TOPIC 1: STRUCTURE OF THE EARTH

Earth is the only planet that support life to living things particularly plant and animal. The earth has its structure and composition.
The earth is a system which composed of two zones.
These are
1) Outer zone
2) Inner zone
Thus, the structure of the earth consists of external structure and internal structure.
The following diagram shows the structure of the earth (internal and external structure)

INTERNAL STRUCTURE /CONCENTRIC ZONE OF THE EARTH

The internal structure of the earth consists of three zones.
These are i) Crust/Lithosphere
ii) Mantle/Mesosphere
iii) Core/ Barysphere

CRUST/LITHOSPHERE

Is the outermost and thinnest zone of the earth which found between 8 – 50 km or 5 – 30 miles. - It is largely composed of igneous rocks. - Other types of rocks also exist as a result of changes on the earth's surface. When subjected to forces or any stress. - Igneous rocks are hard and brittle. - The crust also consist of two layers are sial and sima layers.
THE SIAL Is the outer layer of the crust which rich in silica and Aluminium minerals. - The sial for the basis of the continent. - The presence of silica and aluminium minerals collectively form SIAL layer.
THE SIMA - Is the layer which found beneath the sial. - Is the inner layer of the crust which separated from sial layer by the zone called Conrad discontinuity line. - The sima layer is composed by silica and magnesium. - It forms the basis of ocean floor. Note: - Sial and sima layer together forms the crust.

MANTLE /MESOSPHERE

Mesosphere or mantle which found between the crust and core. - It lies beneath the crust - It separated from the crust by the zone of separation called Mohorovic discontinuity line has temperature which may reaches to. - It consist of pale green minerals called Olivine (Ferromagnesium silicate) in form of ultra basic rock - It consists of lower and upper mantle. - The upper mantle is rigid and crust to form a large layer called lithosphere. - The lower mantle is less rigid and forms the moltern layer within the earth's interior called asthenosphere. - Asthenosphere is the molten layer layer which responsible for the balancing movement of the earth's material called isostatic readjustment. - Asthenosphere has been investigated is found between 100 to 200km below the upper surface.

CORE /BARYSHERE

The core is the innermost zone of the internal structure of the earth. - It has diameter of about 69000km (4300 miles) density of about. - The core is also classified into two parts i.e. the outer and inner core. - It separated from the mantle by zone of separation called Gutenberg discontinuity - The outer core is consist of nickel and Iron (NIFE) - It estimated to be 2100 km - The inner core is solid in nature because of high pressure exerted from different parts toward the center - It composed mainly by iron - It has diameter of about 2600 – 2700km. (1600 – 1700 miles)

EXTERNAL STRUCTURE OF THE EARTH

External structure of the earth consists of four main layers'. These are Atmosphere, Hydrosphere, Lithosphere / Land mass Biosphere, Biosphere

THE ATMOSPHERE

- Is the thin layer of gases held on the earth by gravitation' attraction. - It composed by abiotic (non-living matter) and biotic living organism. - Non-living matter found in the atmosphere includes mixture of gases, water vapor and dust particles. - The living organism include the smallest or microscopic organisms like bacteria

COMPOSITION OF ATMOSPHERE

Atmosphere is the outer zone or external structure of the earth composed by Abiotic and Biotic components.

• Abiotic components of Atmosphere The abiotic components of the atmosphere include the following. Mixture of various gases These include Nitrogen (78%), oxygen (21%), argon (0.009%) and carbon dioxide (0.03%). - Other gases include neon, helium, Krypton, xenon and other which are present in minite (small proportion) percentage. Water vapor Is the colorless and odorless (smell less) gas in the form of water which makes up a perfect mixture with other gases - The degree to which water vapor is present in the atmosphere is called humidity. - Humidity is very important to weather as condensed to form clouds and fog. - Excess water vapor brings about precipitation in form of rain, hail, snow and sleet. - Water vapor is capable of absorbing heat which penetrates into the atmosphere in the form of radiant energy from the sun to the earth. - It is also act as a blanket which prevents the rapid escape of heat from the earth's surface and therefore maintain heat budget. Dust particles. The dust particles may exposed to the atmosphere naturally or artificially - Natural dust particles are those caused by natural phenomena like winds and volcanic eruptions - Artificial dust particles are those derived from industrial pollutions such as soot and ashes. It includes the particles caused by other man's activities like construction, mining and farming activities - The function of dust particles serve as a nuclear or center around which water vapor condenses to produce clouds.

• Biota components of atmosphere includes bacteria et.

STRUCTURE OF ATMOSPHERE

According to the temperature changes, atmosphere divided into two zones. These are Homosphere and Heterosphere

HOMOSPHERE

Homosphere is the layer which found between 0 – 80km above the sea level. - This is the lowest part of the atmosphere which composed of uniform composition gas of uniform composition of gases and temperature - Homosphere consists of three layers. These are

i) Troposphere - This layer extends by 0 – 15km above the sea level. - Troposphere is the first layer of homosphere located nearest to the earth - It contains water vapor, gases and dust particles - It is the layer of atmosphere which support life on the earth due to the presence of plenty oxygen gas. - All processes of rainfall formation take place in this layer and the temperature decreases as the altitude increases at the rate of per every 100 meters or per every 1000 meters. Note: - This situation where by temperature decreases as altitude increases is called lapse rate and because it occur near to the ground is called environmental Lapse rate. ⇒The upper limit of Troposphere which separates it to the next later is called Tropopause. Tropopause makes the upper limit of troposphere to the next layer called stratosphere.

ii) Stratosphere Stratosphere exists between 15 – 48 km above the sea level. - This is the second layer of homosphere which lies above the tropopause. - It is also composed of water vapor, dust particles and various gases - It is the layer of atmosphere which characterized by high concentration of Ozonic gases. This gases form Ozone layer which found particularly at 20 –35 km in the stratosphere - The Ozonosphere or ozone layer is the layer which form a shield or cover that prevent the earth's surface from destroying by the sun rays. - It prevents the direct incoming of harmful rays from the sun to fall direct on the earth's surface. - The temperature remains unchanged about between 20 –35 km from the earth's surface. Then temperature increases with height to about at the upper limit of stratosphere called stratopause. - The increase in temperature with height is referred to as temperature invasion.

iii) Mesosphere - This layer extends between 48-80 kilometers above the sea level. - Mesosphere is the third part of the homosphere where temperature decreases as the altitude increases. - It separated from the stratosphere by the zone of separation called stratopause. - The upper limit of mesosphere is called mesopause. - Mesopause record minimum temperature of this zone that may fall to making this zone to be coldest. - It is at this zone where strong upper air streams of wind like jet streams are experienced.

HETEROSPHERE

- Is the second layer of atmosphere which extends from 80km towards the interplanetary space - Heterosphere divided into two layers which include Thermosphere and Exosphere

THERMOSPHERE

- Is the lower part of heterosphere where temperature increases as the altitude increases from - i.e. temperature invasion. This is because; there is no water vapor or dust particle in this zone - Ionosphere consists of some ions which influence radio waves. This is because, ionosphere is electrically charged with free electrons that allow the passage of radio waves, television waves and telephone or mobile phone waves

EXOSPHERE

- Is the part of heterosphere which found above the thermosphere. - It has high temperature through it has little significance as it has not been greatly researched. Note: - Within the heterosphere, there is also a scientific significant layer called ionosphere. - Ionosphere consists of some ions which influence radio waves. This is because, ionosphere is electrically charged with free electrons that allow the passage of radio waves, television waves and telephone or mobile phone waves.

THE HYDROSPHERE

- Is the layer of water bodies of the earth including all oceans, rivers, precipitation and underground water. - It is estimated that 75% of the Earth's surface is covered by water bodies.

THE LITHOSPHERE / LAND MASS

- Is the whole solid body of the earth with various landforms such as mountains, valleys and plateaus. - The lithosphere is also known as the crust. - It includes all land masses. The major land mass is called continent and the minor land mass is called islands.

THE BIOSPHERE

- Biosphere is the complex zone which comprises all living things. - It includes a lower level of atmosphere and the upper level of lithosphere and hydrosphere. - Biosphere receives substantial supply of energy from the sun which gives it condition necessary for life and does not occur in any part of the solar system. - The living organisms that inhibit biosphere interact with each other and their environment. - The sum of all these interaction components is called the ecological system or ecosystem. - Biosphere comprises all living organism both macro and micro organisms living in water bodies, soils and on air.

FUNCTION OF ATMOSPHERE

1) Insulation Atmosphere is an insulator it acts as a shield or blanket and therefore regulates temperature during the night and during the winter.
2) Filtration. The atmosphere is the filter. It filters solar insulation and percent ultra violet rays of certain length due to the presence of ozone layer in the stratosphere.
3) Scientific function. Atmosphere is the scientific field - It is the field through which the scientific experiments and observation carried out. Example ionosphere layer of atmosphere reflects some electromagnetic waves and ration signals back to the earth.

4) It supports much on hydrological cycle. The surface water, evaporation, condensation and precipitation formation take place in the atmosphere.
5) It support life some gases particularly oxygen is important for living organisms - Air has weight which contributes to the occurrence of atmospheric pressure variations without which breathing would be impossible. - Wind movement and direction that balances temperature, humidity and precipitation also result from pressure variations.

MATERIALS OF THE EARTH'S CRUST

The earth's crust is composed of different materials ranging from elements, minerals and rocks. These materials differ in their physical and chemical composition.

ELEMENTS

They refer to the smallest particles of matter which can not be split into different forms by any means. Examples of elements are magnesium, potassium, sodium, iron, aluminum and silicon.

MINERALS

They are naturally occurring substances which have definite shape, colour and resistance formed due to combination of different elements. They are formed as a result of the combination of two or more elements. Some single elements like gold, silver and diamond may occur as minerals. Mineral Element Quartz Silicon and oxygen Feldspar Potassium, sodium, calcium and aluminum

ROCK

A rock is an aggregate of minerals in a solid state. On the other hand the term rock can include substances like clays, shells, sandstones and corals. Rocks which contain metallic compounds are called ores.

TYPES OF ROCKS ON THE EARTH'S CRUST

1. Igneous rocks Are rocks that formed when molten rock cools and solidifies within or outside the earth's crust. The origin of igneous rocks is inside the earth where they are under great pressure. Igneous rocks do not occur in layers and they don't contain fossils. Igneous rocks solidify either within the earth's crust and form intrusive features or outside the earth's surface and form extrusive features. Igneous rocks are formed when the molten magma is forced out from the upper mantle to the earth's surface, where it cools and solidifies due to low temperature. Crystals form on cooling and the rocks are called crystalline rocks. There are two main types of igneous rocks:
1. Plutonic: these have solidified deep in the crust and they are seen on the surface only after being exposed by prolonged erosion.
2. Volcanic: these have been poured on the earth's surface where they are called lavas.

Characteristics of igneous rocks

- Igneous rocks reflect light.
- They are not found in layers.
- They do not contain fossils.
- They are crystalline rocks.
- They are formed through cooling and solidification of magma.
- They can undergo metamorphic and weathering processes.
- They contain different minerals like iron, magnesium etc. In Tanzania igneous rocks are found in Dodoma, Iringa and in the shores of Lake Victoria (Mwanza). The main examples are granite, gabbro, basalt and diorite. Some are found in Kilimanjaro and Rungwe (Mbeya) such as basalt, pumice, diorite, gabbro, syenite and peridotite rocks.

2. Sedimentary rocks

Sedimentary rocks are rocks formed through weathering processes when sediments are accumulated, compacted and cemented together. The sediments are compacted by compression to form sedimentary rocks. Sedimentary rocks are found in layers; they contain fossils and are very soft. These are weathered particles formed through deposition and lithification processes

Characteristics of sedimentary rocks

- They are formed when particles or sediments are accumulated, compacted and cemented together.
- They contain fossils.
- They are found in layers (strata).
- They do not reflect light.
- They are non-crystalline rocks.
- They can undergo metamorphic process.

Types of sedimentary rocks

a) Mechanically-formed sedimentary rocks These are formed through weathering process. When weathering agents erode and deposit rock particles, they are accumulated, compacted and cemented together to form sedimentary rocks. Examples of mechanically formed sedimentary rocks are clays, gravels and alluviums (all deposited by water), moraines, boulder clay and gravels (deposited by ice) and loess (deposited by wind); sandstones and shale.

b) Chemically-formed sedimentary rocks These are formed through chemical precipitation process. They include carbonate (as it is in stalactite and stalagmite), sulphate, chloride, etc. The main examples are gypsum, rock salt, lignite, dolomite, flint, borax, limonite, haematite, etc.

c) Organically-formed sedimentary rocks These are formed through mineralization process of decaying and decomposition of dead organisms such as animals and plants. The remains of living organisms are accumulated, compacted and cemented together to form these sedimentary

rocks. The main examples are chalk (limestone) and coral (formed from animals), and peat, coal and lignite (formed from plants).

3. Metamorphic rocks

These are rocks which have changed from one type of rock to another due to the contact of heat, pressure or both. This process is referred to as metamorphism. Any rock can be changed into a metamorphic rock. Examples of metamorphic rocks are slate, marble and granite.

There are three kinds of metamorphism

(i) Dynamic metamorphism. This is influenced by pressure of the earth's crust. Examples; Shale to Schist, Clay to Slate, Granite to Gneiss

(ii) Thermal or contact metamorphism. This is caused by intense heat. This can take place when the rock comes into contact with hot molten material like magma or lava. Examples Lime stone to Marble, Sand stone to Quartzite

(iii) Thermal dynamic metamorphism This is the process that takes place as a result of a combination of heat and pressure. It is when the existing rocks are subjected to both pressure and heat to change their shape and appearance. Example Coal to Graphite

Characteristics of metamorphic rocks

- They are very hard due to prolonged action of heat and pressure.
- These rocks can change to another to another type of rocks.
- They can undergo weathering process.

ROCK CYCLE

Rock cycle is a relationship in which rocks tend to change from one type of rock to another. This is the cycle in which rocks tend to change from one type to another. For instance igneous rocks may change to metamorphic rocks or sedimentary rocks; sedimentary rocks to metamorphic or igneous rocks, etc. Necessary conditions for rock cycle to take place or Process of rock cycle.

1. First, the molten rocks erupt from the interior of the earth and then cool and solidify to form igneous rocks.
2. Secondly, the igneous rocks are subjected to denudation process to form sedimentary rocks.
3. Third, either igneous or sedimentary rocks undergo metamorphism, due to prolonged heat and pressure, to form metamorphic rocks.
4. Fourth, metamorphic or igneous rocks can undergo weathering process through erosion and transportation of sediments which are further deposited in layers in the ocean or lake floors where they are cemented and consolidated to form sedimentary rocks and vice versa.
5. Fifth, metamorphic or sedimentary rocks can be subjected to heat and pressure where melting take place and later cooling, due to low temperature, to form igneous rocks.

Simplified geological time scale

The geological time scale is a chart for dating the history of the earth including rock span. It tries

to explain the age of rocks as far back as 600 million years ago. Era Period Years in millions before present Major geological events in Africa Man and animals Cenozoic Quaternary 1 Glaciation of East Africa mountains. Formation of river terraces and raised beaches. Age of man Tertiary 163 Formation of the Atlas mountains. Lava flows in Ethiopia. Age of mammals, Mesozoic Cretaceous 135 Deposition of marine sediments in the Sahara and Southern Nigeria. Formation of Enugu coalfield. Age of reptiles Jurassic 180 Break-up of Gondwanaland and Marine invasion of East Africa coastlands and separation of Malagasy Island from mainland. Triassic 230 Drakensburg lavas and formation of upper Karro beds. Volcanic activity in West Africa. Paleozoic Permian 280 Formation of lower Karro beds. Formation of rich coal deposits in Tanzania and South Africa. Ice age in central and South Africa. Age of amphibians Carboniferous 345 Cape fold formed. Devonian 405 Marine invasion of Libya, the Sahara and Western Sudan. Continental basins formed by crustal warping Silurian 425 Continental sedimentation in Zaire basin, Tanzania and South Africa, followed by intensive folding. Ordovician 500 Extensive deposition of sediments. Formation of sandstones in Guinea, Mali, Volta basin and North West Ethiopia Age of marine invertebrates Cambrian 600 Marine invasion of Western Sahara and Kalahari basin. Proterozoic Pre Cambrian or Archarean Glaciations of Africa South of Equator. Extensive metamorphism of oldest known fossilized, unicellular algae formed in Swaziland and Mali. Algae

The importance of rocks

1. Rocks are very important in the formation of soils which can be used for agricultural production.
2. Rocks are used for building purposes: some rocks such as limestone, sandstone, gravels and sand are used for building houses, construction of roads, etc.
3. Some rocks are used as sources of energy or fuel such as coal and petroleum (mineral oil).
4. Limestone is widely used for cement manufacturing. In Tanzania, cement is produced at Tanga, Mbeya and Wazo Hill.
5. Salt extraction: salt usually originate from rock accruing strata, for instance, in Tunisia and Morocco there are large deposits of salt.
6. Manufacture of chemicals: some rocks contain nitrate or phosphate, while others have potash. This kind of rocks can be used for making dyes, fertilizers and medicines.
7. Mineral deposits: mineral ores occur in veins of some rocks such as igneous rocks. The minerals are formed when the magma coos down. Valuable minerals extracted from rocks include gold, lead, tin, silver, diamond, copper, zinc, aluminium, calcium and manganese.
8. Some rocks are so impressive such that they attract tourist to come and view them. In so doing, the country earns a lot of foreign exchange.
9. Some rocks are used for decoration of houses as ornaments or they are grinded to produce powder which is used for decoration.

Topic 2: FORCES THAT AFFECTS THE EARTH

Forces are the processes that operate (work) within or on the earth's crust. There are different forces that affects the earth.

INTERNAL FORCES: These are forces which operate within the earth's crust. Internal forces include vulcanicity and earth movements, that is, horizontal (lateral) and vertical movements. These forces may result into formation of several landform features.

EXTERNAL FORCES: These are natural forces that operate on the earth's surface. The force s mainly act on the earth's crust or close the surface of the earth. Often the features produced by these forces are seen on the surface of the earth. They include mountains, volcanoes, moraines and valleys, just to mention a few.

INTERNAL FORCES (ENDOGENETIC/ENDOGENIC)

These are forces that operate within (inside) the earth's crust OR These are forces which operate beneath (under) the earth's surface. These forces are generally referred to as TECTONIC FORCES. The internal forces (tectonic forces) are divided into the following. (1) Earth movement (Diastrophism) (2) Vulcanism/ Vulcanicity/Volcanic erruptions

EARTH MOVEMENTS

Earth's movement is the movement of the solid parts of the earth towards each other or away from one another or side way. These are also known as Diastrophism Types of Earth movement Earth movements are classified into two (2) main groups:- (i) Vertical or radial movements (ii) Lateral or horizontal movements or tangential.

I) VERTICAL OR RADIAL MOVEMENTS.

These are the upward and downwards movements or forces .These forces cause the uplift (epeirogenic) and the downward movement (cymatogenic). These forces which cause the vertical earth movements operate from the interior upward toward the surface or downward from the surface to the interior. The result of vertical movement

(a) The crustal rock to fault. When faults develop produce feature like plateaus, basin, Block Mountain (host) and escapements.

(b) Changes sea level because of the upward lift of the land or sinking of the land. NB: This changes in the sea level is not eustatic changes but is due to vertical forces. The eustatic change is the changes of the sea level due to ice melt during ice ages

II. LATERAL/HORIZONTAL MOVEMENTS

Are the organic forces (movement) because they are on the process to build mountains. Orogenesis means the process of mountain building There are two (2) types of lateral forces

1) Compressional forces

2) Tensional forces.

Compressional forces

Are forces which move towards each other i.e move against each other. - They tend to shorten the crust (the land) i.e. they squeeze the land. Compressional force causes the following.

(i) Folding of land hence fold mountains

(ii) Break the land to form faulting which may produce features like block mountains, rift valley and faults. **Tensional forces**

Are forces that tend to stretch the land i.e. the force move away from each other, they pull the land away. The forces cause faulting of the crust and produce features like faults, Block Mountains, and rift valley.

