Section C

SOILS

This is defined as a thin layer of loose unconsolidated materials on the earth's surface. It provides a medium for plants and animals to grow.

Soil basically results from the breakdown of parent rock through weathering processes I.e physical and chemical weathering lead to the disintegration and decomposition of rocks into regolith. The weathered material may then be modified by other soil forming processes to give a wide range of soil types. The soil formed may combine with organic matter to give an ideal soil type.

Soils have different elements or components that may include air, water, temperature, organic matter, inorganic matter ,living organisms and others.

Organic matter ; This consists of the remains of plants and animals though much of it is derived from vegetation for example leaves, grass, roots and branches. Such materials under go gradual decomposition which converts them into humas. The humas has a pronounced effect on soil as it's the major source of plant nutrients such as sulphur ,phosphates nitrates etc and therefore soil fertility,gives soil a losseness and aeration capacity that is favourable for plant growth,helps soil to develop and maintain a structure.

Inorganic matter; This is derived from the break down of rocks ie it consists of weathered rock materials and it is the major source of minerals required by plants and animals living in the soil. The minerals are both primary and secondary.primary minerals are compounds present in the unaltered rocks for example silicate,silicon , aluminum, calcium , sodium, iron and magnesium while the secondary minerals develop from the former(primary) having under gone alteration. NB inorganic matter forms the largest portion of soil.

Soil Air; The air present in soil is attained from the atmosphere for example corbon dioxide and methane a blessed day and in high levels and oxgen in low levels. Air enters soil through pore spaces. This air is meant for respiration and germination as well as enabling plants and animals obtain energy for metabolism.

Soil water; Water in the soil is derived from precipitation that is received at a given time in a particular area ie rain water and snow melts enter the soil by percolation although some times by capillary attraction when underground water is sucked upwards above the water table.soil water is responsible for dissolving minerals and make them available for plants.

In humid areas excessive water facilities leaching while in the arid regions salinization of soils occurs as water is forced to move upwards thus aiding

the upward transportation of minerals to the upper soil layer.

Living organisms; These include microscopic organisms such as bacteria that aids in the decomposition of organic matter in the desired components necessary for plant growth and fixing nitrogen into the soil and macro organisms such as insects, earth worms that create tunnels in the soil to enhance aeration and penetration of water into the soil.

FACTORS INFLUENNCING SOIL FORMATION AND ITS DISTRIBTION IN EAST AFRICA

Soil forming factors refer to the elements in the environment that facilitate soil development from the parent rock. The factors that determine the type, character and nature of the soil as well as the rate of soil development include:

1. The nature of the parent rock (lithology), this provides the basis for soil development. It is the parent rock that breaks down to form soil particles. it also determines the rate of soil development. It includes softness and hardness, color, mineral composition, jointedness. The character of the parent rock influence soil formation in the following ways.

- Parent rock may be hard or it may be soft. Hard parent rock is normally resistant to weathering processes resulting into skeletal or immature soils and delayed soil formation. On the other hand, relatively soft rocks are easily disintegrated, chemically into small particles through oxidation, carbonation, hydration resulting into the formation of deep or mature soils.
- The mineral composition of the parent rock determines the nature of the soil nutrients or soil fertility. Rocks of limestone nature once decomposed through carbonation process will give rise to soils that are rich in lime. In addition mineral composition may determine the nature and rate of chemical decompositionof the rocks forming deep mature fertile soils. Homogeneous rocks encourage physical weathering through block disintegration forming skeletal infertile soils.

NB: the mineral composition of the parent rock will also determine the acidity and alkalinity of the soil.

- Porosity or permeability of the parent rock may determine the rate of soil formation. Porous rocks allow in the agents of weathering such as moisture and air, which accelerate the chemical breakdown of rocks through processes like carbonation, hydration, oxidation forming deep mature fertile soils. On the other hand nonpermeable

rocks may to the formation of thin immature soils because they discourage weathering processes that would breakdown rocks.

- The colour of the parent rock also determines the rate at which soil is formed. Shiny/ light coloured rocks may be more resistant to weathering processes because they reflect heat thus limiting the ratee at which they can be disintergrated resultingbinto skeletal or thin immature soils. On the other hand, dark coloured rocks absorb heat, expand and later contract after cooling leading to break down through processes of temperature changes like exfoliation, granular disintegration hence faster rates of soil formation.

- The parent rock structure may be characterized by joints/lines of weakness or may be a block of massive rock. Well jointed rocks are susceptible to weathering and easily breakdown into particles that form soils. Jointed rocks can easily be percolated by water and air to cause chemical decomposition through processes like carbonation, oxidation, et.c. Rock joints can also aid physical weathering processes like frost shattering, action of plant roots, forming particles that form soil. On the contrary, massive rocks may not easily allow agents of weathering to penetrate and therefore there is a low rate of weathering and soil formation.
- The origin and age of the parent rock determine the nature of the soils that is to say, old rocks give rise to fertile soils because they have been subjected to weathering processes for a long period of time while young rocks give rise to skeletal soils as they have just been exposed to weathering processes.

QN: To what extent is soil formation in East Africa influenced by the parent rock (25 marks)

2. Climate (Atmosphere) influences soil formation through its role in weathering that leads to the formation of soil.

- In areas of heavy rainfall and hot temperatures, adequate moisture is provided which accelerates chemical weathering processes such as carbonation, oxidation, hydrolysis leading to formation of deep soils with developed profiles.
- In areas where temperatures are hot with limited rainfall, physical weathering is accelerated through processes like exfoliation, granular disintegration due to alternate heating and cooling leading to the development of thin skeletal immature soils.

- In very cold regions like mountain tops the nature of soil formation is through physical weathering processes like frost shattering forming hill creep scree soils that are immature for example on the slopes of mountain Rwenzori.
- Heavy rainfall and high temperature also determine the nature of animal life and vegetation that consequently contribute to soil formation through the addition of humus through processes like humification, mineralisation forming fertile soils.

