CLASSIFICATION SYSTEMS

Table of Contents

1.0 Introduction

Do you know that opinion is still widely divided among pedologists and soil scientists as to which of the traditional systems of soil classification is best to use? As a result of this, most of the soil classification systems in use today attempt to combine features of these approaches. Hence, soils are common arranged in a hierarchical order or in an upward and integrative assemblage such as soil type, soil series and soil order.

Therefore, in these units, we will consider how two organizations have evolved some soil classification systems that are accepted to a large extent. These are the United States Department of Agriculture (USDA) and the Food and Agriculture (FOA).

2.0 Objectives

By the time you finishes with this unit, you should be able to:

- Know how integrative systems of soil classification are achieved;
- List some integrative systems of soil classification in use nowadays;
- Distinguish the characteristics of two the integrative systems of soil classification soil.

3.0 Main Contents

3.1 Integrative classification of Soils

As indicated earlier, integrative soil classification systems emerged as a result of differences of opinion in the way traditional systems of soil classifications were done. Integrative classification of soils simply implies bringing together some methods which will make classification holistic other than segmental. In integrative systems of soil classification, soils type or soil series to soil order.

There are many available systems under the integrative classification systems of soil. Examples are the Seventh Approximation Soil Classification USDA, the Australian Systems of Soil Classification Systems in Europe and the UNESCO/FAO System of Soil Classification. In this unit, we will consider two integrative classification systems that are commonly used. These are the USDA and the FAO classification systems.

3.2 Seventh Approximation Soil Classification

This soil classification system was developed by USDA in 1974. This system is based on the morphological characteristics of the soil profile and especially on the recognition of certain diagnostic horizons which reflect the dominant soil-forming processes and environments. It is a system that adopts, to some extent, the principles of zonal, intrazonal and azonal grouping of soils. The names used in this classification have classical language roots in botany and zoology, utilizing Latin or Greek roots words as the bases for the names.

3.2.1 Advantages of the Seventh Approximation Soil Classification

The major advantages of the USDA's classification are that it

- Permits classification of soils rather than soil forming processes.
- Focuses on the soil rather than related sciences such as climatology.
- Permits the classification of soils of unknown genesis since it is only the knowledge for their properties that is needed.
- Permits greater uniformity of classification as applied by a large number of soil researchers.

3.2.2. Twelve Soil Orders

In the Seventh Approximation Soil Classification, there are six categories of classification. They include order, suborder, Great group, Sub-group, Family and Series. While Order is the broadest group, series is the most specific category.

In this study, we will concern ourselves with the order category. The order category is based largely on morphology and a given Order includes soils whose properties suggest that they are not too dissimilar in their genesis. For example, soils developed under grassland vegetation have the same general sequence of horizons and are characterized by a thick, dark, surface horizon that is high in bases and are grouped as Mollisol Order.

There are twelve Soil Orders in the Seventh Approximation Soil Classification of USDA. They are now listed indicating their characteristics as well.
Gelisols: There are soils with permafrost within 2 metres of the surface.
Histosols: These are soils with a surface organic layer of at least 30 – 45cm thick.
Spodosols: They are acid forest soils with a subsurface accumulation of iron and aluminium oxide.
Andisols: They are soils formed in volcanic ash.
Oxisols: These are soils that are intensely weathered and are mostly found in tropical and subtropical environments.
Vertisols: They are dark clayey soils that have high capacity to shrink and swell.
Aridisols: They are soils of arid environments with subsurface horizon development.
Ultisols: These are strongly leached soils with a subsurface zone of clay accumulation and less than 35% base saturation.
Mollisols: These are soils with dark brown to black surface horizons possessing high base status.
Alfisols: These are moderately leached soils with a subsurface zone of silicate clay accumulation and more than 35% base saturation.
Inceptisols: These are young soils with profile features that are weakly developed in subsurface horizons.
Entisols: They are soils with little or no profile or morphological development.

3.3 The FAO Soil Classification

The FAO developed what can be called a supra-national soil classification i.e. World Soil Classification. This classification conveys useful generalizations about the genesis of soils in relation to the interactive effects of the main soil-forming factors. It was first published in form of the UNESCO Soil Map of the World in 1974 at a scale of 1 to 5 million. It makes class separations on the basis of diagnostic horizons.