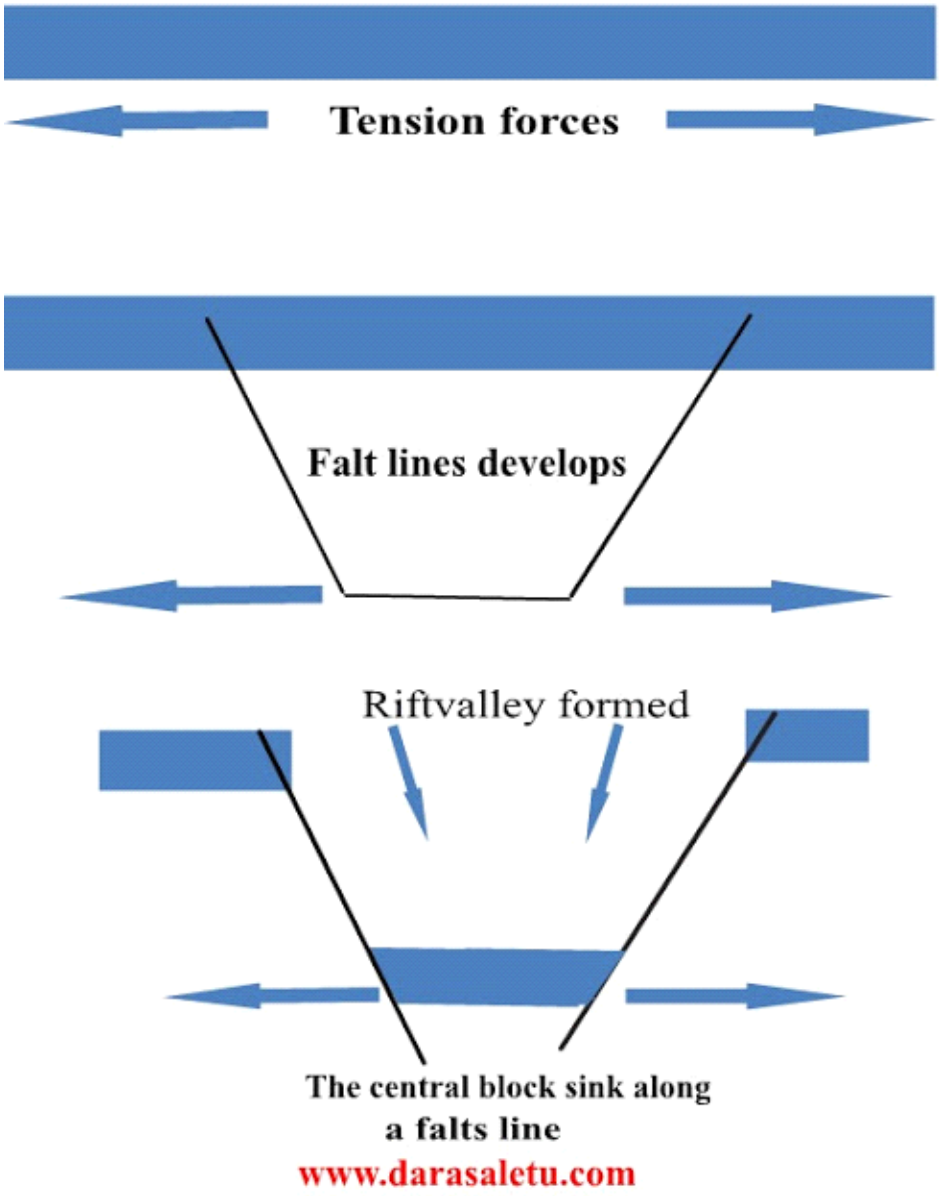
Features associated with earth movements

Rift Valley

Rift valley is a trough or hollow which may result from both vertical and lateral movements of the earth's crust. It is formed when two faults develop parallel to each other. It can develop either by tensional forces or compressional forces.

Formation of rift valley by tensional forces

This is formed when tensional forces move away from each other. These forces of tension produce faults and the block between two parallel faults subsides to form a rift valley.

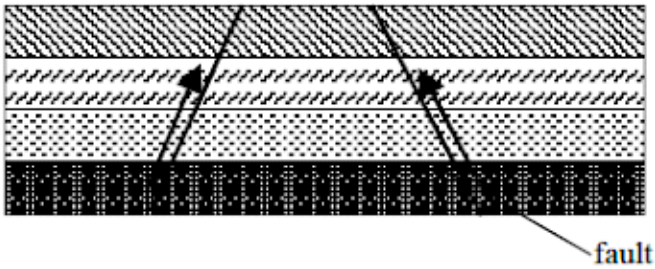


Formation of the Rift Valley by compressional forces

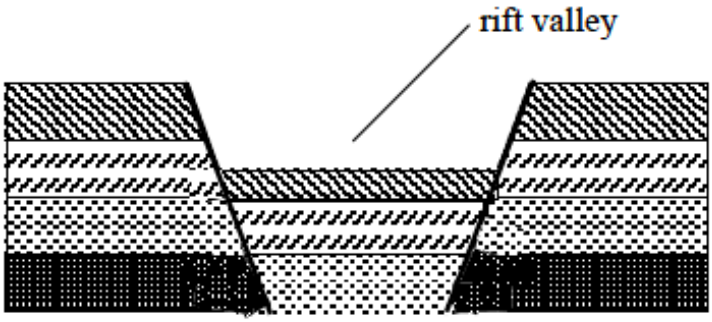
This is formed when horizontal forces act towards each other. These forces of compression produce faults on the outside of the two parallel faults and the pieces of land on either side are lifted up above the general level of the ground to form a rift valley. Diagrammatically, formation of the Rift Valley occurs like this:

(a) Movement of tensional forces

(b) Uplifting of the land on the outside of the two faults



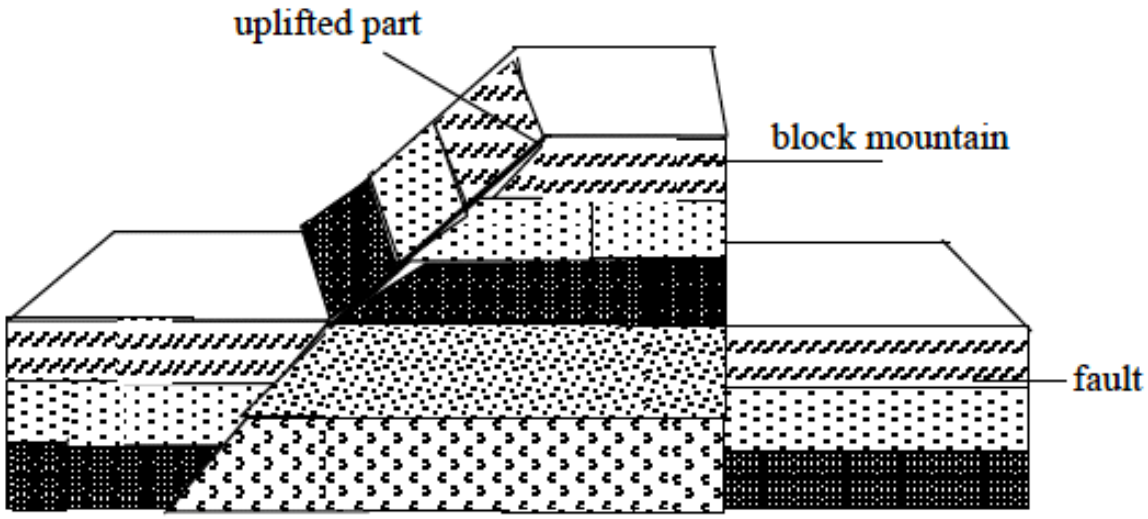
(c) Rift valley formed



Examples of rift valleys include:
• East African rift valley – Africa; • Jordan rift valley – Asia;
• Rhineland rift valley – Europe.

Block mountain (horst)

A block mountain refers to a table-like mountain formed due to the influence of faulting that leads to rising of crustal rocks. It is nearly a flat surface. A block mountain can be formed by either tensional or compressional forces. This is when the earth's movements cause parallel faults which results into uplifting of some parts. Examples of Block Mountains are: Usambara and Uluguru, in Tanzania, Ruwenzori, in Uganda, Vosges and Black Forest, in Europe; and Mount Sinai in Asia.

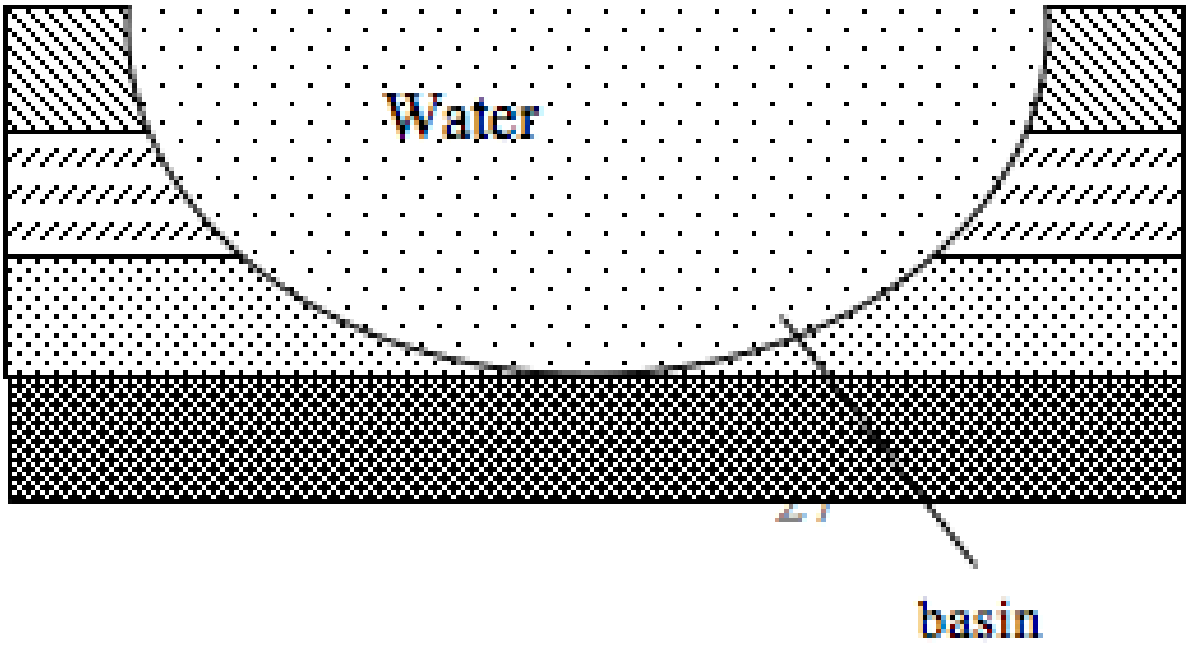


Plateau

A plateau is a large, extensive uplifted part of the earth's crust which is almost flat at the top. The top of the plateau is mostly a plain. Plateaus were formed during Mesozoic and Jurassic eras. It was due to uplifting of the earth's crust. Such landforms are East African and Brazilian plateaus. High plateaus especially in tropical latitudes are used for agriculture and settlement.

Basin

A basin is a large, extensive depression on the earth's surface. Most basins are formed due to vertical movement of the earth. Examples of basins include: an inland drainage e.g. Congo basin, Chad basin; and Amazon basin.



2. VOLCANIC ERRUPTIONS/VULCANICITY/VULCANISM VULCANICITY

is the range of processes by which molten materials and gases are either intruded (injected) or extruded (ejected) into the earth's crust or into the earth's crust respective Vulcanicity is the formation of various feature due to the intrusion or extrusion of molten materials, and gases. The molten materials are called magma when found within the earth's crust and magma when poured on the earth's crust. Vulcanism/Vulcanicity –Is a broader term which includes both extensive and intrusive igneous activities while volcanicity –Refers to the extensive volucancity in which the materials are forced at onto the surface. Types of vulcanicity There are two types of vulcanicity which are classified as follows

1. INTRUSIVE VOLCANIC FEATURES

This is when magma intruded within the earth's interior. The features resulted due to the intrusive volcanic eruption is called intrusive features. The intrusive volcanic features are the features which are found within the earth's interior. These include the following. Sill–is a rock sheet formed when the magma solidifies horizontally along the bedding plane. Eg:- Tyolo scarp in Malawi Dyke- is a rock sheet formed when the magima solifies vertically across the bedding planes. Eg:- Kinkon Laccolith is the cone dome shaped mass of rock with flat formed of viscus lava. It look like a mushroom. Eg:- Laccolith found in Morafonobe in Madagases. Lapolith –is a scar shaped mass of rock formed in glosyncline. It forms a saucer –like shape may be due to the increased weight of the deposits Phacolith –is a leans shaped strip of igneens rock formed when the magima solidies along the anticline or syncline. Eg: Cordon wills in U.K Phacolith Batholith is the large mass of solidified rock formed when magma cools plutonically at the great dept Eg: at the heart of the mountain ranges. Eg:- Chilu Batholic in Gabon

2. EXTRUSIVE VOLCANIC FEATURE

Are the features formed when the magma cools and solidifies on the earth's surface. The extrusive volcanic features can be classified into the following

I. Central features and II. Fissure features I. Central features is due to the violent eruption and this include the following Ash and cinder cone Lava is blown to great heights when it is violently ejected and it breaks into small fragments which fall back to earth and build up a cone, example Busoka and Bitale in South west Uganda. • Composite cone This type of cone is formed of alternate layers of lava and ash. The volcano begins each eruptions with great violence forming a layer of ash. As the Eruption proceeds the violence ceases and lava pours out forming a layer on top of the ash, Lava often escapes from the sides of the cone where it builds up small conelets.Example mount Kilimanjaro in Tanzania and mount Cameroon • Volcanic plug/plug dome volcano. Is a rigid cylindrical plug formed when very viscous lava is forced out of the volcano and form a plug dome that may completely block the vent. Good examples of a plug dome occurs in the Atakor volcanic area of Haggar mountains in Algeria. These are almost 300 plug domes in these region • Crater is a depression formed on the summit of the cone after the plug dome has been blown off on the top of the cone. • Caldera is a large crater formed when the upper part of the volcano is either bombarded away by violent eruptions or subsides into the

crust. Eg:- Alaska, Ngorongoro in Tanzania, Eboga in Cameroon Features due to peaceful eruptions The lava coming onto through the vent can be acidic and hence viscous or basic and hence less viscous. The following are the central features due to peacefull eruptions • Acid lava cone/comulo dome volcano is the dome shaped volcano with convex slopes formed when acidic lava solidifies around the vent Eg:- Ntumbi dome (Mbeya) •Shield volcano Is an extensive cone with gentle sloping sides formed when basic (basalt) is poured on the surface and spread to occupy large area. Sometime times these features can be formed when lava comes out through a single fissure or many fissures. • Fissure eruption The fissure eruption involves lava coming out through a crack or fault. The feature formed is called lava plateau. Minor volcanic features A variety of minor volcanic forms can be distinguished, usually though not necessarily associated with volcanoes approading extinction. They include the following •Mofettle –is the volcano which emit carbondioxide gas. •Hot spring – is the volcano which emits hot water With dissolved minerals suspension. Hot springs mostly occur in island or in some of the African countries such as Kenya and Ethiopia. Salfatara –is the volcano which emits sulphur gas. •Fumerole –is the volcano which emits steam, mud and other gas than sulphur. Is the outflow of super-heated water from the ground which contains some mineral substances in solution or in suspension Geysers – are the forceful omission of hot water from the ground to high level in the atmosphere when emitted contains fine material forms mud volcano which later can lead to the formation of very fertile soild Types of volcanoes according to the activity There are three types of volcanoes according to the activities. These include:-

I. Active volcano: is the volcano which erupts frequently. Eg:- Oldonyo Lengai in Tanzania and Mount Cameroon.

II. Dormant volcano is the one which has stopped erupting but not extinct and it is expected to erupt. The dormant volcano is also known as sleep volcano. III. Extinct volcano. Is the volcano which has stopped erupting for a very long time in history and is not expected to erupt. It is also known as dead volcano.

INFLUENCES OF VOLCANIC ERUPTION TO MAN AND ENVIRONMENT

The following include the economic importance of volcanic eruptions to man. i. Lava on weathering head to the formation of very fertile soil which support agriculture. ii. Volcanicity eruption lead to the formation of mineral deposits like copper deposits of butte in USA, diamond of kimberley in South Africa. iii. Volcanic eruption provide geothermal power for electric generation iv. Some hot springs utilized for heating homes in glaciated region v. Volcanic features attract tourist vi. Volcanic cones are the source of rivers.

EARTHQUAKE

Earthquake these are sudden earth movements or vibration in the earth's crust i. When one tectonic plate sliding over/or past another plate along the line of a faulty ii. Volcanic eruption- The movement of molten rock below or onto the earth's crust which in turn is caused by the movement of plates. The Nature of Earthquakes •The point of which on earthquake is originate is called focus. And sometimes it is several kilometres below the surface. •The point on the earth's

surface immediately above the focus is called the Epicentre, This is where the shock waves first hit the surface. It is the shock waves which gives rise to an earthquake.

TYPES OF SHOCK WAVE

There are two types of shock waves:-

1. Body waves. Are waves which travel through the crust and are of two types i. Primary waves- which cause the crustal rock to move back and forth in the direction of wave movement ii. Secondary waves- Are waves which cause the crustal rock to move side to side ie right angles to the direction of wave movement.
2. Surface wave. These travel through the surface and are of two types i. Love wave;- Which cause the surface rock to move side to side of right angles to the direction of wave movement. ii. Rayleigh wave;- Wave which cause the surface waves to have a circular movement very similar to that of water wave movement.

DETECTING MAGNITUDE AND INTENSITY

The intensity of an earthquake is measured by an instrument called seismograph. Seismograph record the vibration produced by an earthquake. The magnitude of an earthquake is the total amount of energy released and the scale which gives the magnitude is called the Richter scale. The scale range from 0 to 8.9 Effects of Earthquake. For example the earth quake occurred in Bukoba Tanzania Sept. 10, 2016 has 5.7 Richter scale. Rise and fall of the sea floor Eg. Agadir Earthquake in Morocco in 1960 Displacement of the earth's crust, it can happen vertically or laterally. Land slides and open up deep cracks in the surface rocks eg. The El Asnam earthquake in Algeria 1954 destroyed an area of radius 40km and open surface cracks up to 3m deep. Destruction of infrastructure and properties Loss of life, can lead to death's They can raise or lower erosion rocks eg. In Alaskan the earthquake of 189 lead to raise of some rock for about 16km.

THE CAUSES OF EARTHQUAKES

• Faulting of the lithosphere caused by tectonic movement where one plate slides over another plate. • Volcanism can cause occurrence of the earthquake. This is due to the fact that the magma moves under the influence of intense pressure from within the earth's interior. • Mass wasting like land slide and rock fall can cause occurrence of earthquake, but this is for local scale. • Falling objects from the atmosphere such as meteorites may lead to the shaking earth's crust. • Man's influence through his activities such as mining using explosives like dynamites and transport vessels like trains and heavy trucks.

EFFECTS OF EARTH QUAKES

1. Loss of life and property. An earthquake is a natural disaster. For example, the earthquake that hit Toro in Uganda in 1966 killed 157 people, injured about 1300 people and destroyed about 6000 houses. Displacement parts of the earth's crust vertically or laterally.

2. They can raise or lower parts of the sea floor. The Agadir earthquake in Morocco in 1960 raised the sea floor off the coast. In some areas the depth of the sea decreased from 400 m to 15 m after the earthquake. 3. They can raise or lower coastal rocks. In the Alaskan earthquake of 1899, some coastal rocks were raised by 16 m.
4. They can cause landslide and open up deep cracks in the surface rocks. The El Asnam earthquake in Algeria, in 1954, destroyed an area of radius 40 km and opened up deep cracks up to 3 m deep.
5. Destruction of infrastructure and houses in Bukoba Tanzania 2016 earth quake causes more than 100 without settlement. Precautionary measures to avoid high damage from earthquakes • Refraining from building high-rising structures on the land vulnerable to earthquake as well as strengthening buildings by using reinforced concrete, steel frames, deep foundations and light roofs. • Geologists should detect epicentres and tell the people to evacuate the places likely to be affected by earthquakes. • To avoid constructing very large water bodies like Kariba dam which can cause the earthquakes due to the weight of water and other materials. • Discouraging the use of explosives like dynamites in breaking the rocks during mining and construction operations.

EXTERNAL FORCES

These are natural forces that operate on the earth's surface. The forces mainly act on the earth's crust or close the surface of the earth. Often the features produced by these forces are seen on the surface of the earth. They include mountains, volcanoes, moraines and valleys etc.

MASS WASTING

Mass wasting is the movement of the weathered materials downslope due to gravitational forces accompanied by rain action. Mass wasting also known as slope movement or mass movement Types of Mass Wasting Types of mass movement are distinguished based on how the soil, regolith or rock moves down the slope as a whole. Based on this factor, mass wasting can be categorized or grouped into two types. These are slow and rapid mass movements, each with its own characteristic features, and taking place over timescales from seconds to years. Slow mass movement This is the movement of soil at very slow speed, water acting as the lubricant. Slow mass wasting is categorized into several types.