3. Living organisms or Biotic factors

These include bacteria, insects, animals, human beings and factors

- Bacteria play an important role in the breakdown of rocks through complex processes. Organisms such as earthworms, termites also breakdown rocks into simpler/smaller substances that constitute soil.
- Rodents e.g rats, moles, squirrels, physically breakdown rocks as they dig holes into the ground aiding in soil formation.
- Burrowing animals create holes in the rocks and aerate the soils or rocks which accelerates processes of chemical weathering especially through oxidation hence paving way for rock decomposition and development of deep soils.
- Man influences soil formation through activities like mining/quarrying, digging. As a result masses of rock are physically broken down to produce soil.
- Plant roots physically break rocks as they grow into the ground. Plant roots also secrete substances that chemically decompose rocks to produce soil.
- Plant leaves, branches fall down and decay to form humus that is added to the soil through soil forming process of humification and consequently mineralisation. Thus areas of thick vegetation cover have soils rich in organic matter while areas with limited vegetation cover the soils have limited humus.
- In forested regions where there is a lot of humus soil erosion is discouraged and therefore accounting for the development of deep soils with well developed profiles.

QN: to what extent have living organisms influenced soil development in East Africa (25 marks)

4. Relief or Topography influences soil formation through erosion and deposition.

The nature of relief influences the rate and nature of soils formed

- Steep slopes are easily eroded and this implies that the weathered material on the steep slope is as well removed thus soils tend to be skeletal due to erosion. However the rate of soil formation is high because erosion exposes the parent rock to further weathering.
- On the gentle slopes soils tend to be deep, mature and with a well developed profile due to deposition of materials eroded from the upper slopes and deeSchemical weathering processes.
- In the lowlands or flat lands where rainfall is high leaching takes palace and may lead to formation of laterite soils that are poor in terms of nutrients.
- But in areas where the valleys are water logged or poorly drained peat soils develop.

5. Time

Soil formation is slow and continuous process that takes a long period of time.

Time refers to the duration of the interaction of soil forming processes and the factors. Soil formation requires adequate time, time is important in that the nature of the soil depends on how long the processes band factors have been interacting.

If a parent rock has been exposed to the weathering processes for a long time, soil formation will be complete as compared to a parent rock exposed for a relatively shorter period.

SOIL PROFILE

This refers to the vertical arrangement of the various soil layers from the top layer down to the parent rock or bottom layer. Its a vertical section through the soil horizons extending into the bed rock.

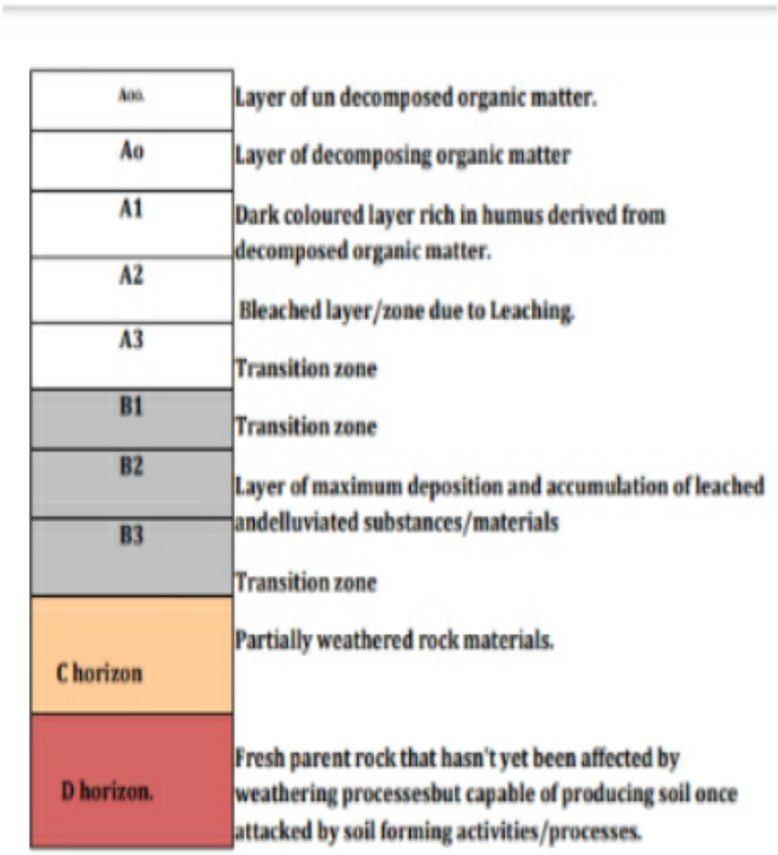
It describes the sections downwards through the soil which comprises of differing characteristics in terms of texture, colour, mineral composition, ratio of combination of organic and inorganic matter, hardness and rate of weathering.

The different layers are referred to as **horizons**

Soil horizon is a well-defined layer within the soil profile parallel to the local round surface.

There are four main horizons namely: A horizon, B horizon, C horizon and D horizon. Each horizon has different physical and chemical properties which result from various soil forming processes such as weathering, introduction of humus and movement of minerals.

It can be illustrated as below:



Aoo- Layer of un decomposed litter.
Ao- Layer of decomposing organic matter
A1- Dark coloured layer rich in humus derived from decomposed organic matter.
A2- Bleached layer/zone due to Leaching.
A3- Transition zone
B1- Transition zone
B2- Layer of maximum deposition and accumulation of leached andelluviated substances/materials
B3- Transition zone
C- Partially weathered rock materials.

D- Fresh parent rock that hasn't yet been affected by weathering processesbut capable of producing soil once attacked by soil forming activities/processes.

A- horizon

It is the upper most layer known as the top soil. It is sub dived into other layers ie Aoo which is made up of undecomposed litter, below Aoo is Ao made up of decomposing organic matter that yields humus, Ao is followed by A1 a layer that is rich in humus hence a dark colour. Below A1is A2 where maximum leaching and eluviation occur making it a bleached layer with light coloured soils and A3 is transitional zone leading to B horizon.

B horizon

This is known as the sub-soil. Nutrients removed from the A horizon through leaching and eluviation accumulate or are deposited in this horizon (B2). The process of plant nutrients precipitating or accumulating in this horizon is know as illuviation. This horizon may also be characterized by hard pans due to the accumulation of large quantities of clay and other nutrients.

Once it is exposed, it forms duricrusts as it is the case with the hill tops of the Buganda hills. It has a dark colour.

C horizon

This consists of partially weathered rock known as regolith, this is because weathering and other soil forming processes may not effectively operate at this depth.

D horizon

This consists of the solid parent rock or in weathered rock or fresh parent material. It is also called the bed rock. It has no soil particles but has potential for future soil formation.

NB: the A and B horizons together make up the true soil and not all soils have these four horizons.

FACTORS AFFECTING THE DEVELOPMENT OF SOIL PROFILE

The nature of the soil profile may be such that it is fully developed or partially developed implying that soils may be deep or skeletal, or soils of medium depth. Soil profile development is influenced by a number of factors namely.