The major criteria used include soil phases, textural classes and slope classes to arrive at 106 soil Units which are mapped as Soil Association. Soil Units have been grouped on the basis of generally accepted principles of soil formation to arrive at 26 World Classes.

The FAO soil map is far from being ideal but it is the only truly international system, incorporating Soil Units used all over the world and most soils can be accommodated on the basis of their field descriptions. Therefore, you should be aware that the FAO soil classification is intended for classifying soils at a continental scale rather than at a local scale.

3.3.1 The FAO Soil Classes

As stated earlier, the FAO soil Classification grouped world soils into 26 classes. These are Cresols; and Soils; Arenosols; Cambisols; Chernozems; Ferrasols; Fluvisols; Gleysols; Greyzems; Histosols; Kastanozems; Lithosols; Luvisols; Nitosols; Phaeozems; Planosols; Podzols; Podzoluvisols; Rankers; Regosols; Rendzinas; Solonchaks; Solonetz; Vertisols; Xerosols and Yermosols.

4.0 Conclusion

In this unit, we have briefly considered how institutional classification of soils have been done by various organizations the world over including the FAO which is an agency of the United Nations Organization (UNO). These classification systems are referred to as integrative as a result of upward and hierarchical assemblage. In this study, the USDA's Seventh Approximation Soil Classification that of FAO have been considered. While it can be said that the Seventh Approximation classification has twelve soil orders, the FAO classification has 26 classes.

5.0 Summary

Our concern in this unit is the consideration of integrative soil classification systems. Two of these systems are considered. They are those of United States Department of Agriculture and the Food and Agriculture Organization. The USDA's Seventh Approximation Classification system is based on morphology and possess some advantages such as permitting classification of soils rather than soil forming processes and greater uniformity of classification by many soil scientists. I am sure you remember that this classification system has six categories with the ***Order*** being the broadest one while the ***Series*** is the most specific category. You need to recollect too that there are 12 soil Orders.

The FAO Soil Classification is known to be a supra-national soil classification. You must not forget that it was first published in 1974 as the UNESCO Soil Map of the World and at a scale of 1 to 5 million. Could you list the major criteria used? Well, let me assist you here for now. They are soil phases, textural classes and slope classes. There are 106 soil Units mapped as Associations. From these 106 soil units, 26 World Soil Classes are derived. Note that the FAO soil classification is far from being ideal but it is the only truly international system.

6.0 Tutor's Marked Assignments

- List the advantages of the Seventh Approximation Soil Classification
- Write a short note on the FAO Soil Classification System.

7.0 References and Other Resources

Brady, N. C. (1996). *The Nature and Properties of Soils.* Macmillan, New York.

Cruickshank, J. G. (1972). *Soil Geography.* David and Charles, Newton Abbot.

Faniran, A. and Areola, O. (1978). *Essentials of Soil Study.* Heinemann, Ibadan

Jeje, L. K.; Ekanade, O. and Osunade, M.A.A. (1996). *Man's Environmental Relations.* Macmillan Nigeria Publisher Ltd., Lagos and Ibadan.

UNIT 11: SOIL EROSION

Table of Contents

1.0 Introduction

We have been talking about different aspects of soil. The aspect we start considering in this unit is so important to mankind. Do you remember that soil is regarded as a resource? And that when it is injudiciously used, soil is robbed of its fertility. The major process that robs soil of its fertility quickly is soil erosion. Therefore, we are going to see what erosion is, its types and its agents. We will also attempt to indicate the factors of soil erosion.

2.0 Objectives

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

- Define soil erosion;
- Identify types of erosion;
- Describe agents and forms of soil erosion, and
- Enumerate and discuss factors of soil erosion

3.0 Main Contents

3.1 What is Soil Erosion?

Soil erosion could be defined as the detachment and removal of the topsoil either partially or completely by water, wind and ice especially by water and wind.

3.2 Types of Erosion

There are two main types of erosion. They are:
(i) normal geological erosion and
(ii) accelerated soil erosion.