These are as follows.
Soil creep Soil creep is the slow movement of the soil downhill after it gets soaked by water. This process is very slow and its evidence is provided by tilting of trees and falling of buildings and fences. Sol creep is activated by any process that loosens the soil, making it easy to move gradually down the slope. Factors influence soil creep: a. Alternate heating and cooling of the soil particles. b. The freezing of water in the soil causing frost heaving. c. Removal of the soil further down the slope. d. Percolation of water into the soil, acting as a lubricant. e. Ploughing of the soil, a fact which makes the soil loose and more mobile. Talus Creep It takes place due to the processes of thawing and freezing and is more pronounced in high latitude regions. It is very

common on sides of mountains, scarps and valleys. This is also a very slow mass movement of screes. Rock creep It occurs commonly where individual rock blocks are lying over clay materials. In the presence of moisture, the clay surface becomes slightly slippery. The rock blocks may creep slowly down the slope under the influence of gravity. Individual rock blocks may move very slowly down a slope. Solifluction This is the slow movement or flowing of weathered materials, especially when mixed with water and gravels. It is limited on highlands and cold regions. Rapid mass wasting This involves the movement of materials in form of mud flow, land slide, rock fall and earth flow. Earth flow This type of movement occurs in humid regions. The materials on the earth's surface gets so saturated with water that it gains much weight, and starts to move down the slope under the influence of gravity. This normally occurs on the slopes of the hills or mountains. The removed earth material leaves a shallow scar on its place of origin and it creates terraces or mounds in its destination.
Mudflow Mudflow is the movement of a large mass of unconsolidated rocks down the slope when saturated with water. It flows in semi liquid state. It is common in desert slopes, which are not protected by a cover of vegetation. This occurs, for instance, during a torrential storm when more rain falls than the soil can absorb. Land slide This is the rapid movement of surface rocks and soil down a steep slope such as a cliff face. It includes slumping and sliding of materials. During the movement, the block tilts and leaves holes. It is common in well jointed limestone rocks, shale or clays. The common forms of landslides are slump, debris slide, rock slide, rock fall, debris fall and avalanche. Rock fall This is the free-falling of a single mass of rock, common on steep slopes of mountains and along scarp slopes of the sea. This is the most rapid of all mass movements. If a rock fall occurs repeatedly, for a long time, the broken rocks collect at the bottom of the slope in a mound called talus.

The Factors which Cause Mass Wasting Mass wasting is caused by a number of factors which include the following:
1. Gradient or slope: When the gravitational force acting on a slope exceeds its resisting force, slope failure (mass wasting) occurs. Mass wasting is very common and severe in areas with steep lands as compared to flat or moderately flat lands.
2. Weathering: weathering processes weaken and loosen the rock, hence accelerating the process of mass wasting. For example, oxidation of metallic elements and hydration of the minerals in rocks create lines of fracture and, consequently, the onset of mass wasting.
3. Amount of water present in the rocks: Water can increase or decrease the stability of a slope depending on the amount present. Small amounts of water can strengthen soils because the surface tension of water increases soil cohesion. This allows the soil to resist erosion better than if it were dry. If too much water is present the water acts as lubricating agent, reducing friction, and accelerating the erosion process, resulting in different types of mass wasting (i.e. mudflows, landslides, etc.).
4. Vegetation: The roots of plants help bind the soil particles together making the soil resistant to agents of erosion and weathering. This makes the soil hard to break and hence resistant. Mass

wasting processes, such as soil creep, cannot occur easily in soils well-covered with vegetation. Also the mass of vegetation cover blocks and prevents movement of the eroded material. Plants remove water from the ground through absorption. There for absence of vegetation accelerates mass wasting.
5. The nature or type of the rock materials: Clay soil is compact and resistant to various types of soil erosion agents and mass wasting as compared to sandy soil, which is normally loose and easy to remove and transport by water, gravity, wind, etc. Thus, mass wasting may be more severe on sandy soil than its counterpart clay soil under similar prevailing conditions.
6. Overloading: When the soil accumulates in one location as a heavy mass of the rock material, it can be moved either by action of gravitational force or application of just a little force. Landslides occur as a result of the soil accumulated on a sloping land to an extent of exceeding the resistant force of gravity. Movement occurs when the gravitational force exceeds the resistant force of soil material.
7. Earthquakes: Earthquakes cause sections of the mountains and hills to break off and slide down. Earthquake tremors tend to loosen the soil material and make it easy to be removed and transported. It can accelerate rock falls, landslides and soil creeps.
8. Human activities: The activities of man such as cultivation, burning, mining, transportation, animal grazing, etc, removes the soil cover or leads to shaking of the soil.
9. Climate: Climate has a great influence on mass wasting. Areas that receive heavy rains often experience mass movements, such as landslides and soil creep, more often compared to dry areas. On the other hand, a little amount of rainfall does not wet the soil and so cannot cause the soil to move. In cold regions, alternate freezing and thawing triggers mass wasting. 10. Vulcanicity: Volcanic activity often causes huge mudflows when the icy cover of a volcano melts and mixes with the soil to form mud as the magma in the volcano stirs preceding an eruption.

The Effects of Mass Wasting to the Environment Mass wasting has significant effects to the environment.
The following are some of the effects of mass wasting to the environment:
1. Formation of scars and bare land: When a large mass of soil moves, such as it occurs in landslide, the process leaves behind a large portion of eroded, bare and unproductive land. This land is often not easily colonized by plants, a fact which stimulates further erosion on the bare scar. Scars are very common on slopes of mountains such as mounts Kilimanjaro, Kenya and Rwenzori.
2. Soil erosion: When mass movement takes place, the load often removes almost all the vegetation on its way. This exposes the land to agents of erosion such as wind, animals, water, ice, waves, etc. Also the place from which the material has been removed forms a scar upon which water, ice and other agents of erosion can act and remove the soil, further leading to gullies, depressions and gorges.
3. Formation of new landforms: The materials removed and transported to a distant location may

form hills at their destination and form scars and depressions at the place of origin.
4. Formation of lakes: Materials of landslide can block ariver bedand valley, preventing downward movement of water. The blocked water accumulates on the upper side of a river valley to form a lake. Examples of such lakes include Lake Bujukuin theRwenzori Mountains, Nyabihoho in Uganda and Funduziin South Africa. Lake San Cristobal in Colorado, USA, was formed when mudflow dammed (blocked) a river in the San Juan Mountains.
5. Diversion of a river course: The landslide material can block the natural river bed, forcing the river to divert and form a new route. This makes the river leave its usual flowing course, and form a new course. The direction of flow of the river is thus changed. This happened in the Rif Atlas Mountains of Morocco in 1963 when a mudflow pushed the course of RiverRhesana100 metres to the east.
6. Formation of a fertile soil: If the removed material comes from a fertile land, it can form a fertile soil at the place of destination, where fertile soil never existed, and encourage agricultural activities to take place.
7. Damage to property: Different categories of landslides may cause various damages to property and can adversely affect other resources. The effects of landslide are dangerous because they destroy everything in their path. Roads are blocked, hampering traffic flow. Homes, buildings and other infrastructures are destroyed. The water mains, sewers and power transmission lines are disrupted. Oil and gas production and transportation facilities are ruined. Farms are also destroyed by various forms of mass wasting.
8. Loss of life: The more populations expand and occupy more and more of the land surface, mass movement processes become more likely to affect humans. The table below shows the impact of mass movement processes on human life over the last century. Year Location Type Fatalities 1916 Italy, Austria Landslide 10,000 1920 China Earthquake triggered landslide 200,000 1945 Japan Flood triggered landslide 1,200 1949 USSR Earthquake triggered landslide 12,000-20,000 1954 Austria Landslide 200 1962 Peru Landslide 4,000-5,000 1963 Italy Landslide 2,000 1970 Peru Earthquake related debris avalanche 70,000 1985 Columbia Mudflow related to volcanic eruption 23,000 1987 Ecuador Earthquake related landslide 1,000 1998 Nicaragua Debris avalanche and mudflow triggered by heavy rains during Hurricane Mitch ~2,000 2001 El Salvador Earthquake-induced landslide 585 2006 Philippines Rain triggered debris avalanche >1100 2009 Taiwan Typhoon Marakot triggered landslide 397 2010 Gansu, China Rain triggered mudflows 1287 2013 Northern India Heavy rain triggered landslides 5700

WEATHERING

Weathering refers to a processes where by rocks disintegrate into small particles due to the agents of weathering such as water, ice, wind, wave, etc. The process results from the forces of weather, that is, changes in temperature, frost action and rain action.

Types of Weathering

The main forms of weathering include:

• Mechanical weathering;

• Chemical weathering; and
• Biological weathering.
Mechanical weathering This is also referred to as physical weathering. It is a type of weathering caused by changes in temperature. It is common in areas where there are extreme changes in temperature such as hot deserts, arid and semi-arid regions. Mechanical weathering includes the following types: Exfoliation This process occurs due to temperature change. During the day time rocks expand due to high temperatures and contract during the night due to low temperatures. Alternate heating and cooling set up powerful internal stress in the top layer of the rocks. The stress produces fractures which cause the outer layer to pull away leading to the cracking and disintegration of rocks into small particles. The peeled off rock fragments fall to the bottom of the standing rocks and are subjected to further alternate expansion and contraction and disintegrate to even smaller fragments. The fragments collect at the base of the standing rocks to form mounds of steeply sloping rock fragments called talus or sometimes screes, but the term is better used for angular rock particles produced by the action of frost. The rocks that remain standing as exfoliation takes place are called exfoliation domes. Exfoliation domes occur in desert, semi-desert and monsoon regions. There are many exfoliation domes in the Egyptian, Kalahari, Sahara and Sinai deserts. Frost action This is common in temperate regions where temperature falls up to freezing point. When temperature falls (freezing point) water collects in the rocks and it freezes, its volume increases causing the crack to deepen and widen. Usually it involves the freezing of water in the cracks during the night and thawing (melting) during the day in mountainous areas. This action of thawing (melting) and freezing of water in the cracks cause the rocks to shatter (break) into angular fragments which form screes and talus. After thawing the cracks deepen further. Alternate wetting and drying This usually occurs in tropical regions. These areas have seasonal rainfall and they get rain during summer season and during winter season they are dry. This causes the blocks to disintegrate. Self-check: Differences between Weathering Processes Chemical weathering Refers to the weathering involves the decomposition of some of the minerals contained in a rock. Some rocks decompose when they come into contact with water (H_2O), or oxygen (O_2) and carbon dioxide (CO_2), two of the gases that make up air.

Chemical weathering includes the following processes:
1. Oxidation– This happens when oxygen combines with a mineral. It takes place actively in rocks containing iron, when oxygen combines with iron to form iron oxides. This process is often preceded and accompanied by hydrolysis. The new minerals formed by oxidation are often easily attacked by other weathering processes.
2. Carbonation– This process occurs when hydrogen carbonate ions react with a mineral to give a soluble compound which can be carried away in solution. Hydrolysis often accompanies carbonation.
3. Solution–This refers to dissolution of a mineral with a chemical substance. Rain water combines with both atmospheric carbon dioxide and oxygen to form weak carbonic acid. $CO_{2(g)}$

+ $H_2O(l) \rightarrow H_2CO_3 (aq)$. So when the rain reaches the ground it consists of a weak acid called weak carbonic acid. This acid helps to dissolve many insoluble minerals into minerals soluble in water, and which can be carried away in solution. When rain containing weak carbonic acid falls in a limestone region, it reacts with limestone (calcium carbonate) and dissolves it into soluble calcium hydrogen carbonate, which can easily be carried away in solution.$CaCO_3(s) + H_2CO_3 (aq) \rightarrow Ca(HCO_3)_2 (aq)$ In limestone regions, the rocks are dissolved and produce features like grike and clint (trough and ridge).

4. Hydration– This is the process in which some minerals absorb water and swell up, causing internal stress and fracture of the rocks.

5. Hydrolysis– This process involves the reaction of hydrogen (in the water) with certain mineral ions (in a mineral). This gives rise to the formation of different chemical compounds that can be easily weathered through other weathering processes.

NOTE: Usually two or more chemical weathering processes take place at the same time. Chemical weathering is most marked in hot wet regions. Biological weathering: It resulted when plants grow on rocks and their roots penetrate into rock joints which later force the rocks to break apart. Also man contributes much to rock disintegration through farming activities, mining, quarrying and construction. Macro- and microorganisms also disintegrate rocks through burrowing and by mineralization process. Bacteria, for example, in the presence of air, break some minerals which are dissolved in the soil. Plants also absorb minerals from the soil by their roots. Decayed vegetation produce organic acid which remain in the soil. All of these actions help to weaken the rocks. The Significance of Weathering

1. Weathering leads to soil formation. Soil is formed through the process of weathering of rocks. Various forms of weathering lead to rock disintegration and hence formation of the soil. The soil is an aggregate of organic and inorganic particles formed by different processes of weathering.

2. Weathering may shape the rocks into attractive features which can attract tourists and hence earn the country and communities the much needed foreign exchange. An example of a feature that can attract tourists is the Bismarck Rock on the south shore of Lake Victoria.

3. The processes of weathering weaken the rocks such that they can be easily acted upon by agents of erosion. The process helps to shape the earth and produce various landforms. This, in turn, influences the type of human activities that can take place in an area. So the process is very important in supporting life.

4. When the rocks are weathered they become weak and hence easy to exploit, e.g. by quarrying. This process also helps to break up large rocks into small fragments such as sand, which is used for construction purposes.

5. Weathering serves as carbon sink. Any process that reduces the amount of carbon dioxide from the atmosphere is termed as carbon sink. Some processes of weathering involve absorption of carbon dioxide from the atmosphere. This helps to remove excess carbon dioxide from the atmosphere. Limestone and other carbon-based sedimentary rocks are important carbon sinks.

EROSION AND DEPOSITION BY RUNNING WATER, ICE, WIND AND WAVE ACTION

The Concept of Erosion and Deposition River refers to a mass of water flowing through a definite channel over a landscape from river source to river mouth. River source is the place where a river starts. It may be in the melt water from glacier e.g. river Rhome (France), a lake, e.g. Lake Victoria, the source of river Nile, a spring e.g. Thames (England) or it can be formed following steady rainfall e.g. river Congo. River mouth can be anywhere a river pours its water, e.g. a lake, ocean or sea. How Agents of Erosion and Deposition Operate on the Landscape The river has three functions as it flows through its channel. These are river erosion, transportation and deposition. River erosion Erosion of a river operates in three ways, that is, head ward, vertical and lateral erosions.

- Head ward erosion– this is the cutting back of the river at its source. It is through this erosion that a river increases its length.
- Vertical erosion– this is erosion by which a river deepens its channel.
- Lateral erosion– This is the wearing away of the sides of a river by water and its load. It is responsible for widening of a river valley.
- River erosion involves four related processes. These are abrasion (corrasion), attrition, corrosion (solution) and hydraulic action.
- Hydraulic action: This is the process whereby the force of moving water plucks and sweeps away loose materials, such as silt, gravel and pebbles. Materials plucked by hydraulic action are responsible for bank caving and slumping.
- Corrasion (abrasion): This is when the load of the river rubs against the bed and sides of the river channel. This causes wearing away of the sides and bed of the river. The amount of load determines the nature of erosive power and rate of erosion. This is a source of pot holes in the river bed.
- Attrition: This is when the rock fragments in a river's load are broken into small fragments due to collision against one another as the load is carried downstream along the river channel. As the river moves along its course, its fragments get progressively smaller because of disintegration and wearing away.
- Corrosion (solution): River water dissolves certain minerals leading to dissolution and disappearance of some rocks, e.g. limestone, rock salt and chalk. River transport This is the process which involves carrying away of the weathered and eroded, loose materials from one place to another. The materials carried out by river is called load. River transports its load in four ways. These ways are as follows:

1. Saltation– this is the process in which small pieces of the rock fragments are carried by a river while bouncing on the river bed.
2. Traction– this is the dragging or rolling of large boulder such as pebbles along its river bed.
3. Suspension– This involves transport of fine or light materials like silt and mud, which are carried in suspension forms. This is common when the river flow is too strong.
4. Solution– this involves moving some materials that dissolve in water, which are carried away in solution form. A river transports its load until it has insufficient energy to transport it any

further. When this happens, the load is deposited. River deposition A river deposits its load when its volume and speed decrease.

A river volume decreases when:
1. It enters an arid region especially a hot desert;
2. it crosses a region composed of a porous rocks e.g. sand and limestone; and
3. During the dry seasons or in a period of drought.

A river speed decreases when:
1. it enters a lake or sea; or
2. when it enters flat or gently slopping plain such as a valley bottom. Deposition takes place when the river has insufficient energy to carry its entire load. The first part of the load that is dropped consists of boulders and pebbles. The last part to be dropped is the fine sediment, called silt. Deposition takes place at any point in a river's course.

THE LONG PROFILE OF A RIVER
The long profile of a river is the line following the course of a river from its source to its mouth. Three courses or sections of a river can be distinguished.

These are: • The upper course. • The middle course. • The lower course.

The upper course/section
This is the first stage of a river. It is sometimes called the youth or torrent course. Its characteristics are as follows:
1. It is the river source.
2. The speed of a river is high. 3. Most of the works of the river include vertical erosion.
4. The cross-section of a river valley in this section of a river is V−shaped.
5. The slope of a profile is very steep.
6. It is sometimes utilized for hydroelectric power (H.E.P) generation. Erosional and Depositional Features for each Agent The main features of the upper section are deep and narrow, V-shaped valley; a steep gradient; pot holes on the river bed; interlocking spurs and waterfalls and rapids, often with plunge pools.
• V−shaped valley: this is a deep, narrow valley at youth/first stage of a river.
• Pot holes: These are circular depressions on the river bed. They are formed when pebbles carried by the swirling water cut circular depressions in the river's bed.
• Interlocking spurs: An interlocking spur, also known as an overlapping spur, is one of any of a number of projecting ridges that extend alternately from the opposite sides of the wall of a young, V-shaped valley down which a river with a winding course flows. Each of these spurs extends laterally into a concave bend of the river such that when viewed either upstream or from overhead, the projecting ridges, which are called spurs, appear to "interlock" or "overlap" in a

staggered formation like the teeth of a zipper. As the river erodes the landscape in the upper course, it winds and bends to avoid areas of hard rock. This creates interlocking spurs. Waterfalls and rapids-Waterfall: A waterfall is a place where water flows over a vertical drop in the course of a stream or river. A waterfall is formed when there is sudden change or drop in the bed of a river. Although waterfalls can occur in almost any part of a river's course, they are most common in the upper course. Examples of waterfalls are Owen Falls in Uganda, Victoria Falls in Zimbabwe and The Livingstone

- Rapids: These are sections of a river where the river bed has a relatively steep gradient, causing an increase in water velocity and turbulence. Rapids are characterised by the river becoming shallower with some rocks exposed above the flow surface. As flowing water splashes over and around the rocks, air bubbles become mixed in with it and portions of the surface acquire a white colour, forming what is called "whitewater". Rapids occur where the bed material is highly resistant to the erosive power of the stream in comparison with the bed downstream. Very young streams flowing across solid rock may be rapids for much of their length.
- Plunge pool: This is a large depression formed at the base of a waterfall.
- Gorge: It is a steep, narrow and elongated valley. A gorge often is formed when a waterfall retreats upstream, e.g. a gorge found in Victoria Falls. The middle/maturity stage This is the second stage of a river. The main features of this section are bluffs and waterfalls and rapids.

The characteristics features of the middle course of a river valley
1. The speed of a river is fairly low.
2. Most of the work of a river is transportation.
3. The cross–section of a valley in this section is an open V.
4. The slope of a relief is gentle
5. The volume of a river increases.
6. Lateral erosion predominates.

Features associated with the middle course of a river valley
1. Bluffs: These are steep slopes of the truncated spurs in middle course where interlocking spurs turn into bluffs.
2. Waterfalls and rapids: Waterfalls and rapids can also be found in the middle stage of the river valley. This is mainly caused by river rejuvenation which increases erosive activity and transportation, hence development of waterfalls. The old/lower stage Third is the third stage of a river. The main features of the lower section of a river valley are a flood plain; braided river; ox-bow lake; levee and deferred tributary and delta.

Characteristics of lower stage 1. It is the river mouth.
2. Always there are gradient falls or slope falls.
3. The main work of a river is deposition.

4. The cross–section of a valley is a U–shaped valley.
5. The speed of a river is decreased.
6. The river valley is very wide.

The Importance of Erosional and Depositional Features to Human Beings
The following is the importance of features resulting from erosion and deposition
a) Loess form very fertile soil in desert land,
b) Water falls attract tourists; headlands in coastal areas are natural ports.
c) Coastal features form breeding places for fish,
d) Coral reefs are used as building materials and for settlement.