1. Climate, rainfall and temperature determine the nature and rate of weathering and soil forming processes

- Areas with high temperatures and heavy rainfall over 1500mm encourage deep vertical weathering through processes like carbonation, hydrolysis, oxidation resulting into the formation of mature soils that are likely to contribute to the development of complete soil profile. This is because forests in these areas accelerate humification characterized by hot temperatures.
- Climate also determines the growth of plants and animals that contribute to the development of the A horizon of the soil profile through weathering and humification.
- Heavy rainfall and high temperatures in humid tropical environments encourage leaching and eluviation processes responsible for the eluvial zone in the A horizon and an illuviation zone in the B horizon of the soil profile.

- In arid areas, where there is limited rainfall of less than 5oo mm the temperatures are hot and there is a lot of physical weathering. This leads to a partially developed soil profile devoid of A horizon.
- Cold regions like mountainous areas, tundra region there is a lot of snow and therefore cold temperatures that result in the formation of a permanent frozen sub soil and therefore a partially developed soil profile.

2. Parent rock

The parent material is the nature of the rock upon which weathering and other soil forming processes operate to create soil. In the first place the parent material provides the basis for soil profile development. It plays the role below:

- Hard rocks are resistant to weathering processes and lead to development of thin soils with poorly developed profiles while soft rocks are easily weathered and acted upon by other soil forming processes such as leaching, eluviation leading to the formation of deep soils with a well developed profile.
- Jointed rocks facilitate physical and chemical weathering processes forming small particles that are acted upon by other soil forming processes like humification, illuviation, leading to formation of fairly deep soils with profiles of medium development.
- Young parent material leads to immature soils with partially

developed profiles while older rocks that have had a long time of exposure to weathering processes and processes of soil formation develop into mature profiles with clearly marked horizons.

- Permeable or porous rocks enable easy percolation of agents of weathering like rain water, air resulting into deep weathering and consequently deep soils with well developed profiles unlike impervious rocks.

NB: different soil profiles can develop from the same parent rock under different conditions.

3. Relief or Topography.

- Steep slopes experience a lot of soil erosion that removes the top soil leaving shallow skeletal soils that tend to have partially developed profiles. They have thin soils and devoid of A horizon.
- In flat or gently sloping areas deposition exceeds erosion and they lead to the formation of deep soils with well developed soil profiles.
- In valleys, water logging deprives the bacteria of oxygen and bacterial activities hence preventing weathering and humification processes leading to a partially developed soil profile.
- Hill tops tend to encourage leaching and eluviation processes of soil formation that lead to the bleaching of the top soil leaving it devoid of the A horizon and consequently a partially developed soil profile.

4. Living organisms

- Thick vegetation cover provides the needed organic matter to the soil through humification process. It also protects the top soils from being eroded away keeping it in place forming a well developed profile.
- Forested areas also accelerate physical and chemical weathering processes through their roots penetrating through jointed rocks, breaking them into small particles as well as widening the joints to create passages for water and air that accelerate deeper chemical weathering forming deep soils with fully developed profiles.
- Man's activities through agriculture like monoculture, up and down ploughing, overgrazing among others lead to partial soil profile development while some activities done by man like afforestation, mulching, fertilizer application, and forest conservation, bush

fallowing, encourage complete development of mature soil profile because weathering and soil forming processes are enhanced.

5. Time.

It takes time for the soil profile to be fully developed. A typical or well developed profile of soil must have undergone adequate time, therefore the longer the time to which the rocks are exposed to weathering and other soil forming processes, the more the developed profile.

Young rocks normally yield skeletal soils I.e with partially developed profile.

QN: What is soil profile?

Explain the factors influencing soil profile development in East Africa

SOIL CATENA

This is the successive arrangement or sequence of arrangement of differing soil types along the slope from the hill top (summit) to the valley bottom.

This sequence varies with relief and drainage though it may be derived from the same parent material e.g the soils at the valley bottom are likely to be different from those of the hill top.

Soil catena may be due to factors like relief, climate, living organisms and time.

A catena usually has four to five different soil types with varying characteristics as described below:

a) Hill top or Upper layer

b) The vertical slope or the free face

c) The convex or steep slope

d) The low lying/gentle/concave slope

e) The valley bottom

At the hill top, there are laterite capping with thin and skeletal soils.**Th**is is mainly composed of bear land with rocks that are exposed to regular leaching and heating. These slowly break up into fragments of the skeletal lateritic soils and normally forms a lateritic capping.

Below the hill top is a free face or a vertical slope which is usually composed of bare rock or sometimes stony soils due to rapid surface runoff.

This is followed by waxing/convex/steep slope with coarse stony soils due to erosion. They are shallow and infertile

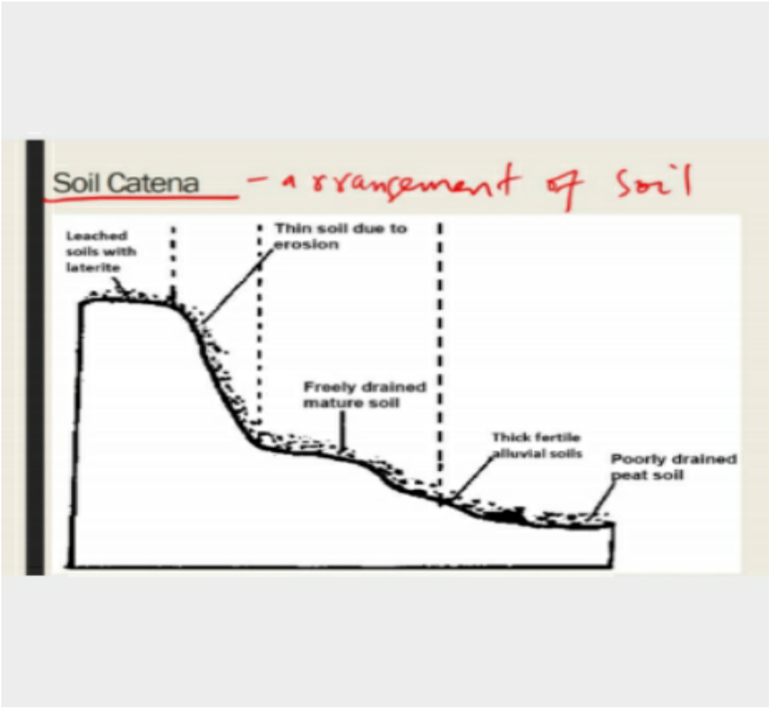
This is followed by the waning/concave/gentle slope with deep

The soils in this zone are normally deep,fertile, fine grained in nature.