Normal geological erosion is widespread. It occurs whenever there is a flow of energy and matter on the earth's surface. As it is very slow, it is not injurious to the soil cover of the world. More often than not, its rate is slower than, or at worst on a par with the rate of soil formation and renewal. Its effect is therefore rarely noticeable.

Accelerated soil erosion is usually associated with man's activities. As a result of its spectacular nature, it is the one that attracts man's attention. Its side-effects include the physical loss of the soil constituents leading to severe economic loss as a result of reduced crop yield or total crop failure. Accelerated soil erosion may also result in a total loss of farmlands to gully erosion. Its may also increase sediment yield and pollutants of streams rivers, lakes and oater water bodies.

3.3 Agents and Forms of Erosion

The most common agents of erosion are water and wind. Ice is also recognized as an agent of erosion but not as effective as both water and wind.

It is important for you to know that soil erosion by water is known to be the most common. This is because it affects the largest parts of agricultural world. There are three forms of soil erosion by water. They include rills, sheets and gullies.

Rills are parallel shallow, narrow channels on bare hill-slopes. They are especially common where the subsoil is poorly permeable as to allow surface flow.

Sheet erosion occurs where turbulent unchannelled flow exerts more energy than soil cohesion can resist. The removal of soil in sheet erosion may not be very noticeable but it removes the topmost soil.

Gully is a channel cut so deeply into the underlying material. Gullying is a very serious form of soil erosion especially in agricultural areas. Gullies are very common in many parts of Anambra, Imo, Edo, Plateau, Kwara and Kaduna State, all in Nigeria.

Wind is principally an agent of sheet erosion, with very devastating results. Wind erosion occurs in wide, flat areas where winds blow strongly, where there are no wind-breaks and where the soil is dry and unprotected by plant cover. Areas of semi-arid and arid continental plains are especially notable for wind erosion. It is, therefore, partly, if not entirely, a dry weather phenomenon.

Another very important point to note is that the degree of wind erosion is very largely related to wind strength. Wind velocity tends to be highest in wide, open, level areas, for there is nothing to impede its progress. Furthermore, in areas subject to wind erosion, not only is the land denuded of its richest soil but any growing crops may be destroyed or serious damaged.

3.4 Physical Factors of Soil Erosion

There are two main factors responsible for accelerated soil erosion. These are physical and human factors. In this section we will consider the physical factors.

Physical factors of soil erosion are natural factors that could bring about soil erosion. They include the nature of the soil itself, the nature of the land surface or topography, climate and vegetation cover.

Nature of Soil: concerns such attributes as infiltration capacity, permeability and water holding capacity. In as much as all these are low erosion will take place once the land surface is disturbed.

Topographic factor of soil erosion is exemplified by the type of slopes found in an area. Soil erosion on slopes tends to vary with both the degree and length of slope. Generally, the rate of soil loss increases with increase in slope angle and slope length. It is to be noted that soil erosion rates differ on the slope form i.e. convex, concave and even. Concave slope form is the most susceptible form of slope to rapid soil erosion.

Climate influences soil erosion in two main ways. First, it dictates whether the erosive agent will be water, wind or ice. Secondly, climate regulates the intensity of soil erosion.

Vegetation cover usually protects the soil from being eroded but where vegetation covers non-existent or scarce, soil erosion is common. Vegetation cover disallows direct raindrop impact on the soil by reducing the quantity of rainfall that reaches the soil surface. It also improves soil structure and increases infiltration capacity of the soil. Roots of plants also make soil firm and stable.

3.5 Human Factors of Soil erosion

The human factor in soil erosion is depicted through man's activities that include farming, grazing, mining, industrialization, urbanization and indeed, civil engineering constructions. All these activities disturb the delicate balance of terrestrial ecosystems that may induce accelerated soil erosion.

Agriculture is, perhaps, the most important cause of soil erosion, principally because of its widespread occurrence. Agriculture, particularly arable farming involves the removal, wholly or partly, of the original vegetation. Note, however, that the extent of soil erosion will depend on the system of cultivation, the intensity of cultivation and the types of crops grown.

Grazing of animals can also lead to soil erosion. The constant removal of vegetal cover by cattle, sheep and goats leads to the exposure of the land surface to the harsh effects of rainfall.