ARTIFICIAL FORCES
These are forces that are caused by human beings through their activities such as farming, mining, setting up settlements, road construction, transport, etc. Man can influence in destruction or removal of some parts of the earth's surface. This shows that man can modify natural landforms and, therefore, acts as the agent of weathering, mass wasting, erosion, transportation and deposition on the earth's surface. Human modification of the land helps loosen large chunks of earth and cause them to slide downhill. Man produces forces that affect the earth through the following activities:
• Removing vegetation: A slope with lots of vegetation is less susceptible to mass movement than a bare slope. Bare, exposed soil is very easily eroded, and can contribute to mass movement activity. Vegetation: helps hold soil, loose rock, and regolith together by its roots; reduces the direct erosive impact of rainfall and other precipitation; actively reduces ground moisture by using it to contribute to plant growth; and produces litter and organic products (leaves, twigs, grasses, fruits) that help stabilize the soil.
• Mining: In the course of mining, man uses machines to dig the soil and blast rocks. These activities results to earth tremors which loosen the soil particles making then vulnerable to removal by agents of weathering and denudation. Blasting also causes fractures in rocks, a fact which makes them less stable and resistant to shear and stress. If this happens, especially on steep slopes, the probability of occurring landslide is very high.
• Farming activities: Farming involves digging the soil by using farm implements such as hoes, tractors, harrows, spades, etc. These activities involves breaking up the soil and rocks by the implements. In this way, crop cultivation directly leads to weathering and erosion. Overstocking (keeping many animals in just a small piece of land) also leads to soil erosion. This is because overstocking is usually accompanied with overgrazing, an act which removes the vegetation cover. This triggers soil erosion and other weathering processes.
• Building and construction: Breaking up the soil for construction of houses and other infrastructures can dramatically increase the potential of mass movement. These processes involve tearing rocks to get room for setting up infrastructures such as roads, railways, airports, seaports, etc. This leads to destruction of the soil, hence triggering mass movement, weathering

and erosion.

- Fishing: Fishermen in less developed countries sometimes use weapons such as dynamites to kill and catch fish. Tremors produced by these illegal fishing tools can cause fracturing of the coastal rocks. This causes both weathering and erosion.
- Navigation: In some few cases, marine vessels accidentally crush onto stones in water, peeling or breaking then into pieces. This leads to rock disintegration, a typical form of weathering.
- Transport: Vibrations from machinery, traffic, weight loading, stockpiling of rock or ore from waste piles and from buildings and other structures loosen the soil and make it prone to soil erosion and weathering.
- Construction of dams and canals: Construction of dams, such as the Mtera dam in Tanzania and canals such as the Suez Canal in Egypt, involves removing a large junk of rock. This breaks up the soil, leading to weathering and soil erosion.
- Warfare: The use of atomic bombs and other heavy weapons in war leads to destruction of the soil. During times of war, heavy and destructive weapons such as atomic bombs, shells, rockets and grenades are dropped or fired towards the enemy. When these weapons fall on land, they detonate and blow up a large mass of the earth, causing weathering and erosion. Military equipment such as tanks, heavy trucks and caterpillars break up rocks over which they pass. At the same time, they loosen the soil and carry away some of it as they move along.

The Causes and Effects of Artificial Forces Apart from the effects caused by natural forces that affect the earth, man-made (artificial) forces have an effect of creating artificial landforms and features on the earth's surface. These include the following features:

1. Man-made lakes such as LakeCahoraBassain Mozambique, Lake Volta in Ghana, LakeKaribain Zambia (the world's largest artificial lake and reservoir by volume) and Lake Nasser in Egypt.
2. Man-made rivers in the form of canals such as Suez and Panama Canals. 3. Wells and boreholes
4. Roads, harbours, railways, airports, bridges, etc.

Topic 3: SOIL

Soil is the thin upper layer of the earth's crust which has been weathered from the parents material and decomposed animals and plants. soil support plants growth and animal life.

FACTORS INFLUENCING SOIL FORMATION

Soil formation is sometimes called Pedogenesis The formation of soil is mainly initiated by weathering process. There are several factors which influence soil formation these are as follows

a) PARENT ROCK MATERIAL

This is one of the Achief factors of soil formation. It determines soil type, color, depth, rate of soil formation, structure, texture, porosity and soil fertility. Parent rock influence soil maturity, therefore hard rocks take a long time to mature while soft rocks take a short time to mature. Shallow and poorly productive

b) CLIMATE

The most variable elements under climate are temperature, precipitation (rainfall) and wind Temperature affects decomposition of organic matter hence it influences the development of soil profile Rainfall and wind encourage the formation of soil due to their role in the erosion process On the other hand rainfall adds moisture which encourages chemical and physical weathering

c) LIVING ORGANISM

Some plants have nodules with bacteria which add nitrogen into the soil hence improve aeration of soil. Microorganisms are active in the decomposition of the organic matter to form humus on the other hand barrowing of animals and plant roots facilitate the state of both physical and chemical weathering hence lead to the formation of soil easily.

d) RELIEF [TOPOGRAPHY]

The role of relief in soil formation is mostly in indirect way. Relief influences climate and vegetation. The most important aspect of topography in soil formation, steep slopes areas soils are shallow due to erosion while on a gentle slopes and low land areas soils are deep due to deposition of materials.

e) TIME

This involves the duration that has been taken in the process of soil formation. Time determines the maturity of soil, when soil formation has taken a long time, soil tends to be mature i.e. they are deep and well developed.

IMPORTANCE OF SOIL

Soil is virtual life support to both flora and fauna organism ,because all the organisms depend on the soil as their source of food . soil is therefore important to both plants and animals life in various ways including the following:-

(i) Animal life support; soil acts as plant habitat in which animals uses plants as food for their survival.

(ii) Building materials soil is used directly in making of bricks, tiles and white wash, The materials are the used in building of houses ,bridges and other structures.

iii) Source of minerals some soils contains minerals which can be extracted for commercial purposes. For example Titanum is obtained from soil deposit of Kwale near Mombasa in Kenya Bauxite, which is mined in Guinea in West Africa

(iv) Cultural and medicinal values Some soils are cultural value in some communities e.g red ochre and clay are used for body decorations by Maasai communities and clay mixed with herbals and being used for medicines

(v) Farming and settlement fertile soil influence cultivation of crops .settlement distribution also depends on arable fertile soil where as people tend to dwell in areas with food availability.

(vi) Habitat for organisms soil functions as a habitat for organisms such as burrowing rodent, earthworms and termite. These organisms perhaps are significant in the process of soil formation

SOIL CONSTITUENTS / COMPOSITION

Soil is made up of the following components;

1. Organic matter This forms 5% of the total volume of soil and is made up of plant and animal remains. This forms humus as a result of decomposition of animals and plant remains.

IMPORTANCE OF HUMUS

i) Improving the structure of the soil and its water retaining capacity limits the leaching process and improves the soil acceleration

ii) Storing and supplying nutrients to the plant like nitrogen, phosphorus, potassium, calcium - high production.

iii) Humus regulates the temperature of the soil and soil pH iv) The living micro-organisms help in decomposition.

2. Inorganic matter This forms 45% of the total volume and is made up of minerals from the parent rock. Minerals constitute several nutrients which are needed by plants.

3. Soil water Forms 25% of the total volume and it is one of the most important soil components. It is derived essentially from rainfall especially from infiltration and through flow.

IMPORTANCE OF WATER

a) It regulates temperature in the soil

b) It helps in the solution and transfer of nutrients in the soil

c) Too much water in the soil leads to the leaching of mineral nutrients in the soil

d) It controls chemical processes like weathering as well as mechanical weathering.

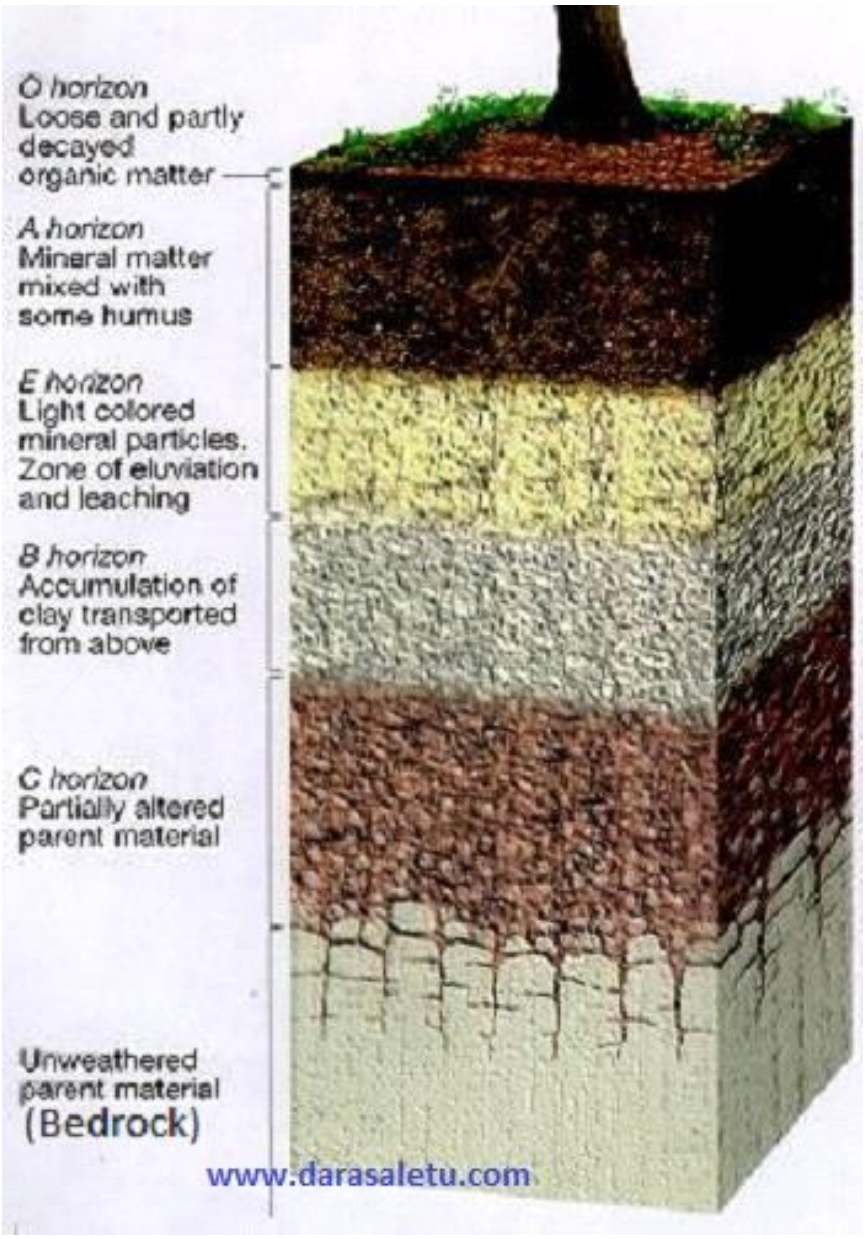
4. Soil air It forms 25% of the total volume. It consists of the soil atmosphere from which plants and soil organisms obtain oxygen for their metabolism and dispose of carbon dioxide and other gases.

SOIL PROPERTIES

A: PHYSICAL PROPERTIES

1. SOIL PROFILE

This is the vertical section from the surface to the parent rock characterized by distinct layers usually of different texture and colors.



A- horizon Is the topmost layer and can include organic matter to form humus.

Horizon 'A' varies in color from place to place for example dark, grey etc. this zone is also called the zone of Elleviation from which materials are washed down ward. It is in this place where leaching process takes place.

LEACHING Is the washing down of nutrients in solution from the topmost layer to another layer

B- horizon This zone is also known as the zone of accumulation. In this layer the materials washed from 'A' horizon are deposited or accumulated.

C- horizon Is the partially weathered parent rock from which the soil develops, it is underlined the D horizon which is the fresh [un weathered] parent rock.

D-horizon (Bedrock) It is the un weathered parent rock. it is the parent in sense that it is the

source of the in organic content of the soil

2. SOIL DEPTH

Soil depth varies from place to place depending on maturity. Maturity is influenced by the nature of the rock as well as duration of the soil forming processes which have been operating. Soil depth is important for agricultural activities. Thus deep soil is important for agricultural activities while shallow soil is not good for cultivation.

3. SOIL COLOUR

Soil color is determined by the materials and the mineralogical composition from which the soil is derived and organic matter content. It varies from one place to another. Soil color can be classified and described in terms of; a) Dark [black, grey, dark brown etc] and cinnamon b) Bright [yellow, orange, red, reddish brown and yellow brown] c) Light [white, whitish grey]

4. SOIL TEXTURE

This refers to the degree of coarseness of soil (especially soil mineral particles). It can also be referred to as variations in the particle size, caliber or mechanical composition According to the soil texture, soil can be classified as; a) Coarse sand (2 to 0.2mm) b) Fine sand c) Silt (0.02mm) d) Clay (less than 0.002mm) e) Loan soil is a mixture of sand, clay and silt. NB; measuring of soil texture can be done through the use of finger testing

IMPORTANCE OF SOIL TEXTURE

1) It influences soil porosity, permeability, structure and retention capacity
2) It influences plant growth and root penetration
3) It influences the cultivation during agricultural activities
4) It influences soil resistance against erosion
5) It influences soil fertility

5. SOIL POROSITY

These are the total volume of the pores or empty spaces between particles of the soil materials especially in the soil. Soil porosity is mainly influenced by soil texture, organic matter, soil structure, individual undisturbed soil aggregate compounds referred to as peds.

IMPORTANCE OF SOIL STRUCTURE

i) It determines water retention capacity and aeration
ii) It is an indicator of soil fertility or suitability for agricultural activities, settlement locations and construction iii) Good structure facilitates the activities of the micro organism
iv) It influences the cultivation process
v) It influences the plant growth by influencing the root penetration and water retention - Therefore it is quite fundamental to note that the best soil is that which influences the water

holding and aeration capacities of the soil.

6. SOIL STRUCTURE

This is the arrangement of soil particles into aggregate compounds particles. Individual undistributed soil aggregate referred to as peds.

7. SOIL TEMPERATURE

Soil has a certain degree of temperature and this tends to vary from one place to another due to the variation in the climatic condition.

IMPORTANCE OF SOIL TEMPERATURE

1) It controls biochemical and chemical processes especially the decomposition of organic matter and plant growth. Thus plant growth and decomposition tend to be fast in warm areas and slow in cold areas, this is due to the fact that growth cells and micro organisms tend to be very active in the warm areas unlike in the cold areas where they tend to be inactive or less active.

2) It also determines the existence of micro organisms in certain areas. In extremely hot areas and cold areas may not support the survival of animals and other micro organisms

3) It controls the amount of moisture in the soil where there is high evaporation soil moisture is less or the soils are dry

B: CHEMICAL PROPERTIES

These include soil properties like soil reaction (PH), reaction exchange and leaching. Soil reaction (soil PH) This is the term used to describe the degree of acidity and alkalinity in the soil and it is related mainly to climate. This degree of acidity and alkalinity is expressed in the PH value which is the measure in terms of hydrogen ions concentration held by the soil colloid. Soil PH scale range from 1 to 14 where ph 7 is neutral, the condition below 7 is acidic while the condition above 7 is alkalinity which means it has more alkalis.

IMPORTANCE OF SOIL PH

It helps in determining the selection of crops and agricultural distribution It affects plant growth such that where there is too much acidity there will be poor plant growth. This is because the increase of acidity leads to the increase in leaching with affects soil structure

FACTORS INFLUENCING SOIL FORMATION

Soil formation is sometimes called Pedogenesis. The formation of soil is mainly initiated by weathering process. There are several factors which influence soil formation these are as follows:

a) PARENT ROCK MATERIAL This is one of the chief factors of soil formation. It determines soil type, color, depth, rate of soil formation, structure, texture, porosity and soil fertility. Parent rock influence soil maturity, therefore hard rocks take a long time to mature while soft rocks take a short time to mature. Shallow and poorly productive

b) CLIMATE The most variable elements under climate are temperature, precipitation (rainfall) and wind Temperature affects decomposition of organic matter hence it influences the

development of soil profile Rainfall and wind encourage the formation of soil due to their role in the erosion process On the other hand rainfall adds moisture which encourages chemical and physical weathering

c) LIVING ORGANISM Some plants have nodules with bacteria which add nitrogen into the soil hence improve aeration of soil. Microorganisms are active in the decomposition of the organic matter to form humus on the other hand barrowing of animals and plant roots facilitate the state of both physical and chemical weathering hence lead to the formation of soil easily.

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SIMPLE SOIL CALSSIFICATION

Soil classification refers to the grouping of soil according to specific characteristics, such as properties or factors like climate also soil can be classified according to the age, texture and color. One common classification is that based on texture. According to the soil texture triangle, there are three main texture namely sand, silt and clay. This is based on the size of their particles as discussed earlier. There percentage content of each one of these determines the type of soil

according to texture. Note that sandy soil have sand content of over 45% clay soil have above 27% while silt soil have silt content of above 40%.

SOIL TEXTURE TRIANGLE

SAND: This soil consists mainly of course and fine sand and contain very little among of clay such that it not sticky when wet and is lose when dry, percentage of sand is above 85, that of clay is up to 10 and silt is up to 10. When such soil is rubber, it does not leave any film on the figures.

LOAMY SAND: This consists most of sand but with sufficient clay such that it gives it a slight plastic quality when it is very moist. When it is rubbed between figures it leaves a slight film of fine material, sand particles account for 70% to 90% clay up to 15% and silt up to 30%.

SANDY LOAM: This soil has high percentage of sand between 43% and 85% with clay content of up to 20% and silt up to 50%. It moulds easily when it is sufficiently moist but does not stick easily to the figures.

LOAM: In this soil, sand and silt dominate an average of 40% each while clay account for about 20% on average. It moulds easily when it has sufficient moisture and does stick to the figures to some extent.

SILT LOAM: It has a high percentage of silt of between 50% and 87% sand between 13% and 50% and clay up to 27%. It is moderately plastic and not very sticky it has a smooth soapy feeling due to high content of silt.

SAND CLAY LOAM: This has over 45% sand, up to 28% silt and clay between 20% and 35%. It can be a bit sticky because of the clay content but quit porous because of the sand.

CLAY LOAM: Sand content between 20% and 54% silt between 15% and 53% clay between 27% and 40%. This one has sticky distinction when moist because of clay.

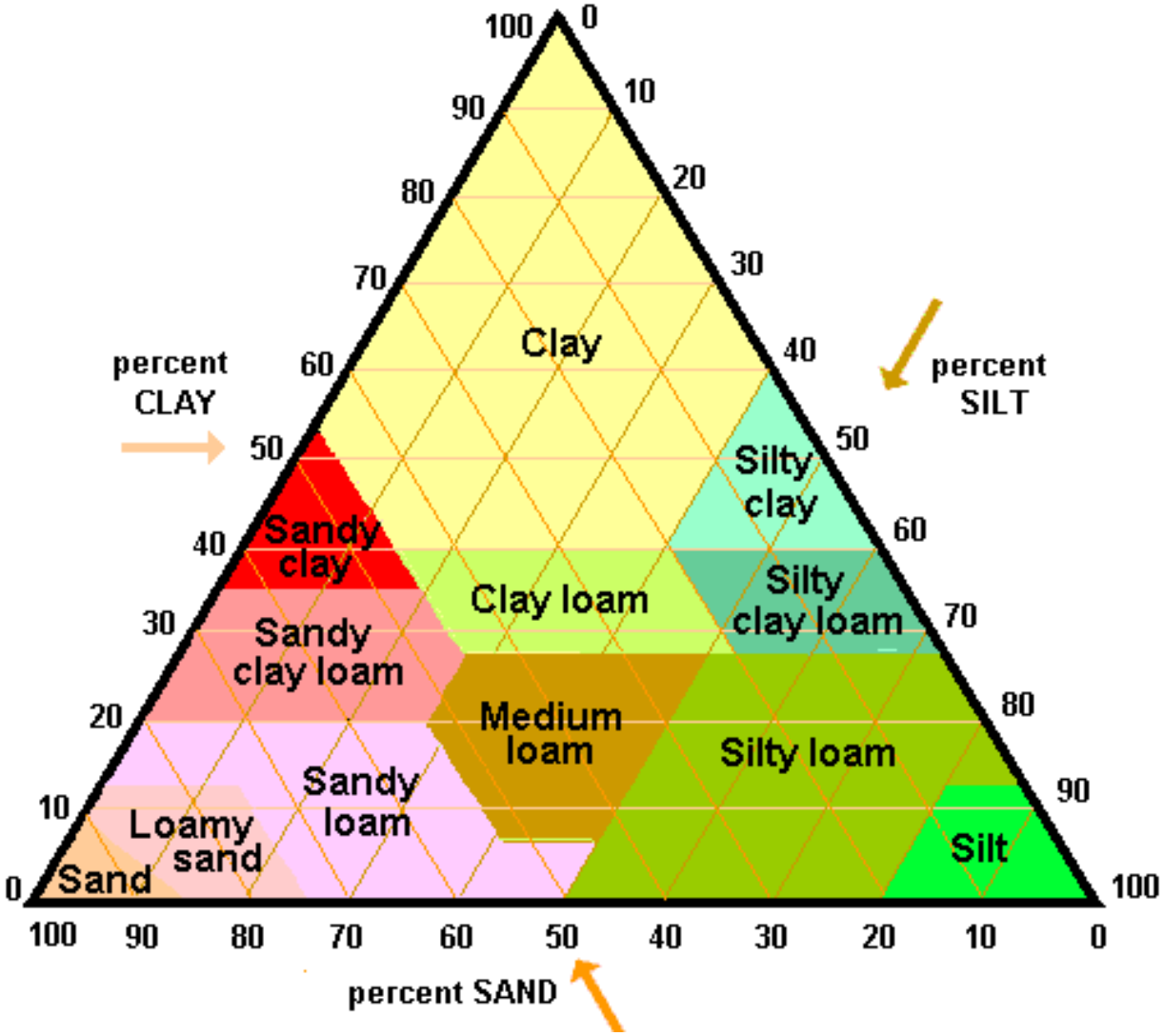
SILT CLAY LOAM: The amount of sand is between 27% and 60%, silt between 40% and 78% and clay between 27% and 40%. The high silt content makes it smooth and has a soapy feeling. It is less sticky than clay loam or silt clay.