The valley bottom is characterized by dark grey fine grained soils which are deposited either by rivers or run off from rain. The soils in the valley have an impided drainage.

NB. In Buganda the flat topped hills display a true soil catena.

Illustration



FACTORS INFLUENCING THE DEVELOPMENT OF A SOIL CATENA

1. Topography / relief, which is the physical appearance of the landscape affects the development of soil catena in such a way that differences in relief affect the nature or soil type due to the fact that they influence erosion, deposition and human activities.

- Hilltops have lateritic capping with the resultant thin/skeletal soils due to leaching.
- The very steep slope/free face hardly has any soil. It has a

bare rock due to erosion

- The waxing slope/convex slope is characterized by coarse stony creep soils due to erosion.
- The waning slope has fairly deep clay loam soils due to deposition.
- The low lying area/valley bottom has fine particles of clay. It is deep and poorly drained. It is generally a zone of deposition or illuviation ie zone of accumulation.

The steep slope encourages erosion and hence has shallow soils. The gentle slopes are well drained and experience some downslope translocation of soil particles while the valley bottom experiences deposition hence accounting for the deep clay soils.

2. Drainage, steep slopes have swift erosion and therefore skeletal soils, gently sloping areas have reduced / slight erosion and therefore they have well drained soils that are likely to develop into mature or deep soils.

In areas with accumulation of water, peat soils are likely to develop.

3. Nature of the parent rock, the differences on the soil types along the slope could be as a result of them having developed from different parent materials.

4. Climate: This influences the development of the soil catena in the following ways;

The heavey rain fall encourages leaching leading to formation of lateritic soils on the hill tops.

Heavey rain fall encourages erosion on the steep slopes accounting for thin skeletal soils, and deposition in the lower slopes and valley leads to formation of deep dark loam and dark clay soils.

Heavey rain fall also accounts for flooding in the valley bottom and lower slopes hence water logged soils.

5. Living organisms ie plants and animals. Areas with thick Vegetation have loam soils especially in the middle and lower slopes due to plenty ful supply of humas. Thick vegetation also acts as a protective cover to the top soil preventing erosion, accounting for deep loam fertile soils on the waning slope

Human activities like defforestation, crop cultivation especially on hill slopes encourage erosion hence thin soils on the steeper slopes while on the other hand deposition of eroded materials occurs on the lower slopes and valley bottom forming deep loam soils that are fertile.

6. Time, the development of soil catena needs ample time. The processes involved take long and therefore, the longer the geological time scale the more development of soil catena of an area.

PROCESSES OF SOIL FORMATION

Soil formation processes are the various activities that act upon the parent rock and organic matter to produce soil. These processes are a result of a combination of different factors identified already that lead to creation of profiles and structure.

These processes include:

1.Weathering, this is the physical disintegration or chemical decomposition of rocks in situ. Rocks breakdown through various physical and chemical processes leading to soil formation.

High rate of weathering result into deep and mature soils meaning that with high rates of weathering, a mature soil profile is easily reached. In the tropics weathering under humid conditions leads to deep latosols and tropical black earths. Deep podzols in humid temperate conditions. Deep mature tundra and Arctic soils in high latitude zones, etc.

On the contrary, areas of more resistance to weathering have led to shallow soils or soils of partially developed profile. Such include the recent volcanic soils, mountain soils, glacial soils and marine soils

2. Leaching, this is the removal of soluble mineral nutrients from the upper layers of the soil profile to the under lying layers. Soluble nutrients like salts, iron, carbonates among others which are removed / transported in a solution form from the A horizon to other horizons. Sometimes this makes the A horizon acidic.

3. Eluviation, this refers to the movement of soluble materials in solution or suspension from one place to another within the soils. Movement can be vertical as it is the case with leaching or lateral depending on the movement of water and soil structure with in a given area. It is influenced by the climate and nature of the parent rock. It also leads to a poor A horizon which is commonly known as Eluvial zone.

4. Illuviation, this is the accumulation and precipitation of leached and eluviated materials in the B horizon of the soil profile. The soluble nutrients that were removed from A horizon are subsequently deposited in the B horizon. It leads to the development of B_2 layer (dark coloured) and there is maximum accumulation of colloids.

5. Humification, this is the process through which organic matter is

decomposed to form humus a task performed by soil living organisms like bacteria, earth worms, termites among others. It is very common in humid areas where there is heavy rainfall, forests and hot temperatures. It mainly influences the development of the A_0 and A_1 zones of A horizon.

6. Mineralization, this is the process of soil formation which takes place in extreme conditions where decomposition of organic matter that forms humus goes beyond Humification such that organic matter is broken down into basic parts and changed into mineral substances like carbon dioxide, water and silica. It is common in the A horizon but can also occur anywhere in the soil profile where organic matter exists.

7. Calcification, it is a process where or process which takes place in dry places as a result of upward movement of capillary water where evaporation exceeds precipitation. The excessive evaporation causes water containing dissolved calcium to move upwards through the soil by capillary action. At the surface, the water evaporates leaving the soil to have or be rich in calcites. It is common in the karst regions of East Africa where shallow soil profiles have developed soils rich in calcium and these soils are known as the pedocals.

8. Gleization, this occurs in wet /cool climatic regions with poor drainage especially in the swampy areas. In polar regions the perifrost provides an impervious layer where the top soil is circulated with melt water. This reduces oxidation or causes dioxidation of ferous compounds. They occur as bluish grey with sticky clay soils and usually structure less and this process leads to the development of shallow soil profile.

9. Laterisation, it involves weathering under hot and damp conditions within the tropics. This is a process in humid areas that involves the migration of soluble mineral nutrients from the upper layers to the under lying layers. Silica is leached from the A horizon leaving behind iron and aluminum which gives rise to red brownish soils. The iron hardens on exposure giving rise to lateritic soils.

This process is common in the tropical regions where the following conditions prevail;

-Abandant supply and rapid decay of organic matter.

-Deep and intence weathering of rocks.

Accumulation of iron and alluminium .

10. Podzolisation, this is a complex soil forming process that occurs under cool moist climatic regions with coniferous forests. It involves Leaching of salts and iron compounds, Elluviation and Humification processes that aid in the formation of podozoic soils. It is common in regions with short

summers (cool humid environments). Prolonged winter which doesn't allow full decomposition of organic matter.