Mining activities render vast areas valueless for other land uses. These usually lead to land shortage resulting to pressure on the land, land exhaustion, and consequently excessive soil erosion. A very good example of this is provided by the Jos Plateau where tin and columbite ores have been mined for many decades.

Engineering Constructions also lead to erosion which may take the form of gully. Similarly, footpaths, roads, settlements and market places can cause accelerated soil erosion since all of them concentrate runoff which initiates channelized soil erosion after they have stripped the soil of its vegetation.

4.0 Conclusion

You can see that this unit has opened your eyes to the fact that when soil, as a resource, is misused or mismanaged, erosion takes place. And do you remember the definition of soil erosion? It is the detachment and removal of the topsoil. The types, agents and form of soil erosion are considered and it is observed that while water erosion is the most prevalent, wind erosion occurs in arid and semi-arid lands. The worst form of soil erosion is the gully. It is important to note that certain factors are responsible for soil erosion. These are divided into physical and human factors.

5.0 Summary

Soil erosion has been defined as the detachment and removal of the topsoil either completely or partially. There are normal geological erosion which occurs but whose effect on soil removal is so negligible; and accelerated soil erosion whose effects are quite noticeable on the land surface. The most common *agents* of soil erosion are *water* and *wind* but ice is also regarded as an important agent as well. Water erosion is of three main forms. They are *rills*, sheets and gullies. Gullies are the most prominent, destructive and dangerous. In fact, their effects are the concerns, not only of the Local Government Areas in which they are found, but also of those the states, Federal Government and International Agencies in Nigeria. Wind erosion is found mainly in arid and semi-arid areas of the world. Note that the extent of wind erosion is largely related to the strength of the wind.

A set of factors have been identified for bringing about accelerated soil erosion. They are divided into *physical* and *human* factors. Physical factors are natural including the nature of soil, the topography, climate and vegetation cover. However, human factors result from activities on the land surface. These could include agriculture, grazing, mining and engineering constructions.

6.0 Tutor's Marked Assignments

- Define soil erosion and discuss the forms of soil erosion arising from water.
- Enumerate the main factors of accelerated soil erosion and fully discuss any one of them.

7.0 References and Other Resources

Ahm, P. M. (1970). *West African Soils.* Oxford University Press, London

Brady, N.C. (1996). *The Nature and Properties of Soils*. Macmillan, New York.

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Sanchez, P. A. (1976). *Properties and Management of Soils in the Tropics.* John Wiley, New York.

UNIT 12: SOIL CONSERVATION

Table of Contents

1.0 Introduction

In the last unit we discussed soil erosion. Then we examined what soil erosion is. We also discussed its types, forms and factors. In this unit we are going to look at how we can conserve our soils and make them useful to us. Therefore, be prepared to know what to do when a land is eroded. Three main practices are common. They include managing soil when it is being cultivated in a sustainable manner; applying certain control techniques and reclaiming of land that is already damaged by accelerated soil erosion.

2.0 Objectives

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

- Know what soil conservation objectives are,
- Recognize the soil conservation practice,
- Discuss the various conservation practices.

3.0 Main Contents

3.1 Soil Conservation and Its Objectives

In the course of this study, it has been pointed out that it takes a long time for any soil to form. Similarly, it has been indicated that the same soil can be lost very easily. This brings about the issue of soil conservation. By definition, soil conservation is the protection of soil against erosion or deterioration. It can also be regarded as the preservation and careful management of soil resources for sustainable development.

The objectives of soil conservation are to:
(i) minimize the rate of soil loss attendant on the use of land for agriculture and other purposes; and
(ii) render suitable for cultivation land which has been wasted by accelerated soil erosion.

3.2 Categories of Soil conservation Practices

It has been stated earlier that when soil is mismanaged, soil deterioration occurs. This is usually followed by accelerated soil erosion in differing degrees. Since this is the case, it is important that steps should be taken to halt soil erosion whenever there are signs of its actions. This is because, once soil erosion has occurred and the topsoil has been lost, it takes a lot of effort to bring it back to its former status.