SILT: This have over 80% silt particles, up to 20% sand and less than 12% clay. It is predominantly smooth and has a typical soapy feeling of silt.

SANDY CLAY: Sand between 45% and 65% silt up to 20% and clay between 35% and 55%. In the presence of sufficient moisture this soil is plastic and sticky clay and sand is dominated.

CLAY: The proportion of sand goes up to 45%, while that of silt is up to clay account for above 40%. The soil is sticky when moist has a plastic feel. It can be rolled into threads when moist and can be molded into different shapes. And can retain fingerprint.

SILT CLAY: Sand up to 20% silt between 40% and 60% and clay between 40% and 60%. This soil is composed of almost fine particles throughout. It is smooth and has to some extent the soapy feel of silt but has a degree of stickiness because of the high proportion of clay



SOIL EROSION

Soil erosion is the wearing away, detachment and removal of soil material from one place to another place through the agents like water, wind, ice etc

AGENTS OF SOIL EROSION

1) Water This is the most important agent of soil erosion Erosion by water involves: Splash erosion caused by rain drops Sheet erosion which involves the removal of the maximum cover of soil by surface water Sill erosion which leads to the formation of small channels called sills on the surface Gully erosion that leads to the formation of deep troughs called gullies due to severe under cutting River erosion that takes place in the specific channels called river valleys

2) Wind This is another agent of soil erosion. It takes place in arid and semi-arid areas or where the soil is loose

3) Ice It is also another agent of soil erosion. It takes place in cold areas where there is the formation of ice

4) Gravity This leads to the gradual movement of weathered material down the slope without involving transporting agents.

TYPES OF SOIL EROSION

1) Normal geological erosion It is the wide spread type of erosion that occurs wherever there is a natural flow of energy and matter on the earth's surface without man's influence. It is normally very slow and so infectious to the soil cover of the world.

2) Accelerated soil erosion Is the type of erosion associated with man's activities [man included] it is spectacular in nature therefore it has attracted man's attention.

FACTORS AFFECTING /ACCELERATING SOIL EROSION

1) Climate Where there is heavy rainfall erosion tends to be severe while where there is low rainfall erosion is low

2) Topography On steep slopes soil erosion can be fast while on gentle slopes the rate of erosion tends to be low

3) Nature of soil This depends on the characteristics or features like texture, structure, permeability e.tc. Unstable soils with coarse textures are prone to severe erosion than fine textured stable soils

4) Vegetation cover Where there is dense vegetation soil erosion is less or low rate unlike where there is scanty or no vegetation cover.

HUMAN FACTORS

5) Good management of the soil Which involves the way human beings use soil wisely and skillfully and undertaking conservation measures to reduce or mitigate erosion through afforestation.

6) Poor management That involves unwise use of soil through over cultivation, over grazing and deforestation.

7) The increase in pollution This leads to the over exploitation of resources especially minerals, forests and over cultivation.

EFFECTS OF SOIL EROSION

Soil erosion is a serious challenge which has many effects on social and economic activities. Some of these effects are explained below:- (i) Loss of productive soil. When the to productive soil is eroded it is lost forever only the unproductive stony soil is left behind the consequently is the lowering of agriculture productivity of land.

(ii) Depict of vegetation cover. The eroded land cannot hold the plants including crops are washed away or are buried in the deposit soil way from their original location.

(iii) Destruction of structures. when erosion takes place bridges can being taken away from their original areas . other structures like road ,railways, as well as buildings can collapse after erosion of soils.

(iv) pollution to environment. Eroded soil that is carried into rivers lake s and oceans may contain chemical pollutants collected by water from farm and dumping grounds, hence resulting to loss of aquatic organisms.
(v) provides sand for building and construction activities. sand which is eroded from steep slope is deposited on river bed from where it is scoped when the water flows in the river has diminished or even stopped. The sand is then used for construction purpose this is common in Mpiji river at Bunju Dar es salaam and most parts of kisarawe II in coastal region.

POPULATION GROWTH AND THE RATE SOIL EROSION ON QUALITY LIFE
As discussed above we can see that soil erosion can affect the quality of life of the people positively and negatively.
• When the region is severely affected by the soil erosion, where crop production is impeded, when useful soils are carried away, the region experiences shortage of food. This causes famine and malnutrition. With inadequate nutrition child mortality rate goes up and population growth is impeded.
• When the foundation of existing buildings and roads are eroded. Accessibility to areas is made difficult. Such areas are isolated in terms of social services such as hospitals and education. The general health and welfare of the people become poor leading to increase in mortality and lowering of population.
• When life becomes unbearable in the rural areas because of severe soil erosion, able-bodied persons especially men migrate to urban areas to other better areas in search of employment.This reduce population in the affected areas as well as the required man power to develop the areas. T

ECHNIQUES FOR SOIL CONSERVATION
When using the land it must at the same time be properly maintained by apply proper farming techniques to reduce erosion and then to improve it productive capacity. Therefore a number of ways of doing this for example
(a) Crop rotations: This practice offers protection to the land from soil erosion and good chance to cover its original fertility crop rotation makes it possible to have the land occupied with crops most of the year. In addition the loss of crop most of the year. In addition the loss of nutrient elements by leaching is minimized and losses from erosion are greatly reduced Erosion hazard are n important factor in determining the kind and sequence of crops to be grown in a rotation of a particular piece of land n area where erosion can easily occur due to either slope or soil characteristic, permanent crops such as trees or pasture should be planted rotation will not provide erosion protection on steep slopes.
(b) Contour farming: Contour farming is ploughing, planting and cultivating across the slope following the contours, generally on gently sloping land each contour row can be viewed as a small dam that checks the speed of non-off water and reduce erosion on well drained soil. Contour farming is simple and easier of all the supplemental soil conservation
(c) strip cropping: This is a system in which crops are grown in strips that are arranged across

the general slope or at right angle to the path of the prevailing wind .The strip don not necessary have to follow contours.

(d) Terracing: A terraced is an embankment of earth or stone or other suitable materials or combination of these materials made across the slope for the purpose of controlling run-off. Terrace decrease the length of the slope thus reducing erosion and run-off .

There are two types of terraces

(i) Level terrace: Is a ridge built generally on sandy soil with little or no grade it is designed to hold water in the field until absorbed it adopted in areas where rainfall and soil characteristics are such that there is only slight danger of water accumulating on the soil and breaking the soil surface.

(ii) Channel terraces: Consist that are cut across the slope these channel carry the excess rain water from the fields but at a low speed thus minimizing erosion .they are commonly constructed in regions that receive heavy rainfall.

(e) Planting of trees and grasses: Trees and grasses can act as wind breakers and can also control water erosion .In controlling erosion caused by wind trees or grasses may be planted in strips so that soil particles carried by wind may be deposited on or near the grass strip.

(f) Controlled grazing: Overgrazing can be dangerous as most or all the vegetation can be removed with resultant exposure of the land to erosion rotational grazing with the optimum number of animals in one area can help to maintain the vegetation cover.

(g) Mulching: Mulching act as a huge sponge which absorbs the water that fall on to it and releases it slowly and harmlessly to the underlying soil if there is no protective cover over a wide area erosion may occur rapidly.

Topic 4: MAP MAKING AND ELEMENTARY SURVEYING

Survey is the scientific and systematic measure of distance, height (altitude) and angles between various points on the ground. OR Survey is the process of observing and measuring in order to determine distance, position, boundaries and elevation of physical features on the land. Purpose of Surveying means the whole process of conducting survey. It involves the whole practices that involves in taking ground measurements of distance, height and angles between various points on the ground.

The purpose of surveying includes the following:-

(i)To determine horizontal distance between points on the earth's surface

(ii)To determine vertical distance or height between the points on the earth's surface

(iii)To determine the area of the piece of land or plot

(iv) To determine the direction of various features on the earth's surface

(v) To determine the location of physical and non-physical features on the earth's surface Stages or procedures of conducting survey/surveying methods/surveying process

(1) Reconnaissance / preliminary inspection/primary surveying Is the process of taking general view of the land to be surveyed in order to get real picture of the work to be done. It is done by visual observation of the area. During the reconnaissance the surveyor does walking around the area to be surveyed and taking general views and noting down the dominant features area, Boundaries of the area, Corners of the boundaries of the area and Other structures such as building, big trees, ponds, lakes, small hills e.t.c Importance of reconnaissance

(i) It helps to get the full picture of the survey to be conducted

(ii) It helps for choosing the scale for map making

(iii) It makes survey for new coordinates and old coordinate easier

(iv) It shows the existing situation on a piece of paper

(2) Actual survey /secondary survey This steps involved observing, measuring and recording direction, angles distance and elevation by using surveying equipment or tools.

(3) Presentation this involves presentation of data or information collected or recorded, the information can be presented by writing or drawing form

BRANCHES /TYPES OF LAND SURVEYING

The following is the branches of survey.

(i) Geodating survey is the type of survey which takes into consideration on account the curvature of the earth's surface. The geodating survey is used for a large area for example at national level. Its purpose is to lay a foundation for other types of survey and research hence it need high accuracy.

(ii) Plane surveying; is the surveying which the area measured is considered as being flat or plane. The earth's surface is projected onto a horizontal plane. Plane survey is only used in small areas for example: - building sites like schools and dispensary, Villages and wards Plane survey does not take into consideration the curvature of the earth. But it is only gives the horizontal plane as if the earth's surface is flat or plane.

(iii) Topographical surveying; This deal with the measuring and plotting of physical features in their horizontal and vertical positions. Nature and man-made features are measured and maps are prepared to show their relative position both horizontal and vertical.

(iv) Cadastral surveying; Is the survey that deals with defining special information for construction activities and all sorts of land development Example:- small construction site, a plane survey can be used and for a bigger site geodetic survey can be used.

(v) Engineering surveying; Is the surveying which deals with obtaining special information for construction activities and all sorts of land development.

(vi) Mine surveying Is the surveying which deals with finding minerals in the ground or rocks into the earth's crust.

(vii) Hydrographic surveying; This surveying deals with searching or finding the amount of water present different parts or place on the earth's surface.

METHODS/TECHNIQUES OF LAND SURVEYING

Depending on how linear and angular measurements are combined, there are four types of methods /elements/technique of land surveying. 1. Chain or tape survey 2. The prismatic compass survey 3. The plane table survey 4. The technique of levelling

CHAIN/TAPE SURVEYING

Is the surveying method in which linear measurements of an area are taken Features of chain surveying

(i) It involves taking linear measurement of angular measurements.

(ii) It is suitable for small area .e.g. schools, market etc
(iii) It is suitable in flat and open areas e.g. are with no forest or no high mountains Equipment used in chain surveying

(a) A chain; This is made up of steel divided into tallies and links it is about 20m-30m long. It is used for measuring long distance on the ground

(b)Tape measure; It is made up of plastic or steel materials having the length of 10, 20 and 30 metres. It is marked in meters, feet or centimeters. It is used for measuring short distance E.g 10m

(c) Surveyor′s band; is made of a steel strip which is rolled into a metal frame with a winding handle. It is 30m, 50m or 100m long. Is used in projects where more accuracy measurement is required.

(c) Pegs; Are made up of wood ,they normally have 40cm to 50 cm long and width of 4mm squares. They are used for marking permanent stations.

(d) Ranging rod/ranging poles; Are made of wood, their length is about 6-10 feet .they are marked red and white or black so as to be seen easily. Used to mark permanent station in the survey line.

(e) Cross staff; Is a wood rod with about 6 feet long used to determine the right angle in survey line (to make off sets). Other equipments used in chain survey include an optical square, a ruler, plumb bob, field sheet and pencil. (f) Notebooks are used during field work to record data obtained. The notebook should be of good quality and 150mm x100mm in size.

(g) A hard pencil and a rubber Hard pencils are used for drawing in the field and a rubber is used to erase mistakes or errors which are made. A pencil should be HB or HHB. Other equipment/ tools used in chain survey include arrows, optical square, Plumb bob etc. Advantages of chain surveying

1. It is suitable for surveying flat surface on the Earth’s surface, for example a school compound
2. It can be red easily and quickly
3. It is the simplest method of surveying through the old method
4. It is suitable for surveying clear areas
5. It can be easily repaired or rectified in the field
6. It tends not to attract attention.

Disadvantages of chain survey

1. They become longer or shorter due to continuous use
2. It is not suitable for surveying large areas
3. More difficult areas cannot be chain surveyed
4. Errors may be encountered due to the use of many chains and other reasons
5. It is time consuming
6. They are heavy and take too much time to open or fold
7. It is a slow method of surveying
8. It is the oldest method of surveying

THE ERRORS THAT OCCUR IN CHAIN SURVEYING

An error is a mistake or shortcoming that happens during the survey process leading to wrong measurements. It is sometimes called discrepancies.

The following are the type of error or discrepancies in chain surveying.

Cumulative (systematic) Errors Cumulative errors are said to be systematic errors as they are one-directional hence keep on accumulating as the survey progresses. If not checked they have serious implications to the accuracy of the survey. Errors in this class included incorrect length of the tape, page of the tape or the tape not being in line. Since the sources of these errors are known, they can be eliminated. They can either be positive or negative errors. Positive errors shorten the measurement (e.g where the tape length is shorter that what it should be) while negative errors elongate the measurements (e.g. where the tape is longer what is should be). Errors can be eliminated by checking the equipment Compensating Errors (accidental) errors Compensating errors are said to be accidental errors hence cancel out and does not pose serious problem to the accuracy of the survey. They arise as are result of not being perfect in the use of the equipment or in the whole survey process. For example, if the pull exerted on the tape in either more than or less than what should be the case, faulty results be gotten. The effect can either be positive or negative Gross Errors These are mistakes that can be attributed to the inexperience of the leaders. These are very serious errors which although are random in accordance my lead to faulty plans and maps if not checked. They include discontinuing the chain length (e.g. where some arrows are cost or misplaced), misreading of the tape, reading tape upside down (e.g. taking 6 to be 9), etc. these errors can be corrected by taking the necessary precautions.

OVERCOMING OBSTACLES DURING CHAINING

Types of Obstacles

1. Visual obstacles: Is an obstacle that prevents an object but the chain remains free. An example of a visual obstacle is a forest.

2. Chain obstacles: This is the obstacle where by the chain is obstructed but visually it is free Examples are rivers and ponds

3. Neither visual nor chain obstacles for example buildings

HOW TO OVERCOME THOSE OBTACLES

1.By rectangular method

2. By triangle method

3. By using similar triangle method

By constructing rectangles Chaining had reached A and encountered an obstacle. To get to B, mark A and B with any arrow. Set of perpendiculars AC and BD high enough to clear the obstacles. Join and measure DC which now equals AB. This allows chaining to continue from B. By constructing similar triangles To continue chaining for B, fix point C away from the obstacle.

Range a pole at D to align with Ac hence AC = CD. In line with BC range another point E in line with BC. Hence BC = CE Measure ED which equals AB hence chaining can continue from B. Obstacles which obstruct both ranging and chaining has reached B from A where an obstacle like a building has been reached. Erect equal perpendiculars AC and BD from A and B along the chain line. Along CD, range E and F beyond the obstacle. Set off perpendiculars EG and FH from E and F equal to AC. AS G and H are in line with AB, then CE equals AG. By constructing triangles Chaining had reached A and there is the need to overcome the obstacles created by the stream to really B. Set out a perpendicular AC and mark the midpoint E. Set out another perpendicular CD so that D, E and B are in a straight line. The 2 triangles created are congruent CD = AB which is the required length hence chaining can now proceeds from B.

IMPORTANCE OF SURVEY

The following includes the general importance of survey

(i) It helps in determine distance between various points on the ground

(ii) It helps to determine heights on the ground

(iii) It helps to determine angles on the ground

(iv) It helps in determine areas of plots of land

(v) It helps to take ground measurements for construction of various structure E.g roads, buildings e.t.c

(vi) Leveling survey helps to determine level of sloped ground

(vii) It helps to determine for sight intermediate and back sight of various points on the ground especial sloped land.

(viii) Survey is help in taking measurements to some areas where underground structure to be constructed E.g. pipe line, underground canal etc.

LEVELLING SURVEY

Leveling: Is the procedure by which the heights of the points on the Earth's surface are determined.

EQUIPMENTS

The following is the equipments used in levelling

i) Leveling staff: Is a long ruler which can be made from steel material either white and black or black and rod. "Used to fix or heights on the earth's surface"

ii) Survey Telescope: It's used to determine the angle of position or height on the Earth's surface

iii) Also tape, chain and pegs are used in Leveling. Used for measuring distance. Used for making station points

iv) Note book and pencils are also used in leveling process for recording or booking all necessary field work information

v) Spirit level or buble tube this is about 50 mm to 225 mm in Length mounted on a telescope. The observer taken recording or graduated telescopic staff from own position whose height is

known The producers of leveling

1. A staff is plat at station one or base station. Then the sighting instrument is put in the direction of travel when a back sight is recorded.
2. The distance from base station to the instrument is measured.
3. The staff man moves along the direction of travel ahead of the sighting instrument (telephone). This will be station two where a fore sight is recorded.
4. The sighting instrument is moved along the direction of travel ahead of the staff man. A back sight is takes and recorded.

The procedure is repeated until all the leveling is done and recorded.

Use Fullness of Leveling

- It helps to determine the relative heights on land that can be used in contour mapping.
- Leveling can be used for determination of heights or elevation of the land surface such as hills, valleys, plans, etc.
- Housing foundation, the location of industrial sites, the route of communication and sites of building can be located and determine with the help of leveling.

Topic 5: MAP READING AND INTERPRETATION

Map is a scaled representation of a part of the earth or whole of the earth's surface on a flat surface such as sheet of paper, wall, piece of wood or plastic etc. or It is a drawing which represents physical features. Map interpretation is the process of examining a given topographical map of an area represented for the purpose of identifying the geographical information of an area. It has two basic process; - Map reading -Map analysis. Map reading -is the process of examining the given topographical map, conventional symbols and signs. Map analysis -is the process of relating the identified information on the map with other geographical information which are not direct shown on the map.

TYPES OF MAPS

According to functions;

1) Topographical maps Are maps which show physical features which are natural features e.g. mountains, valleys, hills etc and man-made features e.g. bridges, ponds, roads, settlements etc

2) Statistical maps Are maps which show the distribution of things in quantitative manner e.g. distribution of rainfall, temperature, crops etc.. Examples of statistical maps are dot maps, choroploth maps, Isoline maps etc

According to Scale size;

1) Large scale maps Are those maps drawn to large scale size e.g. 1:10000 These maps gives a larger representation of small area, they are also more detailed (shows a lot of information). They represent areas like cities, towns and villages.

2) Medium scale maps Are those maps drawn to medium scale size e.g. 1:100000 They show a moderate amount of details. They represent areas like districts, regions and countries.

3) Small scale maps Are those maps drawn to small scale size e.g. 1:1000000 They give a small presentation of a large area; they show little content (little information) They represent areas like continents and the world.

IMPORTANCE OF MAP READING

i) They provide basis for description of geographical phenomenon

ii) They are useful for traveling purpose i.e. they guide people to reach their destination

iii) Maps are useful for storage of geographical information

iv)They are important for field studies

v) They are important for land use planning

vi) They are useful for military purposes e.g. during wars.