NB: this one is not so common in East Africa except on the three glaciated mountains Rwenzori, Kenya and Kilimanjaro.

11. Salinization, is the process by which soils are enriched with salt. This is due to evaporation from the soil surface which draws up salts in solution by capillary movement. Salinization may also be induced by man through intense irrigation. It gives rise to saline top soils (interzonal soils) of high salt concentration especially in the semi arid areas . Salinization gives rise to a poor A- horizon.

12. Chelluviation, is the process that involves chemical bonding of metallic ions and organic matter. In this case when organic matter decomposes it releases chelating agents (organic acids) that attack rocks thereby producing iron., aluminium and magnesium compounds which then move downwards affecting soil movement or development. It normally results into rich horizon A soils.

13. Lessivage, is a process of soil formation especially the break down of peds where clay particles are carried downwards from the upper soils in suspension form leading to an impoverished A- horizon and hard pans in the B- horizon.

CLASSIFICATION OF SOIL

Soil types in E.Africa fall under three major groups (types) namely;

Zonal soils
Intra-zonal soils
Azonal soils

a. Zonal soils:

These are mature soils which have well developed soil profiles

Their formation is dominantly influenced by climate and vegetation (organic matter) upon the parent rock over a long period of time.

They are said to have had sufficiently long periods of exposure to the soil forming processes and therefore have well developed profiles with distinct horizons.

They are formed on gently sloping and well drained areas in E.Africa such as around the Lake Victoria basin and along the foot hills of the highlands They are sub divided into **two groups** i.e.

Pedocals which are rich in calcium carbonate formed in areas of low

rainfall (semi arid areas)e.g chernozems, chestnut or brown soils, sierozems, etc.

Pedalfers which are rich in aluminium and iron. They develop in areas of high rainfall (humid areas). They have low calcium carbonate content due to leaching. They include lateritic soils, tropical red earths and tropical black earths among others.

The following are the **Types of Zonal soils in East Africa**:

Lateritic soils (Latosols): These are soils formed in humid tropical regions where heavy leaching takes place all the year. They consist of mainly hydrated iron and aluminum oxides and have stony particles due to the loss of mineral nutrients by removal of bases and silica from top soil to the underlying horizon.

It is formed by the lateralization process, in which silica is leached out and iron and aluminum compounds become concentrated in the A horizon due to leaching and consequent drying. This gives rise to laterite soils that are reddish brown and tend to be sticky when wet I.e plastic or cohesive. They harden when exposed to dry atmosphere.
Iron and aluminum compounds don't dissolve easily and therefore get concentrated on the top soil. The aluminium and iron compounds form small stones or gravel on the top or within the weathered material known as laterite gravel. After some time the laterite gravel is cemented together to form laterite, it is mainly used for grading rroads.

There are 5 divisions of latosols namely

1. Weathered ferralitic soils
2. Ferruginous soils
3. Leached ferralitic soils
4. Basisols
5. Humic latosols

Factors that influence the development of latosols.

a. Relief, this is one of the most important factors responsible for the development of latosols. They form under areas that are relatively well drained that is to say they develop well on gently sloping areas. This is because water can percolate and allow the leaching of the A horizon and the proper deposition of materials to B horizon. However steep slopes are prone to soil erosion which doesn't allow development

of latosols.

b. Nature of the parent rock, latosols form from soft rocks which allow quick weathering. A parent rock should also contain aluminum and iron components for oxidation to take place.

Hard rocks discourage formation of latosols because they are resistant to

weathering.

c. Drainage, areas with poorly drained soils don't allow the formation of latosols where as well drained areas provide ideal conditions for the development of latosols.

d. Weathering processes, the weathering processes of oxidation and solution change the color and transport the cementing silicate materials to different areas resulting into the development of latosols.

e. Climate, latosols are formed under heavy rainfall amount especially above 1500mm. this Rainfall provides water that acts as a medium for chemical weathering processes and consequent leaching of silica.

Hot temperatures accelerate the rate of physical and chemical reaction paving

way for deep weathering and the development of latosols.

Dry conditions that then enable the laterite to harden.

f. Vegetation cover, presence of forests help to hold the soil particles together and allow weathering processes especially chemical weathering to take place in situ resulting into Humification therefore aiding latosols to devel.

g. Human activities, forexample clearing of vegetation, mining, farming expose the soil to the full force of rain and heat aiding latosols to form.

Some human activies interrupt the development of lateritic soils for example mining, farming tend to retard the formation of latosols.

h. Time / geological period, latosols require a long geological period to allow the formation and accumulation of oxide to take place for example areas with lactosols in east Africa are believed to have developed in tertiary period (250 years)

Latosols are good materials in making roads as they contain carbon oxide and

iron ore.

Tropical red earths: These are formed in tropical regions with definite wet seasons during which heavy leaching takes place. They are characterized by a loamy mixture of clay and quartz

Tropical black earths: These are soils formed in humid tropical regions where there are basalt rocks for example parts of Kenya. It is black in

colour due to high content of titanium salts in the basalt bed rock or parent rock.

Red desert soils: These are soils that are reddish in colour. They are formed in hot and dry regions. They are sandy and contain a lot of salts.

b. Intrazonal soils:

This category of soils occurs where special conditions of the parent rock, drainage and relief exert a stronger influence/effect on the resultant soil type than other factors like climate and vegetation. This could be in form of presence of much water, large amounts of salts etc.

They exist in different parts of the world rather than in specific zones.

Intrazonal soils are intermediate between the zonal soils and the azonal soils.

They show profiles which are distinct, an indication that there has been a dominant control factor in their formation i.e. parent rock material or drainage other than climate.

They mainly occur in coastal areas of east Africa (bog and peat), in river flooded plains (silt and mud) and saline soils in semi desert areas (calcareous).

Examples of Intrazonal soils include:

Saline soils: These are the soils which have high levels of soluble salts. They are grey because of the salt content and they occur in regions or areas where evaporation is very high. They are so common in semi desert areas. They include solonchaks and solonetz soils. They are also known as **Halomorphic soils**

Peat soils: These are soils which occur in water logged (marshy) areas with almost no air space to allow easy water percolation or infiltration. The decomposing plant remains accumulate on top of this impervious soil to form peat or bog soil for example in swamps and valleys as well as the coastal areas of E.Africa such as meadow soils and gley soils. They are also called **Hydromorphic soils**
Relatedly, meadow soils (silt and mud) occur in river flood plains

Calcareous soils: These are soils which are formed from limestone rocks. They include Rendzina soils which are dark-coloured, loamy soils containing chalk or limestone fragments formed under humid conditions and Terrarossa soils which are reddish residual soils that normally accumulate in limestone depressions usually under semi-arid conditions. They are also known as **Calcimorphic soils**

c. Azonal Soils:

They are immature or young soils which show characteristics of their original parent rock.

