

CHAPTER ONE

INTERNAL LAND FORMING PROCESSES

Specific Objectives

By the end of the topic the learner should be able to:

- (a) Define earth movements;
- (b) Explain the causes of horizontal and vertical earth movements;
- (c) Explain the theories of Continental Drift and Plate Tectonics;
- (d) Define folding, faulting, vulcanicity and earthquakes;
- (e) Explain the processes of folding, faulting, and vulcanicity;
- (f) Describe types of folds, faults and forms of vulcanicity;
- (g) Explain features that result from folding, faulting and vulcanicity;
- (h) Explain the causes of earthquakes;
- (i) Describe how earthquakes are measured;
- (j) Account for the world distribution of earthquake zones, fold mountain systems and features due to faulting and vulcanicity;
- (k) Explain the significance of the resultant features of folding, faulting, vulcanicity and Effects of earthquakes.

Content

Earth Movements

- (a) Definition
- (b) Types of earth movements - horizontal and vertical movements.
- (c) Causes of earth movements

Theories of

- (a) Continental drift
- (b) Plate tectonics

Folding

- (a) Definition, and processes of folding.
- (b) Types of folds
- (c) Features resulting from folding.
- (d) World distribution of fold mountain systems.
- (e) Significance of folding to human activities.

Faulting

- (a) Definition, and processes of faulting.
- (b) Types of faults.
- (c) Features resulting from faulting.

- (d) A study of the Great Rift Valley.
- (e) World distribution of features formed through faulting.
- (f) Significance of faulting to human activities.

Vulcanicity

- (a) Definition of vulcanicity.
- (b) Types of vulcanicity and the resultant features.
- (c) World distribution of features formed through vulcanicity.
- (d) Significance of vulcanicity to human activities.

Earthquakes

- (a) Definition of earthquakes.
- (b) Measurement of earthquakes.
- (c) Distribution of the major earthquake zones of the world.
- (d) Effects of earthquakes.

Earth movements

- ✓ It's the Displacement or Movement of Crustal rock caused by Tectonic forces which originate and operate in the interior of the earth.
- ✓ These forces are responsible for the formation of various landforms that can either be external or internal. The formation of these landforms is determined by:
 - i. The nature and age of the earth's materials for example the degree of their elasticity.
 - ii. The type of movement involved.
 - iii. The intensity and scale of the forces involved.

Types of Earths Movements

- ✓ There are two types:
 - Horizontal earth movement.
 - Vertical Earth Movements

Horizontal Earth Movements (orogenic/lateral)

- ✓ These are movements which act along a plane but since the earth is curved, these forces act along a tangent.
- ✓ They occur when the earth's materials are forced to stretch, shorten and shear (divided into many layers).
- ✓ Horizontal earth movements are caused by the forces which pull crustal rocks apart, or push them towards earth other but with equal forces on the Earth's crust.
- ✓ These forces cause tension, compression or shearing in the rocks.
- ✓ This movements causes formation of various features such as:

- Faults
- Rift valley
- Basin
- fault scarps
- Block mountains
- Cleavages
- fault blocks
- Tilt blocks

Vertical Earth Movement (Epeirogenic)

- ✓ These movements occurs along the Earth's radius either towards the earth's surface or towards it centre.
- ✓ Vertical earth movements are caused by strong forces pushing crustal rocks upwards or pull them downwards leading to up warping, down warping or tilting of the crustal rocks.
- ✓ These vertical movements of crustal rocks may cause isostatic adjustments, emergence and submergence of coast, faulting, rifting and crustal displacement.
- ✓ The process may also lead to the formation of various surface features such as basins,plateaus,faultscarps,fault blocks,tilt blocks and rift valleys.

Causes of earth movements

- Magma movement
- Gravitational force
- Convectional current

- **Isostatic adjustment**

Magma Movement

- ✓ When the rocks within the crust and mantle get so hot that they melt, the liquid rock (magma) may flow forcefully into the earth's.
- ✓ As the crustal rocks move, their places are taken over by the intruding magma causing earth movements.

Gravitational force

- ✓ This force tends to pull the rocks towards the earth's centre.
- ✓ This leads to down movement of crustal rocks due to the gravitational pull.

Convectional Currents

- ✓ The convection currents within the molten rock in the mantle are in circular motions from the mantle towards the crustal rocks.
- ✓ These currents exert a frictional drag with the crustal rock causing crustal rocks to move horizontally.

Isostatic Adjustment

- ✓ Isostasy is the state of balance existing between the lighter upper crust (SIAL) and the denser inner region (SIMA) of the earth. This balance must be maintained at all times.
- ✓ If disturbance caused by other movements disrupts this balance, then an isostatic adjustment occurs.