BASIC SKILLS OF MAP READING/ESSENTIAL ELEMENTS OF A MAP

The basic skills required in understanding how to read a map include; 1. Title 2. Scale 3. Key 4. Indication of the north direction 5. Margin/Boundary 6. Date of compilation

1. Tittle gives the name of the country and the area where mapped. It helps the map reader to know what the map is all about. The heading is usually printed in bold capital used on the map

2.Scale is a ratio between the distance on the map and actual distance on the ground. It is used to find

actual distance and areas on the ground. On topographical maps scales are given in form of ratio or lines

3. Key/ legend is a feature which explains the signs and symbols which are used on the map. Not all symbols which are used in the key are applicable to the particular map but all signs and symbols applied on the map are shown on the key. Definition of terms which should be added on others terms under the tittle "Basic skills of map reading/Essential elements of a map" are " margins/Bounder

4. Indication of north direction It gives an idea about the orientation of the map especially in identifying where the north direction is.

5.Margin/Boundary A frame which borders the map. This guide and limit the map user in reading and interpreting the map. The aim of the margin is to enclose the area covered by the map

6. Date of compilation Gives the publisher name and when the map was published .This date is important because physical and human settlements features changes with time but the map drawn representing the land does not. For instance between 1960 and 2007 Dar es salaam has changed in many ways.

READING AND INTERPRETING TOPOGRAPHICAL MAPS

Topographical maps are types of maps which describe the physical (natural) and man-made (artificial or cultural) features of a given area. The physical features include relief, vegetation, and drainage, among others. Some of the cultural or artificial features are roads, railways, cities, towns, dams, schools, and many other structures built by man.

A. DRAINAGE B. ROCK TYPE/STRUCTURE C. RELIEF D. CLIMATE E.HUMAN ACTIVITIES F. POPULATION DISTRIBUTION AND SETTLEMENTS.

A. DRAINAGE

Drainage is the plan or layout of the river with its tributaries until it reaches its destination i.e. lake, main river, swamps or an ocean, therefore the concept drainage includes rivers , swamps, lakes, waterfalls ,flood areas Note:-the common drainage shown on the map is rivers, swamps, lakes and ocean. But expect to see even waterfalls especially on coloured topographical map. Drainage patterns -Simply means the network displayed by a river and its tributaries. Drainage of the river usually posses different network/system depending on the way how tributaries convey to the main river and the general appearance, hence drainage pattern

THE FOLLOWING PATTERNS ARE COMMONLY DISPLAYED IN TOPOGRAPHICAL MAPS

I. Dendritic pattern ; Is a pattern in which its tributaries convey (join) to the main river at an acute angle resembling to the shape of tree trunk and its branches Note: Dendritic pattern are common in areas of gentle slope and of uniform (homogeneous) rock hardness. Therefore it can be made from granitic or metamorphic rock

II.Trellised pattern; Is the pattern in which its tributaries convey or join to the main river at almost right angle. Note:- This type is commonly found in areas with severe cracks or fractures mostly to the

rocks with an alternate hard and soft rock. Therefore this is associated with sedimentary rocks.

III. Radial pattern; Is the pattern or layout in which its tributaries flow outward from the center.(summit) or at the peaks of mountains. Its pattern resemble a spoken ring of bicycles where stream flow out in every direction from the center. Therefore radial drainage pattern is commonly associated with volcanic mountains /region composed of granitic rock or igneous rock

IV. Centripetal Drainage pattern; is the pattern in which almost all streams are following from all direction converging to the center can be to the swamp, lake or depression. The determinant factor of stream flow is a slope .Therefore the drainage pattern can be associated with sedimentary rock.

V. Rectangular pattern/Drainage; Is a pattern which resemble trellised, but it has tributaries joining the main river at a right angle. The pattern is common in areas which are faulted. -Therefore can be found along sedimentary rocks/granitic rock or any faulted rock.

VI. Braided pattern; Is the pattern in which its distributaries tend to split into several channels which rejoin and split again .The Congo River has braided channels between Lisala and river Ubangi.

VII. Annular pattern; Is the pattern with series of streams flowing on flanks or around the dissected dome, depression or crater. Where there are an alternate band of soft and hard rocks. Note: This type is not so common, but is found around Lake Bosumtwi in Ghana .Is commonly found in areas affected by back tilting.

B. ROCK TYPE/STRUCTURE

The surface rock on the topographical maps is not directly indicated. They some clues are needed in order to identify rock type and structure of the mapped area. The following is an indicator used to show type of rock present in a certain area.

LAND FORMS VEGETATION NATURE OF THE ROCK

Land forms Land forms shown on the topographical maps help on interpretation of rock type e.g. The presence of volcanic land form such; crater, caldera, name of the volcanic mountains suggest the presence of igneous rock. The presence of erosion and depositional features such as depression, sand dunes, coral reef suggest the presence of sedimentary rock. Flood plain suggests sedimentary rock. The presence of highland with steep slope indicated that rock are hard and resistance rock that may indicate presence of metamorphic rock. Vegetation Thick forest suggests the presence of igneous rock. Poor vegetation cover suggests the presence of sedimentary rocks or metamorphic rock. Nature of the rock Absence of streams indicates that the rocks are permeable. Thus this depict that the rock is soft which can either be sedimentary, limestone or sandstone. -presence of many streams on surface, indicate that the rock are impermeable such as igneous or granitic rock.

C. RELIEF

Read the contour and the conventional symbols or signs on the map to identify types of relief. Can

either be highland relief with lower arts or lowland relief. Describe the relief with associated land forms. When you determine types of relief first look on the units on vertical interval (V.I) whether the unit is in meters or feet. If units are in feet take the highest value the convent into meter finally determine type of relief (1m=3.3ft)

D. CLIMATE

Climate is the average weather condition experience in a given area over a long period of time not less than 30 years. Topographical maps may be used to identify the climate of given mapped area. Some hints used in interpreting climate from topographic map Latitude of the area. Distance from equator used to determine kind of climate of a certain area. For example the area with latitude 5 degrees north or south of equator the area is considered to be in equatorial climatic condition while the area between 5 to 15 N/S is in tropical climatic condition, 15-30 N/S of the equator imply Semi-desert 30-40 N/S implies desert climate or Mediterranean climate. Water bodies. a general high density of streams indicates that the area receives high rainfall, presence of low density or seasonal streams, salt lakes and boreholes indicate aridity. Vegetation, presence of forest in the map indicates heavy rainfall while woodland vegetation indicates moderate rainfall. shrubs, thickets and grassland indicate dry condition or light rainfall Crops, crops grow in those areas where water and temperature conditions are favorable for their growth. For example area with tea, coffee and sugar cane indicate that area receives heavy rainfall. Crops such as cotton, sisal and sorghum indicate medium rainfall Relief/altitude, altitude of features such as high mountain or mountain ranges and plateaus tend to have orographic rainfall and forest making them makes their own mountainous climate. Mountains do also create their own climate due to effect of aspect which creates rain shadow.

E. HUMAN ACTIVITIES

Topographical map may contain information on economic activities undertaking usually the following are shown on topo maps.

i) Agriculture: - look on the presence of Rural settlement in absence of other activities scattered cultivation storage houses/center plantation or estate (indicate large scale agriculture) industry such as Ginneres, Hulleries and Decotecator. seldom symbols or signs are used e.g. S-sisal, CC-coffee, Su-sugarcane

ii) Pastoralism:- look on the presence of cattle market-cattle dips veterinary installation (Vet. Office)/center Creamers (lace where milk, cream butter and cheese are processed Scattered vegetation or dominated by scrub/shrubs) Bore holes (Bore holes (BH) or water hole (wh)

iii) Mining:- look on the presence of; symbols of PIC () and shovel (salt work quarrying Roasting Sign Tin-TN, Iron-Fe.

iv) Fishing:- look on the presence of; water bodies such as lakes, seasonal swamps, rivers, dams, ocean. These should be surrounded by settlement.

v) Trade and transportation;- look on the presence of ; Road, railway, towns and market

vi) Lumbering;- look on the presence of; forest with track-roads ending on their edges. Saw-mill Sao hill forest -Note: thicket, scrubs/shrubs and bamboo trees cannot be exploited as a timber.

Vii) Tourism:- look on the presence of; National parks Game reserve Recreational centre's e.g. museum, archives beaches etc Landscape e.g. crater depression etc.

Viii) Administration:-Various administrative activities can be identified from abbreviations on the map. These are given in a list in the margin of the map. They include provision of security as evidenced by the presence of a Police Station or Police Post, judicial services as evidenced by the presence of courthouse, and other administrative offices such as District Commissioner (DC) and Regional Commissioner (RC).

F: SETTLEMENT

Urban settlement; Is commonly found in areas of District administrative centers, Regional administrative centers, and Capital city of a country. Rural settlement; Is an area where the majority of people approximately to cover 80% engage in agriculture

SETTLEMENT PATTERNS.

The signs showing settlements on topographical maps are observed to have varied arrangement. The most common pattern include the following

i) Dispersed pattern:- It is alternatively called scattered settlement pattern .The houses are widely spaced one to another

ii) Nucleated settlement pattern: - Houses and other related form are compacted to another.

iii) Linear settlement pattern:- Houses are concentrated along an elongated objected of economic significance like a road, river, railway lines and others

FACTORS ENCOURAGING SETTLEMENTS

1) A reliable source of water supply e.g. presence of permanent rivers, lakes.
2) Gentle slope i.e. people prefer to establish settlement in less hazardous areas
3) Good soil for agriculture
4) Pleasant climate condition
5) Transport and communication.

WAYS OF SHOWING POSITION ON A MAP

A place can be located by its name where it is found. A more accurate way of locating a place is the use of latitudes and longitudes, this method is used by scalars at sea and aircraft in their flights. Generally position of any place can be located by using; place names · Bearing · Latitudes and longitudes · Grid reference

METHODS OF SHOWING RELIEF ON TOPOGRAPHICAL MAP

1. Trigonometric station This is a point on a map with its exact height fixed usually on a hill top, mountain peak or other visible positions. They are the highest points on any locality. The trigonometrical points are commonly marked by a triangle followed by the numbers indicating the height for example Δ725

2. Spot height Spot height is a point on a map with its exact height above a known level e.g. from the sea level. The position and height of the points have been determined by surveyors. The spot height is marked with a dot followed by the numbers indicating height of the land for example .750.

3. Layer coloring/Tinting Is also done to show the relief features on the map, different coloring shades on the map to indicate different heights

4. Hachures Huaraches are short, broken lines drawn on a relief map showing direction and steepness of a slope

5. Contour and form lines Contour are lines drawn on the map to join all places of the same height from the mean sea level. This measurement of heights shown by contour lines starts from the mean sea level which is regarded as zero height. Form lines are usually unnumbered lines drawn on a map joining of nearly the same height areas, Are broken lines drawn between two contour lines

7. A ridge Ridge is a narrow and long relief feature with steep slopes on all sides.

8. An escarpment An escarpment is an area of highland with very steep slopes on one side and a gentle slope on another side. The steep slope of an escarpment is called the scarp slope and the gentle slope is known as dip slope.

9. A plateau A plateau is an extensive highland region and whose top surface is almost flat. A plateau is easily identified on the map by the absence of contour lines on the higher land surface and with a series of contours close together on either sides.

10. Slopes A slope the inclination or slant of the land. This inclination varies considerably, resulting in the following types of slopes A concave slope are widely spaced at the lower ground and closely spaced at the higher ground. A convex slope on the other hand has a steep slope at the lower ground and a gentle slope at the higher ground. Contours of this slope are closely spaced at the lower ground and widely spaced at the higher ground. However some slopes bear both characteristics, a concave slope is gentle at the lower ground and gets steeper at the higher ground.

11. Saddle (pass) and col A Col is the land between two peaks of a mountain or in the mountain ranges. A saddle is generally wider than a col. Saddles provide convenient passages across mountain ranges. Contours showing peaks are usually closed.

12. Valleys and spurs Valley is the low lying part of the land which is bound over higher ground and steep slope. Valleys are indicated by contours forming ‘V’ shape pointing the higher ground and some valleys have rivers flowing in them. Spur (Salient) is a projection of the raised land from the side of a hill or mountain into lowland, contours showing a spur form a ‘V’ shape pointing to the lower ground.

13. Hills/peaks A hill is a rounded upland area not as high as a mountain. Hills rises above the general relative low ground but less than a mountain. Hill height is usually about 350m-650m. Some hills are regular while others are irregular.

14. Cliff A cliff is described as a steep rock face that is vertical or nearly vertical. Cliffs are common in mountainous or hilly areas and along the shores of lakes and seas. On topographical maps, cliffs are shown by contours that are so closely packed that they appear to merge into one another. To emphasize the presence of the cliff, a special symbol is drawn on top of the contours as shown in the figure below.
15. Plain A plain is a continuous tract of relatively flat land covering a broad area of lowland. Some plains may be raised but the slopes are very gentle. Plains occur as lowlands and at the bottoms of valleys but also on plateaus or uplands at high elevations. On topographical maps, a plain is shown by contours that are very widely spaced. Some rivers, if present, may be seen to have meanders.
16. Depression A depression on a contour map is shown by contour lines with small marks pointing towards the lowest point of the depression. The first contour line with the depression marks and the contour line outside it have the same elevation.

CROSS SECTION

This used to show variation of relief across a region. The following stages are followed in drawing cross section. i) Two end points of the area in question are marked AB ii) Join the two points with straight line by a pencil iii) Take a piece of paper measure from point A to B iv) A vertical scale is now required after marking the values of contours on the paper. The horizontal scale of the cross section is in the same scale as that of the map from which the line AB is taken. The highest contour line on the map is 100m v) The horizontal base line represents sea-level; the marked paper is placed along the base line so that A on the paper falls on A on the scale. Then each contour along the horizontal line is marked with a pencil and ruler, vertical lines are lightly drawn up to the line which represents the contour height.

VERTICAL EXAGGERATION (V.E)

Vertical Exaggeration is a number of times by which the vertical scale is larger than the horizontal scale. In Mathematics V.E expressed, V.E=(Horizontal scale (HS))/(Vertical scale (VS)) Horizontal scale is the map scale/ground scale Both HS and VS should be the same units of measurements when calculating VE For example if a map scale were 1cm to 100000cm and the vertical 1cm to 100m, the VE is first converted from 100m to cm VE = 100000cm/10000cm VE=10cm

INTER VISIBILITY

In reading the map it is important to know from a map whether one place is visible from another or not. In cross section two places A and B were to represent two observation points weather the two places are inter visible or not To explain inter visibility we look in the cross section if between the points (A to B) a mountain or hill develops we say the two points are not inter visible because the hill is an obstacle When the basin of depression develops we say the inter visibility, as a line of sight when drawn straight i.e. not obstructed But inter visibility can be affected by other factors such as buildings, vegetation etc.

GRADIENT

Gradient is the term refers to the measure of slope. Gradient/ slope are measured by comparing

vertical distance to the horizontal distance. In map reading the calculation of gradient is done by comparing the vertical interval between two places and the horizontal distance between them. Vertical interval (V.I) is the difference in height between the two places; it can be obtained by subtracting the altitude of the lower point from the altitude of the higher point. V.I = highest contour - lowest contour The horizontal distance is measured on the map then it is converted into ground distance by the use of the map scale In calculating gradient both vertical and horizontal lengths must be brought to the same unit of length The formula for gradient Gradient =(Vertical interval)/(Horizontal distance) Calculating gradient Example: Given; highest contour 700, lowest contour 300 V.I = 400m Length from point A to B is 8.4 cm Scale of map 1cm to 2km Calculate the gradient Solution Step 1 Change 8.4cm into ground /map scale 1cm to 2km 8.4cm to x =16.8km Step2 Change the ground scale into meters 1km =1000m 16.8km =? =16800m Step 3 Gradient =(Vertical interval (V.I))/(Horizontal distance (H.D)) = 400m/16800m Gradient= 1/42

Topic 6: PHOTOGRAPH READING AND INTERPRETATION

Photograph; is an image of an object which is recorded by a camera and then printed on paper Or, is a picture taken by means of chemical lights prepared on a special paper Types of photographs There are three types of photograph that includes the following.

i) Horizontal photographs/Group photographs
ii) Oblique photographs
iii) Vertical photographs/Aerial photograph

1. HORIZONTAL PHOTOGRAPHS/GROUP PHOTOGRAPHS

These are photographs that are taken from the ground when the camera is at the same level as the object being photographed. Objects are large and clearly shown in these photographs when they are close than those far from the camera The fore ground and the horizon is seen but the back /dead ground is not seen There is no fixed scale

2. OBLIQUE PHOTOGRAPHS

Are the photographs taken when a camera is slanting at an angle less than 90°. They are taken when the photographer is standing on an elevated ground and hold the camera on an angle towards the lower ground. They normally cover the horizon.

(a) Low oblique photographs These are taken when the photographer is standing in elevated ground, such as top of a hill, building or cliff, and holds the camera at an angle pointing towards the lower ground. The photograph can also be taken when the photographer is standing at the bottom of an elevated ground, with the camera pointing towards the higher ground.

(b) High oblique photographs These photographs are taken from the sky with the camera tilted at an angle towards the ground. The photographer may take the photograph from a helicopter or low-flying aeroplane. These photographs cover quite a large area of land.

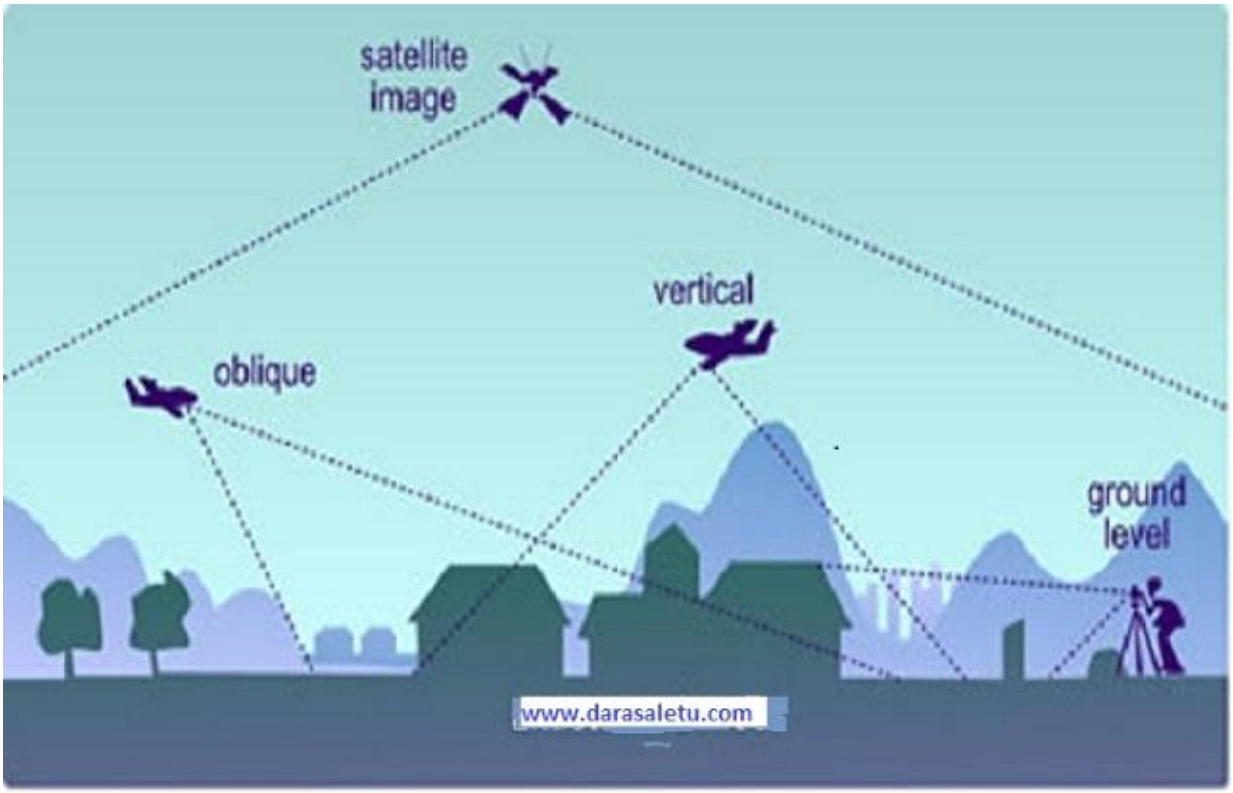
3) VERTICAL PHOTOGRAPHS

These are photographs taken from the aircraft with the camera directly above the object pointing vertically to the ground. Only the top view is seen. Instruments used to capture pictures are called air crafts or the satellites

DIFFERENCE BETWEEN THREE TYPES OF PHOTOGRAPH

These are various differences between 3 types of photographs as follows.