The practices of soil conservation in order to achieve the objectives stated in Section 3.1 fall mainly into three categories. These are:
(i) soil management practice;
(ii) soil erosion control techniques; and
(iii) land reclamation practice.

3.3 Soil Management Practice

The first category of soil conservation practices as indicated earlier is the introduction of soil management ideas and practices into routine farming operations. These operations could include the promotion of wise use of the land so as to conserve its natural fertility or replace it with artificial fertilizers. You should note that these practices are in form of scientific or indigenous farming which involves crop rotation, the sue of cover crops, fertilizers, manures and mulching. Furthermore, this soil management practice could also involve the sensible tillage such as zero tillage, aimed at preserving the soil cover of farmlands.

3.4 Soil Erosion Control Techniques

The second category of soil conservation practices is the use of certain basic techniques for controlling erosion, such as **contour farming, strip cropping and terracing.** The technique adopted will be dictated by the type of cropping and nature of relief so as to reduce soil erosion on agricultural land.

Contour farming involves planting in rows or operating farm equipment across the slope. This method helps to conserve soil and water as the rows of ridges or crops, or both, act to check water flow. This method has been effectively used in USA with soil and water losses were drastically reduced even on high slopes thereby increasing farm yields substantially.

Strip cropping is the practice of planting alternate strips with close-growing row or grain crops following the contour across a slope. This system is usually adopted on slopes that are too steep to terrace. In the same manner of contour farming, strip cropping also slows down runoff water flowing through the close-growing strip. It also increases the infiltration rate which further reduces total runoff. In addition, the crops grown intercept raindrops and so reduce both splash and sheet erosion.

Terracing involves the building of mud embankments or a combination of channels and embankments across slopes, usually at fixed intervals. Terracing may also involve creating flat or nearly flat surfaces along slopes that are normally too steep for cultivation. Generally, terracing controls erosion by reducing slope length as well as slope steepness. It also slows down runoff which may also be conducted across the slope in definite channels where it flows at non-erosive velocity. Examples of terraces are common in Anambra, Enugu and Plateau States in Nigeria.

3.5 Land Reclamation Practice

When accelerated soil erosion is not checked the affected land surface becomes a bad land i.e. a land that is almost useless for any use. However, such land could be reclaimed through afforestation, the reservation of whole areas to prevent or minimize the effects of human activities and the filling of pits. For the success of this third category of soil conservation, the cooperation and total involvement of the local people is needed. More often than not, the governments or agencies usually undertake reclamation projects. In some cases, the projects may be executed through the local people or directly by the government or agency.

4.0 Conclusion

In this unit we have seen that when accelerated soil erosion occurs, it is possible to take steps to regain the land. Furthermore, it is also indicated that efforts could be made to prevent accelerated soil erosion from taking place. In order to achieve the objectives of soil conservation three categories of soil conservation processes are usually effected. These include soil management practice, soil erosion control techniques and land reclamation practice. The first two categories of soil conservation practices are necessary in order to make the use of soil sustainable. The third category of soil conservation practices is done to restore an already bad land surface.

5.0 Summary

We have seen that soil as a resource could be misused by man. When this happens soil erosion occurs. However, in this unit, we have seen that efforts can be made to avert soil erosion; and that even when it is inevitable, steps can also be taken restore it. Therefore, the main objectives of soil conservation are to minimize the rate of soil loss and to render suitable for cultivation purposes land that has been wasted by accelerated soil erosion.

There are three major ways by which soil conservation practices are achieved. The first one concerns managing the soil sustainably in the process of cultivation such as using manure, chemical fertilizers and mulching. The second way is the adoption of certain soil erosion control techniques that will be used to check accelerated soil erosion. These techniques are contour farming, strip cropping arid terracing. Land reclamation practice is the third way by which soil conservation could achieved in places that have been badly damaged by accelerated soil erosion. This category of soil conservation is usually embarked upon by governments and agencies with the cooperation of local population.

6.0 Tutor's Marked Assignments

1. Define soil conservation and state its objectives.
2. Discuss the techniques involved in soil erosion control.

7.0 References and Other Resources

Ahm, P. M. (1970). *West African Soils.* Oxford University Press, London

Brady, N.C. (1996). *The Nature and Properties of Soils*. Macmillan, New York.

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