Their development is incomplete, that is why they don't have well marked horizons i.e they have no clear soil profile.

They are soils which have not been exposed to soil forming processes for a long time to develop mature characteristics hence they are immature soils.

They are skeletal soils with shallow profiles so they reflect (show) similar characteristics of the original parent rock hence, they resist change

Azonal soils can be described as transported soils which are deposited by the agents of erosion because they are derived from un consolidated materials such as alluvium, sand, volcanic ash among others

Azonal soils are divided into two (2) categories i.e **Lithosols** and **Regosols**

Lithosols have a high content of iron and aluminum, mainly found in tropical rain forests
Rogosols comprise unconsolidated parent material of alluvial origin derived from unconsolidated material such as alluvium, sand, volcanic ash, etc.

Examples of azonal soils include:

Mountain soils/Scree soils: These are soils which are stony consisting of large rock fragments that weather down by frost action. They are coarse grained (textured) and heavily leached. They are found on mountain slopes formed from the accumulation of weathered rock fragments

Alluvial soils: These are deposited soils consisting of a mixture of sand, silt, mud and clay (river borne materials). They are fine textured and suitable for agriculture.

Marine soils: They are common in coastal areas associated with water bodies for example lakes, seas and oceans formed as a result of wave action such as mud and clay.

Volcanic soils: They are the soils produced by weathering of volcanic rocks. They are highly acidic and fertile for example recent lava and ash soils.

Glacial soils: They are soils formed as glacial deposited materials for example till soils, fluvial glacial soils, gravels and clay as well as outwash sands deposited in glacial lakes by glaciers and rivers flowing from glaciated highlands.

Wind-blown soils (Aeolin): especially sand sheets, dry sandy soils, sand dunes and loess. They are blown and deposited by wind in arid areas e.g Kotido and Moroto in Karamoja region, the rift valley region in Western Uganda and Chalbi desert in Kenya.

FACTORS/CONDITIONS/PROCESSES RESPONSIBLE FOR THE FORMATION OF AZONAL SOILS IN E.AFRICA:

Denudation processes (Erosion, transportation and deposition)

Weathering of the parent rock leads to the formation of screes on the mountain slopes. These soils normally show characteristics of their original parent material and resist change.

Wave deposition results into the formation of marine deposits and the resultant soils include mud-flat soils/marine clay soils e.g along the East African coast at Mombasa.

Glacial deposition results into the formation of fluvio-glacial soils e.g tills, outwash sands, gravel and clay deposited in glacial lakes e.g Lac du Speke on Mt. Rwenzori.

River deposition results into the formation of alluvial soils particularly silt and mud e.g along the banks of river Pangani and river Rufigi in Tanzania.

Wind action results into the formation of wind blown soils like sand sheets, sand dunes and loess.

Climate

Heavy amounts of rainfall cause floods and sea level changes forming alluvial soils in lower courses of rivers e.g along River Rufigi and River Pangani as well as marine soils in coastal areas.

Heavy rainfall also causes severe erosion along the steep slopes of highlands e.g Rwenzori and deposition in lowlands forming soils such as silt, mud like in some parts of Kasese.

Temperature changes in mountains / highlands like Rwenzori and Mt. Kenya cause frost action to take place consequently forming scree soils or mountain soils.

Differences in pressure within desert / semi desert areas cause strong winds to blow resulting into wind erosion that forms loess soils

Relief

The steep slopes of highlands promote weathering, erosion and mass wasting to take place hence forming scree soils

Valleys / lowlands encourage deposition of eroded materials to form soils like silt and mud

Volcanic activity produces volcanic soils such as lava, ash/cinders etc

Nature of the parent rock (Rock structure)

Dark coloured rocks are easily weathered to form scree soils

Well jointed rocks in highland areas are easily weathered to form scree soils

Soft rocks are easily eroded by rivers and glaciers to form alluvial soils, till soils among others

Loose/light rock particles are easily blown, transported and deposited to form wind-blown soils such as loess and sand dunes

Biotic factors i.e man and the effect of burrowing animals
Human activities like agriculture, quarrying and mining lead to break up of the parent rock into small particles thereby producing loose or un consolidated materials which form scree soils.
Man also dumps waste materials that may result into weathering of the rock hence forming azonal soils.
Deforestation, bush burning, over stocking and over grazing expose the parent rock to weathering processes that lead to formation of young soils.

Time

Azonal soils are young (immature) soils implying that they are exposed to the soil forming processes for a short period of time during their course of formation.

Qn a) Distinguish between azonal soils and intrazonal soils

b) Account for the formation of azonal soils in East Africa

OR

Qn. Examine the conditions/factors/processes responsible for the formation of azonal soils in East Africa.

a) Distinguish between Azonal and Intra-zonal soils.

Azonal soils are soils which are young and without a clear soil profile. They are soils which have not been exposed to soil forming processes long enough to develop mature characteristics.

They are skeletal soils i.e. with shallow profiles and show characteristics of their original parent rock which weathered and resist change.

They are divided into two groups ie lithosols and regosols.

They are derived from unconsolidated materials e.g. alluvium, sand, and volcanic ash.

Azonal soils include,

Scree soils on mt.slopes.

Mud-flat soils/ marine soils.

Fluvio- glacial soils e.g. till, outwash sand and gravel and resorted clay laid down in glacial lakes.

Wind blown soil e.g. sand sheet, dunes and loess

Lava/ ash soils, cinder (volcanic).

Factual marking 03 mks

Intra-zonal soils

Intra-zonal soils occur where special condition of relief or parent rock exert a stronger influence on the resultant soil type than other factors eg climate and vegetation eg bog/peat/gleyed soils in marshy areasof East Africa such as coastal regions, meadow soils in the river flood plains (silt and mud),saline soils in semi- desert areas,

Factual marking 02 mks
05 mks

b) **Account for the formation of Azonal soils in East Africa.**

Weathering of the parent rock leads to formation of screes on mt. slopes, the soils usually show characteristics of their original parent rock and resist change.