Horizontal photograph	Oblique photograph	Vertical photograph
Show relatively small area Objects closer the camera is larger than those far away They show side of the object facing the camera. Are taken when the camera is at the same level with the object	Show relatively large area Size of object near the camera are large than those far away Shows the top and sides of the object Are taken from the ground or from air with the camera tilted below 900	Show relatively largest area possible Objects in the center are larger than those away from the center It shows only the top side of the object Are taken from the air at 900 vertically above objects being photographed



PARTS OF PHOTOGRAPH

A photograph has three parts as described below:

a. Background – the area farthest from the camera.

b. Foreground – the area nearest to the camera.

c. Middle ground – the area between the background and the foreground, which is at middle distance from the camera. Each of the three parts of the photograph can further be sub-divided into three parts to give nine combinations which form the nine minor parts of the photograph as shown in the table below: Left Centre Right Left background Centre background Right background Left middle ground Centre middle ground Right middle ground Left foreground Centre foreground Right foreground

READING AND INTERPRETATION OF PHOTOGRAPH

Is the process of reading, measuring, translating and explaining the meaning of objects identified on that photograph. It is done so as to obtain reliable information about the natural or cultural features on their environments. It involves the following; Determining the title Estimating time and the season Estimating direction Identifying and interpreting physical features Identifying and interpreting human activities Estimating the size of features Suggesting possible location of the scenery in the place

DETERMINING THE TITLE

Can be obtained by carefully studying the photograph, information determines the choice of the title. Photos show landscapes, activities on land, what is on the surface and the sky. The

information contained in the foreground, middle ground and dead ground can help in determining a suitable title

ESTIMATING TIME AND SEASON

Time It is possible to estimate the time of day when the photo was taken if we know where the photograph was taken If the photo was taken during the morning its evidence is through the shadow During the morning; The shadow of the object lies in the western side because the sun rises from the east During the evening; The shadow lies in the eastern side because the sun sets on the west During the afternoon; The shadow lies around the object because the sun is over head of the object Seasons A bright sky with dry vegetation may indicate a dry period or season. Thick vegetation young crops or flowering plants in the field and a sky full of rain clouds indicate a rainy season Clear sunny conditions with health vegetation and flowering plants or plants with fruits indicate summer season Plants with young leaves others bloom and field full of grass indicates spring season Hazy sky with leafless trees and some snow on the ground indicates winter season Also when people appear to be wearing heavy clothes with faces almost completely covered, hand gloves and heavy boots it indicates cold weather, likely winter in temperate regions People wear light clothes and some may even have broad-rimmed hats indicates hot weather When houses appear to have slanting roofs it indicates the region experiencing a lot of precipitation which facilitates the easy flow of water from the roof of the house If people appear to be planting then it is planting season the rains either are about to come or have just started If the people appear to be weeding it is growing season for the crops and there is reduced rainfall If people appear to be harvesting a crop it is harvesting season and probably dry season because harvesting normally takes place during dry weather.

ESTIMATING DIRECTION

This refers to identifying the position of the photographer after studying the relative sizes of objects in the photograph. It is possible to estimate the direction on a photograph using shadows. This is possible if the time and place where the photograph was taken are known. For example, if a photograph shows a tree whose shadow is on the right and it is indicated that it was taken within the tropics and in the morning, then the photographer was facing south. The sun and the shadow are always in the opposite sides of the photograph. If the sun is in the east, the shadow will always be cast westwards and vice versa. If the shadow is pointing towards you and the photograph was taken in the afternoon (meaning that the sun was in the west), the photographer was facing westwards. With such information, it is then possible to fix compass points on a photograph. The other alternative for identifying the position of the photographer or cameraman is by observing the size of objects in the photograph. The objects close to the photographer appear larger those far away. The objects apparently appear to decrease in size as their distance from the photographer increase. Therefore, the part of the photograph showing huge objects is the place close to where the photographer stood.

IDENTIFYING AND INTERPRETING PHYSICAL FEATURES

Many physical features shown in the photograph can be identified and interpreted. These features include relief, drainage, and vegetation, among others.

RELIEF

Before interpretation of other physical features, it is important to first identify relief features on the photograph. Start by giving a general idea about the area shown in the photograph. In describing landscape and landforms, it is important to go even further and describe the forces and processes that are responsible for their formation and modification. This is an essential aspect of relief interpretation. Relief features in the photograph may include the following features: Flat landscapes These landscapes occur both in lowland and highland areas. They are called plains in the lowlands and plateaus in the highlands. Plains altitudes are less than 500 metres while plateau altitudes are more than 500 metres above sea level. It is impossible to tell the average area of the land directly from a photograph. However, other features appearing in the photograph, such as part of the sea, crops and other economic activities may be used in estimating the altitude. Where there is an accompanying topographical map of the area, it would then be easier to state the height of the land from the map. Where there is no sufficient information to tell the height of the land, relief may be described as flat. One can then suggest that it is probably a low-lying plain or a plateau surface. Some flat areas may be described as flat lowlands or highlands. Hilly areas A hilly landscape is shown on photographs as having varied relief of hills and valleys that are not isolated on a flat landscape. Where hills appear to have the same height across the entire landscape, such a landscape is probably a dissected plateau. Streams have cut valleys across former flat land and some interlocking spurs may be visible towards valleys. Ridges, escarpments and conical hills may easily be identified according to their appearance. Mountainous relief This kind of relief stands at an altitude of more than 2000 metres above sea level. As such, not all rising features identified on photographs are mountains. The relief of mountainous areas is characterized by very steep slopes often with no human settlements. The slopes may have vegetation covering them, which could be forests. At much higher levels, snow might be seen. The type of trees growing could give a clue about the altitude of the land. If there are crops growing or animals reared, these could also give a clue as to the altitude. Certain crops such as wheat and apples are high-altitude crops. Likewise, animals such as merino sheep and dairy cattle are also reared in high-altitude areas within the tropics. Identifying relief features on vertical aerial photographs is not straight-forward. The following guidelines could assist in identifying different types of relief:

1. Flat areas would appear as areas with light colour tone except in regions covered with dense vegetation such as forested areas. Rivers may have big meanders while roads, footpaths and railways are generally straight, with gentle bends in some places.
2. Hilly areas could be identified by examining river streams. The streams could be joining one another and getting wider downstream. Hilly areas are the source of rivers. The colour tone in hilly areas is generally dark.

DRAINAGE

Drainage features such as rivers, lakes and seas may easily be identified in all types of photographs. Different aspects of rivers can be studied on a photograph. These include the shapes of river valleys, stages of development and various features. Based on the presence of certain features, one can tell the nature of the rock over which the river flows. For example, the presence of rapids and waterfalls is an indication that the river is flowing over steep land. River meanders are an indication that the river is in it mature or old-age stage. Interlocking spurs indicate that the river valley is made of alternating layers of hard and soft rocks. Drainage patterns are easier to identify on vertical aerial photographs. The colour tone of areas covering deep water appears darker than those of shallow water. The various functions of the river can also be identified.

VEGETATION

Photographs show all types of vegetation in the photographed area. Planted (artificial) and natural forests appear to be distributed unevenly, with planted forests usually in clear straight lines. In planted forests trees tend to be of the same type, size and height because they were planted at the same time. The plant characteristics that may appear on the photograph can be used as a guide to the general types of vegetation, for example savannah or semi-arid vegetation. The following guidelines should be used when describing vegetation on a given photograph: Identify the types of vegetation, for example, forests, thickets, grasslands and swamp plants. Describe the plants, giving details such as height, shape and appearance of leaves. Where possible, give the names of species of plants, e.g. jacaranda, cacti, eucalyptus trees, etc. Planted vegetation should be distinguished from the natural ones by their characteristics. Proper interpretation of vegetation calls upon application of geographical knowledge outside the photograph as well.

SOIL

A clue on the type of soil in a photographed area may be given by the types of crops grown and appearing on the photograph. Rice, for example, grows well in clay soil. Tea and coffee require volcanic soil. Coconuts and cashew nuts thrive well in coastal regions with sandy soils, and a variety of horticultural crops thrive in loam soils. Proper interpretation of the soil requires an application of one’s general knowledge of geography learnt in classroom as well as knowledge from other disciplines.

CLIMATE

Weather and climate are not shown directly on photographs. Features contained in a photograph can be used to make conclusions about the climate of a photographed area. The type of crops grown and vegetation on the photograph can be used as a clue to establish the climate of a place. Vegetation types and crops can also provide evidence about the season or climate of a place. For

example, the presence of many cacti signifies an arid or semi-arid region, and hence a desert or semi-desert climate. Crops such as sisal are grown in hot areas that receive low rainfall while sugarcane thrives in warm to hot climate with high rainfall. The type of clothing people in the photograph are wearing can give an indication about the weather and possible climate.

IDENTIFYING AND INTERPRETING HUMAN ACTIVITIES

Human activities on a photograph are depicted by various forms of land use. The uses of land may in form of agriculture (crop cultivation and animal husbandry), forestry, settlement, wildlife conservation, mining and construction of infrastructures, among other uses.

AGRICULTURE

This includes crop cultivation and livestock rearing. It is practised at subsistence and commercial levels. It is easy to identify agricultural activities on ground photographs. To be able to identify these features on vertical aerial photographs, it requires close examination of the features. Some evidences that can be used to establish the kind of agricultural activities taking place in an area shown on the photograph are summarized in the table below: Type of farming Evidences
Subsistence crop farming

- Some houses are permanent while others are temporary
- The land is often divided into small plots owned and cultivated by individual farmers
- Mixed farming is practiced
- Simple farming tools such as hoes, mattocks, pangas and rakes are used
- Fields are separated by hedges Subsistence livestock farming
- Indigenous and exotic animal breeds are kept
- Animals are grazed on grassland or semi-arid vegetation
- Large herds of local cattle (zebu), goats and sheep Commercial livestock farming
- Large fields divided into paddocks
- Presence of cattle sheds near farm houses
- Windmills for water supply
- Presence of water tanks, ponds or reservoirs in the dry areas
- Evidence of livestock infrastructures such as cattle dips or spray races, abattoir, cattle bomas, slaughter slab, etc.
- High grade exotic or crossed cows with large udders
- Milking parlour with milking machines, and milk processing plants
- Indoor grazing units Commercial crop farming
- Presence of cash crops on an extensive area
- Evidence of modern farming methods, e.g. farm machinery
- Facilities for collecting crops, e.g. sheds and stores
- Presence of access or feeder roads within the farm Plantation farming
- A single crop covering extensive stretches of land, e.g. sugarcane, tea, coffee, sisal, wheat • Processing factories

• Presence of storage facilities, e.g. silos
• Many labourers in the fields
• Nucleated settlement within the farm. These are usually for the workers' housing
• Presence of a network of roads crossing the farm – to facilitate mechanization and haulage of inputs and produce to and from the farm, respectively

SETTLEMENT

A settlement comprises of a group of buildings in an area where people live and carry out social and economic activities. There are two types of settlements; rural and urban settlement. In photographs, rural settlements can be indicated by the following features:
a. Many semi-permanent and a few permanent buildings such as grass-thatched houses or iron-roofed houses with mud or brick walls
b. Evidence of farming, fishing activities etc.
c. Unplanned or unevenly distributed of settlement which associated with plantations etc. Urban settlements can be identified by the following features: a. Permanent buildings, which dominate the area b. Regular street patterns c. Many large buildings and warehouses indicating an industrial area
d. High numbers of people or population e. Availability of Many motor vehicles on the road, which may lead to traffic jams

INDUSTRIAL AND MINING ACTIVITIES

The following evidence can be used as a guide in identifying industrial and mining activities on a photograph: a. Presence of Factory buildings with tall chimneys that might be issuing a lot of smoke
b. Nucleated settlements in the neighborhood, likely to be the laborers' houses
c. Tall chimneys emitting flames and a network of pipes with large tanks in the distance could indicate an oil refinery
d. Large open pits, large excavators and lorries carrying loads of rocks could indicate open cast mining
e. A large area with derricks (oil rigs) could point to an oilfield where oil is mined

LUMBERING

Lumbering activities could be indicated by the presence of the following features/activities: a. Logs floating down the river b. People cutting trees using manual or power saws c. Large forest clearings with tree stumps and piles of logs d. People loading timber onto lorries or tractor trailers e. Logs piled near a saw mill

TRANSPORT AND COMMUNICATION

The following are some of the clues on transport. Presence of motor vehicles and roads Animals carrying loads on their backs Presence of railway line Presence of ports, boats, ships or large

water bodies The clues for communication may be indicated by the presence of telephone lines, telephone booths, satellite dishes, buildings with masts and wires connecting the masts, post office, radio or television station, newspapers or newspaper stands, etc.

ESTIMATING THE SIZE OF FEATURES

Estimating the size of object in the photographed area sometimes is not easy, therefor some clues are used in order to estimate size of objects in the photographed area. Due to perspective nature of photographs, especially with regard to the ground general view photographs, it is not ease to measure and calculate possible distances from them. It is, however, possible to work out approximate sizes of objects using familiar objects in the close-up photograph such as a person, ruler or coin. This gives an impression of the relative sizes of the objects and from this we can be in a position of estimating the size of a given object in a photograph. That is why, we normally see a coin, hammer or ruler or any known object placed against rock strata to give us an idea about the size of the rock.

Topic 7: APPLICATION OF STATISTICS

Statistics is the study of collection, analysis, interpretation, presentation, and organization of data. Data refers to crude or uninterrupted information. Types of statistics Two main statistical methodologies are used in data analysis, namely, descriptive statistics and inferential statistics.
a. Descriptive statistics. Are techniques concerned with careful collection, organisation, summarizing and analyzing from large set of data obtained from the field work where the population is large. Example harvest, temperature and census.
b. Inferential statistics it draws conclusions from data that are subject to random variation (e.g., observational errors, sampling variation). Descriptive statistics are most often concerned with two sets of properties of a distribution (sample or population).

STATISTICAL DATA

Data refers to the actual pieces of information collected through your study. For example, if you ask five of your friends how many pets they own, they might give you the following data: 0, 2, 1, 4, 18. Also data defined as facts or figures from which conclusions may be drawn. Datum is the singular form of the noun data.

Types of Statistical

Data Most data fall into the following groups which is Qualitative and Quantitative data.
Quantitative data; these data obtained through measurement, such as a person's height, weight, IQ, or blood pressure;
Qualitative data are often termed numerical data. Data described by numbers. Numerical data can be further broken into two types: Discrete data represent items that can be counted; they take on possible values that can be listed out. The list of possible values may be fixed (also called finite); or it may go from 0, 1, 2, on to infinity (making it countably infinite). Continuous data

represent measurements; their possible values cannot be counted and can only be described using intervals on the real number line. Continuous data have infinite possibilities such as 1.4, 1.41, 1.414, 1.4142, 1.141421... Qualitative data Quantitative data represent characteristics such as a person's gender, marital status, hometown, or the types of movies they like. Terms such as Poor, Fair, Good, Better, Best are used to describe data. Qualitative data are often termed categorical data.

Ways of expressing data.

a. Nominal scale: This type of scale Nominal data has no order and thus only gives names or labels to various categories such as 'excellent', 'good', 'fair' or 'poor' and maybe use grades, e.g. A, B, C, D and so on. Nominal scale may also include numerical values. For example one may decide to let 1, 2, 3 and 4 stand for 'excellent', 'good', 'fair' or 'poor' or vice versa.
b. Ordinal scale: Is the data that involves rank orders or positions among events or objects. These statistics attempt to provide quality or position. For example, if Faustine scored 7% in Geography Test while Mariam scored 96%, then we can say that the former ranked number 19 while the latter ranked number 1 out of 20 students. Sometimes, values such as ½ of the class scored below 50% in Geography may be included in the ranking.
c. Interval scale: This type of scale employs truly quantitative values and allows the use of mathematical operations such as adding, subtracting, multiplying and dividing. At no time is zero present in this scale. For example, the range of temperature in which rice grows well is 25°C and 45°C; most livestock keepers get between 10 and 15 litres of milk per cow per day.
d. Ratio scale: This is a type of scale that is used to make comparisons between values or quantities. For example, Mr. Mgaya harvested 50 sacks of maize which is twice Mr Mkongo obtained from the same acreage because the former applied fertilizer and good farming practices while the latter did not. Scale Properties Examples Nominal Indicates a difference, without any implied ordering Religion: 1=catholic; 2=protestant; 3=Jewish; 4=Muslim; 5=other Ordinal Indicates a difference, and the direction of the difference(e.g., more or less than) Attitude on a subject:1=strongly disagree, 2=disagree; 3=don't care / don't know; 4=agree; 5=strongly agree Interval Indicates a difference, with directionality and amount of difference in equal intervals Temperature in Celsius Occupational Prestige (12-96) Ratio Indicates a difference, the direction of the difference, the amount of the difference in equal intervals, an absolute zero Temperature in Kelvin Income Years of schooling

VARIABLE

A variable is anything or characteristic that data may have, or an attribute which changes in value under given conditions. Variables include population size, age, sex, altitude, temperature and time. Variable can be classified into two major forms:-
a. An independent variable is a variable factor which influences the changes of other variables or outcomes eg. Sex, year etc. it is expressed on the x-axis. The independent variable is also known as manipulated variable.

b. A dependent variable is an outcome or result that has been influenced by other variables. A dependent variable does not influence or change other variables. The dependent variable responds to independent variable. It is called dependent because it “depends” on the independent variable. For example the higher the attitude the lower the temperature and vise versa, for that reason increase or decrease of temperature depends on attitude.

DATA PRESENTATION

Data presentation refers to the process of organizing data and presenting them into different forms such as line graphs, pie chart, bar proportional diagrams, polygons and others.

GRAPHICAL DATA

After data have been collected, the next step is to present the data in different ways and forms. Some of the forms in which the data may be presented include charts, graphs, lists, diagrams, tables, essays, graphs, histograms, and even sketches.

LINE (LINEAR) GRAPHS

Line graphs have unique properties that distinguish them from other graphs. The properties of line graphs are as follows: General procedure to present data using line graphs

a. Get the data needed for plotting the graph.
b. Identify the independent and dependent variable. Statistically, the independent variables are placed on the x-axis while the dependent variables are placed on the y-axis.
c. Decide on the vertical scale depending on the graph space and values of the independent variable available.
d. Decide on the horizontal spacing of the graph according to graph space available.
e. Draw and divide the vertical and horizontal axes depending on the respective scales.
f. Plot and join the points to get the graph.
g. Write the title of the graph you have drawn.
h. Indicate the scale of the graph.
i. Show the key for the graph where necessary

Line graphs can be sub-divided into the following categories.

a. Simple line graphs
b. Group (comparatives) line graphs
c. Compound line graphs
d. Divergent line graphs

Simple line graph Construction procedure:

Use the following table which shows the average monthly temperature recorded in a certain weather station: Average monthly temperature for station X Month Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec Temp (°C) 23 24 26 28 29 28 26 26 26 27 26 25 The following

procedures may be used:
1. Identify the variables. The dependent variable is temperature and the independent variable is months.
2. Determine a vertical scale.
3. Determine the horizontal scale (y-axis) depending on the available space 4. Draw both axes and label them: y-axis for temperature and x-axis for months.
5. Plot the points and join them by a smooth line to make a curve.
6. Insert the title and scale. The following is a simple line graph showing monthly temperature for station X. Average monthly temperature for Station X Source: Hypothetical data Scale • Vertical – 1cm:3°C • Horizontal – 1cm: 1month

Advantages of simple line graphs

1. They are easy to draw, read and interpret.
2. They show specific values of data
3. They show patterns in data clearly
4. They enable the viewer to make predictions about the results of data.
5. It is easy to read the exact values against plotted points on straight line graphs.

Disadvantages of simple line graphs

1. They limit presentation of only one data or item over time.
2. One can change the data of a line graph by not using consistent scales on the axis.
3. They can give a wrong impression on the continuity of data even when there are periods when data is not available.
4. They do not give a clear visual impression of the actual quantities.

Group (comparative) line graph

A group line graph is the graph that involves drawing more than one line on the same graph. It shows the relationship between sets of similar statistics for two or more items. A group line graph is also known as Comparative line graph, Composite line graph, multiple line graph, Polygraph. Usefulness of a group line graph

• Comparing different values or trends in two or more data variables.
• Examining the possibility of a relationship existing between the distributions of a number of variables over time.
• Comparing the distribution of the same variable at different places.

Construction:

The method of drawing a group line graph is the same as for a simple line graph. Therefore, to draw each single line in a group line graph, follow similar steps used for construction of the simple line graph.

The following things should be considered before drawing the graph:

1. The lines drawn should not be uniform in colour, thickness, general appearance, etc
2. The number of lines that a graph can accommodate should not exceed five (5). The following table shows banana production (in tonnes) by three villages in Ingwe Division, Tarime district. These data have been used to plot the group (comparative) line graph as shown below: Village/Year Geisangora Itiryo Bungurere Nyansincha 2000 10 15 25 25 2001 20 10 15 20 Source: Hypothetical data Maize production by three villages between 2000 and 2002 Scale: Vertical scale: 1cm to 5 tones Horizontal scale: 2 cm to 1 year

Advantages of group line graph
1. The quantity of each component is shown clearly by different line shadings.
2. Gives comparative analysis of data
3. It saves time and space since all the line graphs are drawn as a group.