The continental Drift Theory

- ✓ The theory states that the earth was initially one land mass called Pangea.

- ✓ It was surrounded by a great ocean called Panthalassa whose floor was mainly sima layer.
- ✓ During the late Precambrian period, Pangaea broke up into two blocks Laurasia and Gondwanaland.
- ✓ They were separated by a narrow ocean called Tethys.
- ✓ During Mesozoic era, Laurasia broke up into two; Laurentian shield and Fennoscandia.
- ✓ Gondwanaland broke up into blocks forming seven Continents.
- ✓ Africa and India drifted northwards while Australia drifted eastwards. The Americas drifted westwards.

Evidences that support the continental drift theory

- i. Jig saw fit of continental margins e.g., eastern coastline of South America and western coastline of Africa.
- ii. Similar geological structures between rocks in Brazil (South America) and Republic of South Africa (Africa).
- iii. The Distribution of ancient glacial deposits.
- iv. Sea floor spreading i.e. younger rocks in the middle of oceans while older rocks found near the coasts.
- v. Paleontological evidence i.e. similarities of fossils in southern continents and between North America and Europe.
- vi. Palaeomagnetic evidence shows similarities in magnetic alignment in minerals.
- vii. Paleozoic glacial deposits found widely dispersed in continents of India, Australia and South America.
- viii. Climatological evidence points to coal today found in temperate latitudes but are believed to have formed in tropical climates.

- ix. The Mid-Atlantic Ridge shows that there are continuous mountain ranges extending the whole length of the Atlantic Ocean bed.

Plate Tectonic Theory

- ✓ This is a modern improvement of the continental drift theory.
- ✓ Plate tectonics is the study of the movement of plates and various landforms resulting from such movement.
- ✓ The theory states that:
 - Earth's crust is made of rigid blocks called tectonic plates
 - Each plate is separated from another by distinct boundaries.
 - The plates are sitting on the semi-molten layer of the upper mantle.
 - The plates move relative to each other/towards or away.
- ✓ The seven plates include:
 - The Eurasian plate
 - The African plate
 - The Antarctic plate
 - The North American Plate
 - The South American Plate
 - The Pacific Plate
- ✓ Due to convectional currents that are being generated by the heat from the centre of the earth, plates may move in three different ways. These include:
 - Away from each other.
 - Towards each other.
 - Parallel past one another along transformed faults.
- ✓ There are three types of boundaries associated with plate tectonic movements. These are:

- Extension boundaries/constructive margins.
- Compressional boundaries/destructive margins
- Transform faults/conservative margins

Reasons why geographers study the plate tectonics theory.

- To understand the origin of continents.
- To understand the formation of physical features.
- To understand the significance associated with the movements of plate.

Extension /Tensional/constructive boundaries

Extension boundaries is one where the tectonic plates are moving away from each other.

Compressional/destructive boundaries

Compressional boundary is one where plates move towards each other

Transform faults/conservative boundaries

Transform faults is one in which there are no new materials that are added or lost because it does not destroy the crust and it is also does not not creat any feature.

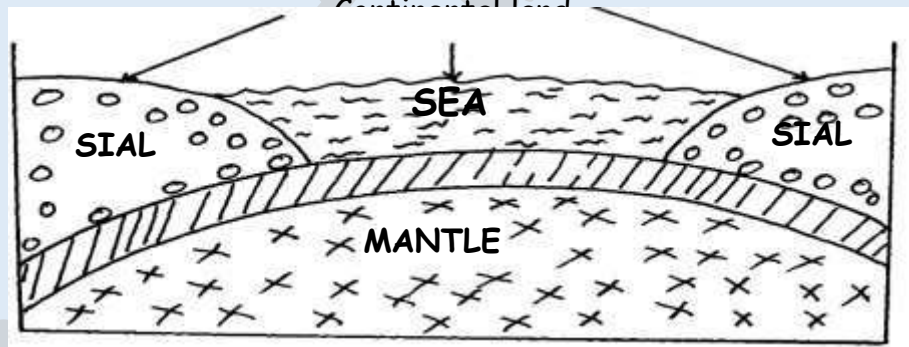
Folding

- ✓ This is the bending of the rocks of the earth's crust due to earth movements.
- ✓ It occurs in sedimentary rocks when they are still in a semi-elastic state.
- ✓ During folding rocks are bend upwards or downwards.
- ✓ The upfolds are called anticlines while the down folds are called synclines.
- ✓ The top part of fold mountains is called the crest while the bottom most- part is called is called the trough.