Tectonic deposits of lava through volcanic action leads its formation

of lava ash soils, cinder, pumice.

Materials may be transported elsewhere by high rate of erosion and agents, deposited through wave action leading to formation of marine deposits. The soils here include:

Mud soils or marine clay soils.

Wind action leading to the formation of wind blown soils like sand sheets, dunes and loess.

Glacial action (fluvio-glacial) resulting into the formation of fluvio-glacial soils, sand and gravel and re-sorted clays (deposited in glacial lakes)

River action leads to formation of alluvial.

Climate,

High amount of rainfall causes river floods that lead to deposition of alluvium in the lower course.

Equally, high rain fall cause erosion on steep slopes and deposition of material in the low lands.

Temperature changes in mt. slopes influence physical weathering thus forming screes.

Relief, the nature of relief mainly influences erosion of screes on mt. slope and their deposition forming new soils.

Time lapse; Azonal soils are immature soils and mainly depends upon the short period of time in their formation.

Human activities like, quarrying and mining leads to the breaking of the parent rock into simpler particles, leave alone dumping of waste material, hence forming Azonal soil.

Deforestation, bush burning and over grazing expose the parent rock to weathering processes that lead to the formation of young soils.

Impression marking	20 mks
Total	25mks

SOIL EROSION IN EAST AFRICA:

Soil erosion is the process of washing away or removal of the top thin layer of soil by agents like running water, wind, ice (glaciers) and man from one place to another. The eroded soils are transported and deposited to another area.

There are **two (2)** types of soil erosion namely **geological** and **accelerated** soil erosion.

Geological soil erosion is regarded as normal erosion which takes place whenever there is a flow of energy on the surface of the earth. It is a slow process in which the removal of the surface soil may be matched by the formation of new soil. It is therefore not dangerous to the soil and occurs in areas with vegetation cover.

Accelerated soil erosion occurs when geological soil erosion is speeded up by man's activities. In this case the rate of soil loss is greater than the rate of soil formation. This type of soil erosion takes place in all environments which have been disturbed by man.

Areas affected by soil erosion include: Slopes of Mt. Elgon, Kigezi highlands in Kabale and Kisoro, Kotido and Moroto in North Eastern Uganda and Ankole Masaka corridor.

In Kenya, it occurs in Machakos (Masai land), Nyanza province, Turkana land, Chalbi desert and the Kenya highlands.

In Tanzania, it is experienced in the Kondoa region, Miombo woodlands, Mt Kilimanjaro slopes and around the Southern highlands among others

Generally, soil erosion occurs in the highland and dry areas of E.Africa

TYPES/FORMS/PROCESSES OF SOIL EROSION IN EAST AFRICA:

1. Wind erosion/Deflation

This is the removal of light soil particles from one place to another by the action of wind. The soil particles are blown away by wind and later deposited to form sand dunes. It's very common in generally flat and dry (semi arid) areas with no or less vegetation cover e.g Chalbi desert of Kenya, Kotido and Moroto (Karamoja region)

2. Sheet erosion

It is the uniform removal of a thin layer of soil over a large area by running water and wind. This mainly occurs when rain falls on a gentle slope which is bare without any vegetation e.g in Nakasongola, Mbarara and Bushenyi

3. Rill erosion

This is the uneven removal of surface soil by running water in which numerous small channels (furrows or rills) of a few centimeters in depth are formed. This occurs on gentle slopes where vegetation has been cleared. It is more frequent in areas that receive frequent rainfall e.g around Lake Victoria in Mukono, Kampala, Wakiso and Mt. Elgon slopes in Mbale.

4. Gulley erosion

It is where deep and wide channels/grooves are created by running water on the earth's surface. It is common in steep slopes which receive heavy rainfall especially where vegetation has been destroyed e.g Kabale, Kisoro and Kabarole in Uganda.

5. Splash erosion

It is caused by the impact of rain drops which dislodge soil particles and scatter them in different directions. The splashed particles are later pulled down by gravity. Therefore rain drops do not only detach loose soil particles but also affect the horizontal movement of the those particles

CAUSES OF SOIL EROSION IN EAST AFRICA:

Soil erosion is influenced by both **Physical** and **human** factors. They include:

a) Physical factors:

Climate

Prolonged and heavy rainfall especially in highland areas creates excessive surface runoff that increases the erosive energy of the running water resulting into rill and gulley erosion

Prolonged but gentle/moderate rainfall leads to minimal rates of erosion

Strong winds especially in semi arid/arid areas with very little rainfall cause deflation (wind erosion)

Vegetation

Areas with limited (thin) vegetation cover experience high rates of erosion. Scanty vegetation encourages excessive surface runoff hence causing wind deflation, rill and gulley erosion

Areas with thick vegetation cover are associated with minimum rates of erosion such as around Mabira

Topography/relief

Steep slopes in highland areas accelerate high rates of erosion especially gulley erosion. In other words, the longer and steeper the slope, the greater the velocity (speed) and erosive power of the surface runoff hence leading to gulley erosion.

Gentle slopes encourage sheet erosion

Nature of the soils

Porous and un consolidated soils especially young volcanic soils and sandy soils offer less resistance to the erosional agents like wind and running water hence causing high rates of erosion. Such soils are very light in nature that's why they are highly susceptible to erosion especially at Kotido and Moroto. Young volcanic soils are found at Buduuda hence promoting gulley erosion

Biotic factors

The presence of harvester ants and wild animals in pastoral and semi arid areas leads to rapid loss of vegetation cover especially grasses leaving such areas bare and less resistant to erosion. This is responsible for wind deflation and splash erosion in areas like Machakos, Ankole-Masaka corridor, Nakasongola and Karamoja areas

Prolonged drought

This limits the growth of natural vegetation cover hence leaving the land bare and exposed to agents of soil erosion like strong winds and heavy rain drops. This is very serious in Karamoja region, Turkana land, Masailand and Miombo woodlands

Human factors:

Deforestation

The excessive cutting down or clearing away of trees by man reduces the protective cover of soil and encourages runoff subsequently resulting into soil erosion in form of sheet and gulley erosion

Shifting cultivation

This is an agricultural practice which involves cutting down trees, planting crops on the land and thereafter abandoning it when it loses its fertility. The soil is easily eroded once the bare land is abandoned by the farmers who shift to other virgin lands which are still productive

Overstocking/over grazing

Large numbers of animals lead to the emergence of bare patches of land leaving the land highly prone to erosion especially wind deflation. This is so common in nomadic pastoral areas