Disadvantages of group line graph
1. The lines can be overcrowded and hence become difficult to read and interpret if many data are involved. 2. It does not give a clear visual impression of actual quantities. Compound line graph A compound line graph is used to analyse the total and the individual inputs of the specific commodities or economic sectors. The graph involves drawing two or more lines, each line corresponding to one item in a different year or region. The items are differentiated from each other or one another by shading differently. Construction: The table below is used for construction of the graph. The table contains hypothetical figures for mineral exports between 2010 and 2012. Year/Mineral Diamond Gold Tanzanite 2010 10,000 16,000 20,000 2011 20,000 25,000 32,000 2012 25,000 35,000 40,000

Procedure:
• Simplify the data to make the presentation work easy by dividing each value by 1000. Year /Mineral Diamond Gold Tanzanite 2010 10 16 20 2011 20 25 32 2012 25 35 40
• Add the values for each year to get the cumulative export
• Plot the values for mineral exports against years on a graph. Usually the line graph for data with the highest values is drawn first.
• Draw the second line graph above the first one to show the next component. To get the values for plotting the second line graph, add the values of the first
• Draw the line graph for the last item (diamond) above that of the second item.
• Shade the component parts between the line graphs using different shadings.
• Label the axes, show the key and indicate the scale used to construct the graph.

Advantages of compound line graph
1. Total values are shown clearly shown
2. It gives good visual impression which encourage understanding and interpreter
3. Combining all graphs in one saves space.

Disadvantages of compound line graph
1. Graph construction is difficult and time-consuming.
2. It involves a lot of calculations which are difficult and time-consuming.
3. Reading and interpretation the value is difficult

Divergent line graph

Are graphs which represents negative (minus value) and positive (plus value) around a mean. They are loss and gain graphs which show divergence or variation between export and import or profit and loss etc. The mean is represented by zero axis drawn horizontally across the graph paper. Year Yield (tonnes) 2012 1000 2013 1500 2014 500 2015 3000

Construction
• Sum up the values of all items or commodities. 1000 + 1500 + 500 + 3000 = 6000 • Calculate the arithmetic mean (average) of the values.
• Calculate the deviation from the mean of each value as shown in the table below. Deviation from the mean value Year X X – 2012 1000 -500 2013 1500 0 2014 500 -1000 2015 3000 +1500
• Plot the graph using the values of deviation from the mean; and remember to include the title and scale of the graph.

Advantages of divergent line graph
1. It clearly shows how items fluctuate from the mean.
2. It compares the values of the items and hence facilitates a sound conclusion.
3. It shows both the positive (profit) and negative (loss) phenomena. 4. It is easy to construct, read and interpret.

Disadvantages of divergent line graph
1. It involves many calculations and hence time-consuming.
2. It might be difficult to interpret if one lacks statistical skills.
3. It is applicable for only one item per graph.

BAR GRAPHS

Are graphs drawn to show variation of distribution of items by means of bars. The bars should be separated from one another by a space. A bar graph is also called bar chart or columnar graph.
Types of bar graphs:
a. Simple bar graphs
b. Group or comparative bar graphs
c. Compound bar graphs
d. Divergent bar graphs

Simple bar graph

A simple bar graph is drawn to show a single item per bar and represents simple data. Consider the data in the table below which shows the value of sisal exported by Tanzania between 1900 and 1993: Year Sisal export (Tsh '000) 1990 106126 1991 107430 1992 142601 1993 161180 1994 202425

Construction:-

1. Choose the appropriate scale.
2. Draw the axes and insert the bars. All the bars must have the same width and spacing.
3. Shade the bars uniformly.
4. Insert vertical and horizontal scales and the title. Tanzania sisal export Scale: 1 cm to 50,000 tonnes

Advantages of a simple bar graph

1. It is simple to construct, read and interpret.
2. It has a good visual impression.
3. It can be used to compare how the amount of an item varies from time to time.

Disadvantages of a simple bar graph

1. It is limited to only one item or commodity and hence not suitable for massive data.
2. Not suitable for continuous data such as temperature.

Group (comparative) bar graph

A comparative bar graph consists of several bars drawn side by side on the same chart for the purpose of comparison. The technique involves grouping of bars in a chart. The graph can be used to show how production of certain commodities varies each year.

Construction:

The procedure for construction of the comparative bar graph is similar to that of drawing the simple bar graph except that the simple bar graph contains a single bar while the comparative bar graph comprises of multiple bars. Consider the data in the table below, showing agricultural production in metric tonnes. Year/Commodity 1986 1987 1988 Sorghum 1200 5000 8000 Tea 9000 7000 6000 Tobacco 3000 5000 4000 The graph for the data is as shown below. Group (comparative) bar graph showing crop yields in '000 kg (1986-1988)

Advantages of a group bar graph

1. The total values are expressed well for illustration of points.
2. It is easy to construct, read and interpret.
3. The importance of each component is shown clearly.

Disadvantages of a group bar graph
1. It is difficult to compare the totals of each item/component.
2. Trends such as fall and rise cannot be shown easily.

Compound (divided) bar graph

This is a method of data presentation that involves construction of bars which are divided into segments to show both the individual and cumulative values of items. The length of each segment represents the contribution of an individual item in the total length while that of the whole bar represents the total (cumulative) value of the different items in each group.

Construction
• Get the data needed for presentation. For example, consider the table below, which shows the number of tourists who visited the named Tanzania National Parks from 1998 to 2002. Year /park 1998 1999 2000 2002 2003 Manyara 120,000 160,000 172,000 170,000 203,000 Serengeti 175,000 160,000 148,000 185,010 201,000 Tarangire 29,000 30,000 54,100 79,000 102,000 Mikumi 100,000 110,000 111,000 150,000 183,400
• Simplify the data (to make the presentation work easy) by dividing each value by 10,000. Then add the values to get the total for each year. The simplified data are as shown in the table below.
• Determine the scale of the bar length based on the highest total value. In this case, the highest total value is 68 (20 + 20 + 10 + 18).
• Decide on the bar spacing, for example, 1 cm apart.
• Draw the axes and label them.
• Start by drawing bars that represent the highest values.
• The first sets of bars to be drawn are those that represent the highest values. On top of these, the second highest segments are drawn. The last segments to be drawn are those with the lowest values in general.
• To make it easy to follow the rise and fall of individual values, a soft line could be drawn across bars to separate individual segments.
• Colour or shade the segments to improve the appearance and simplify interpretation.
• Inset the scales, key and title. Compound (divided) bar graphs showing tourist visits in 0'000 (1998-2002)

Advantages of compound (divided) bar graph
1. It is easy to read and interpret as the totals are clearly shown.
2. It gives a clear visual impression of the total values.
3. It clearly shows the rise and fall in the grand total values.

Disadvantages of compound (divided) bar graph
1. The values of individual segments above the first set are difficult to establish because they don't start at zero. To get the correct values of the top segments, you have to add the figures,

which is difficult for someone not well equipped with statistical skills.
2. The graph is very difficult to construct and interpret.
3. It is not easy to represent a large number of components as this would involve very long bars with many segments.

Divergent bar graph

A divergent bar graph is a graph which shows the fluctuation of individual items from the mean.

Construction:
1. Calculate the arithmetic mean (average) of the items.
2. Subtract the mean from each item.
3. Draw the graph using the resulting values.
4. Insert the scale and title of the graph. The data below show the enrolment of Form One students at Mara Secondary School from 1980–1985. Study the table and present the data by a divergent bar graph. Year Number of students 1980 100 1981 150 1982 175 1983 200 1984 225 1985 300 Procedure: • Find the arithmetic mean:
• Subtract the mean from each item: Year Number of students X – 1980 100 -92 1981 150 -42 1982 175 -17 1983 200 8 1984 225 33 1985 300 108
• Choose a suitable scale and construct the graph using the obtained values (X –). A divergent bar graph showing student enrolment (1980-1985)

Advantages of divergent bar graph
1. Fluctuation in values, which helps to detect the problem in general terms, is shown.
2. It is important for comparison of positives and negatives.
3. Profit (success) or loss (failure) can easily be deduced.
4. They are simple to construct, read and interpret.

Disadvantages of divergent bar graph
1. Graph construction is time-consuming since it involves many steps.
2. The calculations involved may be difficult to someone who is poor at mathematics.
3. It is limited to analysis of only one variable.

Divided circles (pie charts)

A divided circle is also known as pie chart, circle chart or pie graph. The chart involves dividing the circle into “pie slices” to represent and show relative sizes of data. The size of each slice or segment is always proportional to the value it represents.

Divided circles can appear in two forms:
a. Simple divided circles.
b. Proportional divided circles. A simple divided circle involves a single set of data whereas the

proportional divided circle involves more than one set of data such that the circles will be proportional to the total quantity that each circle represents.

Simple divided circle Construction:
• Obtain the data to work on. Study this hypothetical record showing enrolment of Form One students in selected Secondary Schools in Tarime District: A table showing student enrolment in selected schools in Tarime District Name of school Number of students Nyansincha 85 Bungurere 80 Nyanungu 78 Magoto 78 Tarime 65 Nyamongo 70 Total 456
• Calculate the total number of students as shown in the table.
• Calculate the angle in a circle that would represent the number of students enrolled in each school. For example, 85 out of 456 students enrolled in Nyansincha Secondary School will be represented in the circle by a segment with an angle of 85/456 ×630 = 67 degrees. This will give the following results. Name of school Number of students Degrees Nyansincha 85 67° Bungurere 80 63° Nyanungu 78 62° Magoto 78 62° Tarime 65 51° Nyamongo 70 55° Total 456 360°
• Draw a circle of a reasonable size.
• Using a protractor, draw a radius from the 6 o'clock mark to the centre of the circle.
• Starting with the largest segment representing a specific component, measure and draw its angle from the centre of the circle.
• Do the same for other components in ascending order.
• Divide a circle into segments according to the sizes of the angles.
• Shade the segments and write the title and key of the drawn graph. Student enrolment in selected Secondary Schools in Tarime District

Advantages of divided circles
1. It is easy to compare components as they are represented by angles.
2. Analysis and interpretation of data is easy.
3. It is easy to assess the proportion of individual components against the total.
4. Construction of this graphical representation is relatively simple.
5. It is easy to determine the value of each component since it is indicated on each segment.
6. Visual impression of the individual components is clear and facilitates the understanding of the information in the data.

Disadvantages of divided circles
1. It is time-consuming because it involves a lot of calculations.
2. The represented actual values remain hidden as the values shown on the faces of the segments may be in percentages.
3. Where the range of data is large and involves small and big values, accurate construction of the chart is difficult.
4. When the values of data set vary slightly, it is difficult to visualize the proportional differences

between values (as it is the case in the pie chart above).

The Importance of Statistics to the User Statistics is important in geography because of the following reasons:

1. It enables the geographers to handle large sets of data and summarize them in a way that can be easily understood.
2. Statistics is very useful for planning at local and national levels. For example, statistics on census can be used to plan for social services.
3. It can also enable the geographers to make comparisons between geographical phenomena, e.g. to compare the amount of rainfall and agriculture production or population distribution in different regions, etc. 4. Statistics translates data into mathematical ways which make the application of quantitative techniques possible.
5. It enables the geographers to store the information in forms of numbers, graphs, tables, charts, etc.
6. Statistics give precise rather than generalized information. This offers a lot of satisfaction to the user.

SUMMARIZATION OF MASSIVE DATA

The massive data collected from the field have to be summarized so as to make it easy to read, interpret and apply. The massive data can be summarized by the following ways:

1. Frequency distribution A frequency distribution shows a summarized grouping of data divided into mutually exclusive classes and the number of occurrences in a class. It is a way of showing unorganized data e.g. to show results of an election, income of people for a certain region, sales of a product within a certain period, student loan amounts, etc. Some of the graphs that can be used with frequency distributions are histograms, line charts, bar charts and pie charts. Frequency distributions are used for both qualitative and quantitative data. Frequency distribution helps to determine how many times a certain score occurs in a sample. In statistics, a frequency distribution is a table that displays the frequency of various outcomes in a sample. Each entry in the table contains the frequency or count of the occurrences of values within a particular group or interval. In this way, the table summarizes the distribution of values in the sample. Consider the following table which shows family size of 20 families which were interviewed in a certain village:3, 2, 2, 4, 3, 7, 8, 1, 3, 6, 2, 2, 4, 5, 6, 4, 3, 4, 5, and 2. The data can be summarized in a frequency table thus: a. Arrange the scores in a descending order from 8 to 1. It is advised to arrange the scores in ascending order. b. Distribute each score in the sample to determine the number of times each score occurs (frequency) in the data sample. The frequency indicates how many times a score or event appears or occurs in a sample. The steps for making a grouped frequency are as follows: 1. Decide about the number of classes. Too many classes or too few classes might not reveal the basic shape of the data set; also it will be difficult to interpret such a frequency distribution. The maximum number of classes may be determined by formula: Number of classes = C = 1 + 3.3log(n) or C = $\sqrt{n}$(approximately) where n is the total

number of observations in the data. 2. Calculate the range of the data (Range = Max – Min) by finding minimum and maximum data value. Range will be used to determine the class interval or class width. 3. Decide about the class interval denote by h and obtained by h = Range/Number of classes

4. Decide the individual class limits and select a suitable starting point of the first class which is arbitrary, it may be less than or equal to the minimum value. Usually it is started before the minimum value in such a way that the midpoint (the average of lower and upper class limits of the first class) is properly placed.

5. Take an observation and mark a vertical bar (|l) for a class it belongs. A running tally is kept till the last observation. However, it is not always necessary to show tallies in the Frequency Distribution Table because the frequency column serves the same purpose. 6. Find the frequencies, relative frequency, cumulative frequency etc. as required Frequency distribution table Class interval Frequency Cumulative frequency 0 – 9 4 4 10 – 19 9 13 20 – 29 8 21 30 – 39 3 24 40 – 49 4 28 50 – 59 7 35 60 – 69 5 40 70 – 79 4 44 80 – 89 2 46

Characteristics of the class interval

1. A score appears only once. That means no score should belong to more than one class.
2. The size of the class interval should be the same. No score should fall in more than one class. Arrange the class intervals in order of ranks as shown in the frequency distribution table above.
3. The class intervals should always be continuous.
4. The range of class interval should be between 3 and 20. Thus, the intervals should not be below 3 and not above 20. From the summarized data in the table above, one can identify two concepts:

a. Apparent upper limit

b. Apparent lower limit

These limits (or boundaries) are seen in each class interval. The apparent lower limit opens the class interval while the apparent upper limit closes the class interval. The table above shows 80, 70, 50, 40, 30, 20 and 10 as apparent lower limits and 89, 79, 69, 59, 49, 39, 29, 19 and 9 as the apparent upper limits. Apart from the two concepts above, the table has real limits which are not visible. These are 0.5 below or above the apparent limits. From the above summarized data, other measures of statistics can be deduced. Such measures include the measures of central tendency, measures of dispersion (variability), measures of relationship (correlation) and measures of relative position.

METHODS OF PRESENTING SIMPLE AND MIXED DATA

Measures of central tendency (averages) A measure of central tendency is a single value that attempts to describe a set of data by identifying the central position within that set of data. As such, measures of central tendency are sometimes called measures of central location. They are also classed as summary statistics. The mean (often called the average) is most likely the measure of central tendency that you are most familiar with, but there are others, such as the median and the mode. The mean, median and mode are all valid measures of central tendency,

but under different conditions, some measures of central tendency become more appropriate to use than others. In the following sections, we will look at the mean, mode and median, and learn how to calculate them. The Mean, Mode and Median Arithmetic mean The mean (or average) is the most popular and well known measure of central tendency. It can be used with both discrete and continuous data, although its use is most often with continuous data. The mean is equal to the sum of all the values in the data set divided by the number of values in the data set. So, if we have n values in a data set and they have values x1, x2, ..., xn, the sample mean, usually denoted by (pronounced x bar), is: This formula is usually written in a slightly different manner using the Greek capital letter, ∑, pronounced "sigma", which means "sum of...": Example 1 In English exam, students obtained the following percentage scores: 45, 42, 35, 86, 40, 56, 87, 40, 35, 74, 68 and 50 The arithmetic mean of the score is: The average score was 54.8% Advantages of the mean 1. It is rigidly defined by a mathematical formula
2. It is easy to understand and calculate
3. It is based on all observations
4. It is determined in all cases
5. It is suitable for further mathematical treatment or manipulation
6. Compared to other averages, arithmetic mean is affected least by fluctuation of sampling

Disadvantages
1. It is greatly affected by extreme values of the data
2. It cannot be obtained if a single observation (item) is missing
3. It is not appropriate in some distributions

Median

The median is the middle score for a set of data that has been arranged in order of magnitude. Suppose we want to find the median from the data below: 65, 55, 89, 56, 35, 14, 56, 55, 87, 45, 92 We first need to rearrange that data in order of magnitude (smallest first): 14, 35, 45, 55, 55, 56, 56, 65, 87, 89, 92 Our median mark is the middle mark - in this case, 56 (highlighted in bold). It is the middle mark because there are 5 scores before it and 5 scores after it. This works fine when you have an odd number of scores, but what happens when you have an even number of scores? What if you had only 10 scores? Well, you simply have to take the middle two scores and average the result. So, if we look at the example below: 65, 55, 89, 56, 35, 14, 56, 55, 87, 45 We again rearrange the data in order of magnitude (smallest first): 14, 35, 45, 55, 55, 56, 56, 65, 87, 89 Only now we have to take the 5th and 6th score in our data set and average them to get a median of 55.5.

Advantages of the median
1. It is easy to calculate and understand
2. It can also be calculated in qualitative data
3. It is appropriate for skewed distribution

4. It is not affected by all extreme observations. Hence, it is a better average than the arithmetic mean when extreme observations are present.
5. The values of a median can be obtained graphically.

Disadvantages
1. It is not suitable for further mathematical treatment.
2. It is not rigidly defined.
3. It is based on all values or observations.
4. Compared to mean, median is more affected by fluctuation of sampling.
5. In case of ungrouped data, rearrangement of values in order of magnitude becomes necessary.

Mode

The mode is the most frequent score in a data set. It represents the highest bar in a bar chart or histogram. You can, therefore, sometimes consider the mode as being the most popular option. An example of a mode is presented below:

Advantages of the mode
1. It is simple to compute.
2. It is easy to understand and calculate. In some cases it can be located merely by inspection. The value of the mode can be obtained graphically from the histogram.
3. It gives a rough idea of the differences of the data set.
4. It is the only average that can be used when the data is not numerical.

Disadvantages
1. It is not rigidly defined; hence it is unstable for large samples.
2. It is independent of sample size except under special circumstances.
3. It is not based on all the values of the data.
4. Mode is not suitable for further mathematical treatment.
5. As compared to mean, mode is affected to a great extent by the fluctuation of sampling.
6. There may be more than one mode (as is the case in the previous graph).
7. There may be no mode at all if none of the data are the same.
8. It may not accurately represent the data.

The Significance of Mean, Mode and Median

Measures of central tendency are very useful in statistics. Their importance is because of the following reasons:
1. To find representative value: Measures of central tendency or averages give us one value for the distribution and this value represents the entire distribution. In this way averages convert a group of figures into one value.
2. To condense data: Collected and classified figures are vast. To condense these figures we use

average. Average converts the whole set of figures into just one figure and thus helps in condensation.
3. To make comparisons: To make comparisons of two or more than two distributions, we have to find the representative values of these distributions. These representative values are found with the help of measures of the central tendency.
4. Helpful in further statistical analysis: Many techniques of statistical analysis like Measures of Dispersion, Measures of Skewness, Measures of Correlation, and Index Numbers are based on measures of central tendency. That is why measures of central tendency are also called measures of the first order. Interpret data using simple statistical measures In the section about averages (mean, mode and median), we learned how to calculate the mean for a given set of data. The data we looked at were ungrouped and the total number of elements in the data set was not that large. The method is not always a realistic approach especially if you are dealing with grouped data. Assumed mean (A), like the name suggests, is a guess or an assumption of the mean. It doesn't need to be correct or even close to the actual mean and choice of the assumed mean is at your discretion except for where the question explicitly asks you to use a certain assumed mean value. Assumed mean is used to calculate the actual mean as well as the variance and standard deviation. Measures of central tendency can be calculated from grouped data, for example: Calculation of measures of central tendency for grouped data Study the frequency distribution table below: Calculation from the table: Assumed mean (A) = 12 Note: we find the class interval by using the class limits as follows: i = upper class limit − lower class limit + 1 Importance of statistics Helps in the comparison of different geographical phenomena for example climate, population, commodity and production Used to summarize raw and bulk data for easy interpretative and visual explanation It facilitates land use planning Helps resources allocation and provision of social services for example food, health, water, education. Makes it easy to compare data Its knowledge simplifies research activities