Over cropping

It refers to continued cultivation of crops on the same piece of land for a long time without giving it rest. It causes severe soil exhaustion. The soils ultimately become loose and are easily washed away by the erosional agents

Up and down slope cultivation

If there's persistent ploughing of highland slopes without using proper methods of cultivation, it encourages surface run off thereby resulting into rill and gulley erosion

Mining and quarrying

Open cast mining involves the removal of large quantities of surface vegetation and this leaves such areas bare and prone to soil erosion by wind and running water

Construction works

The establishment of roads, motorable trucks and rail way involves removal of vegetation and exposes the soil to the harmful effects of raindrops, running water and wind. In addition, running water easily takes advantage of transport routes to create gullies hence soil erosion

Swamp reclamation

This involves the draining of swamps for agricultural purposes. Floods especially in rainy seasons occur which carry away the soil e.g in Busoga, Tororo, and parts of Buganda

Bush burning

This is mainly done by the pastoralists like the Bahima in Uganda, Masai in Kenya as well as Tanzania and cultivators leading to the destruction of natural vegetation cover. This exposes the top soil to agents like running water and winds leading to wind deflation, rill erosion, sheet erosion and splash erosion

Monoculture

This is the persistent growing of a single type of crop on a piece of land for a long period of time. This makes the soil loose and easily carried away by the agents of erosion e.g Kikuyu land in Kenya, Mukono and Lugazi in Uganda

Growing of poor cover crops

Some crops such as cotton and tobacco leave bare land in between the rows and this incidentally encourages erosion of the soil by running water.

A case study of Kondoa area

It is found in Dodoma in central Tanzania. It experiences mainly gully erosion and the main causes of soil erosion include:

Steep nature of the landscape

The rainy seasons experienced from December to April

The dry season which lasts for over seven months

High population density of 20-40 persons per square kilo meter

The over grazing and primitive cultivation with a big number of cattle in the area.

The scanty vegetation cover dominated by grassland and acacia trees.

Highly porous soils that can easily be eroded.
Extensive deforestation of the few existing trees to provide fire wood
The prevailing dry wind especially the south Easterly trade winds.
The too much bush burning.

A case study of Kigezi highland

It is found in south western Uganda in Kigezi region and the causes of soil erosion in this region include the following
Heavy amounts of rainfall received throughout the year over 1500mm
High population pressure on land
The hilly / mountainous steep slopes
Primitive methods of farming for example cultivation along the slope
There is a lot of deforestation
The social factors, polygamous families

EFFECTS OF SOIL EROSION:

Negative effects:

Soil erosion results into washing away of the finest and most fertile soils which are rich in organic matter. This results into infertile (unproductive) soils which cause low crop yields hence leading to famine.

Soil erosion physically destroys the soil surface by creating gulleys and therefore causing waste Lands leading to loss of farm land. Equally, the waste land / bad lands with gullies hinder transport and communication as well as mechanization

Soil erosion can result into landslides especially where gulleys are formed. These gulleys weaken the stability of a slope thereby leading to landslides.

Soil erosion results into pollution of water bodies e.g. springs, wells and rivers through deposition of silt and sand into the water bodies. It adds other impurities into the water which may be harmful to human health. Relatedly, wind erosion causes air pollution due to excessive dust

Areas with rampant soil erosion are infertile. They are therefore associated with limited vegetation cover since heavily eroded soils are unable to support plant growth. This results into reduced evapotranspiration, low rainfall and scarcity of pasture for the animals

Soil erosion also causes flooding in broad river valleys and lowlands due to siltation of rivers and other water sources. This ultimately results into loss of human life and destruction of property
It costs a lot of money and efforts to individuals and governments to control. Farmers also lose their crop fields because of soil erosion

It may also lead to silting of lakes and irrigation canals. This in turn affects fishing and agriculture

The dust particles carried by wind are deposited around social infrastructure like roads, buildings among others leading to increased costs of maintenance

Positive effects:

Soil erosion leads to removal of top soil thus exposing the fresh parent rocks to the agents of weathering leading to formation of new soils hence it facilitates soil formation.

It leads to transportation, deposition and accumulation of fertile alluvial soils in the low land areas which are utilized for agriculture/crop farming e.g. River Manafwa at Doho irrigation scheme.

It leads to exposure of physical landforms such as inselbergs which attract tourists thus promoting the development of the tourism industry e.g. in Mubende and Nakasongola.

Soil erosion exposes minerals nearer to the earth's surface and this makes them easy to extract e.g. limestone rocks in Tororo. When they are exported, revenue is earned

Steps taken to control soil erosion in East Africa:

Afforestation and re-afforestation programs are being encouraged and people are planting trees in fresh areas and in areas where forests were cleared. This makes soil particles on highland slopes to be held tightly together by the tree roots.

Terracing method of farming on steep slopes is being used where by bench like steps are cut along a highland slope and these become gardens. These steps break the speed of the water and its energy to wash away the soil.

Contour ploughing is used where by cultivation on slopes follows the heights of the slope so that areas of the same contours/height are cultivated together across a slope. This reduces the surface runoff as the raised ridges break the flow of the running water for example in the Kenya highlands.

Crop rotation system of farming is being applied. This involves successive cultivation of different crops in the same field following changes in the season. This helps to maintain the soil structure and soil fertility.

Strip cultivation is being practiced on steep slopes where the gardens are separated by strips of uncultivated grass. This breaks soil erosion because as water begins to run, its speed is broken by entering into a grass strip.

Use of cover crops especially those crops which spread as they grow and cover the soil such as beans, sweet potatoes, pumpkins and other legumes. These break down the speed of the running water and its energy to erode and wash away the soil.

Mixed or intercropping system of farming where different types of crops are grown in the same field at the same time for example crops like maize, beans, ground nuts and Irish potatoes are inter-planted and this assists to bind the soil particles

Restricted or controlled grazing which involves controlling the number of animals grazing in a particular area so as to make the soil remain with some grass to hold it and protect it from erosion for example zero grazing.

Bush fallowing system of rotational farming where some pieces of land are left under fallow or rest, in order to regain fertility naturally. This improves the soil structure which makes it hard for the soil to be eroded away.

Addition of organic manure and other artificial fertilizers to improve on the soil fertility and structure. The soil particles become cohesive and too hard for running water to wash them away.

Qn. Discuss the causes and effects of soil erosion in East Africa.

Geography Department