- ✓ The axis is the central line in a fold from which the rock layers dip/slope away as in the anticline or from which the rock layers rise in opposing directions as in the syncline.
- ✓ The limb of a fold is the layer of rock on either side of the axis/

Processes involved in folding

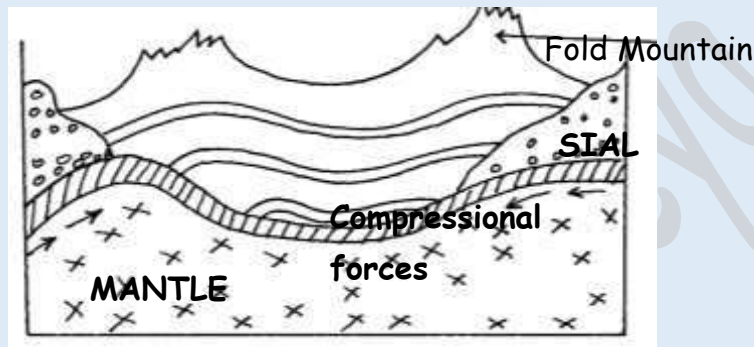
- When the rocks are subjected to the forces of compression.
- The rocks bend upwards forming upfolds/anticlines and downwards forming downfolds.
- An extensive depression called a geosyncline is formed on the surface of the
- The geosyncline is then filled with water to form a sea



earth.

- The surrounding land masses are eroded and resultant materials deposited in the geosyncline in layers.
- Accumulation and weight of sediments causes the floor of the geosyncline to subside further.

- Further subsidence of the geosynclines triggers off compressional forces drawing higher grounds close.
- The layers of sediment in the geosynclines are the folded bending upwards form mountain

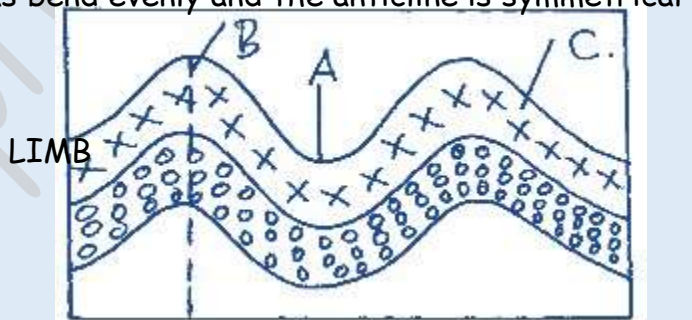


Types of folds and Resultant Features

- ✓ Fold mountains can be classified into the following:

a.) Simple/symmetrical folds

- Formed when compressional forces of equal magnitude and of moderate strength act on crustal rocks
- The rocks bend evenly and the anticline is symmetrical about its axis

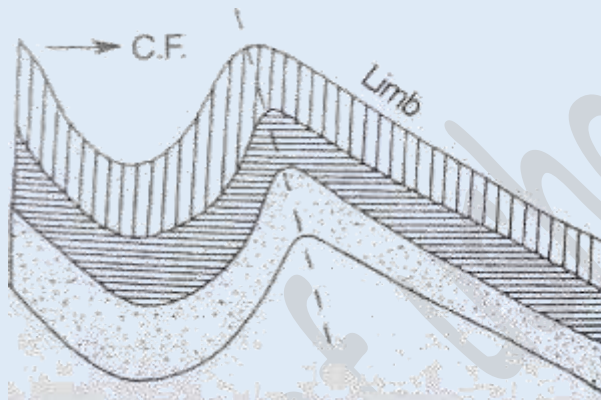


-----> Compressional force <-----

A - Syncline B - Limb C- Anticline

b.) Asymmetrical folds

- Results from unequal compressional forces acting on crustal rocks
- One of the forces is slightly stronger than the other resulting to limbs that are asymmetrical about the axis.



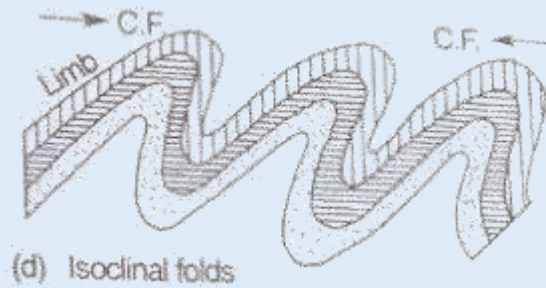
c.) Overfold

- It is an asymmetrical anticline which has been completely pushed over or overturned by compressional forces.



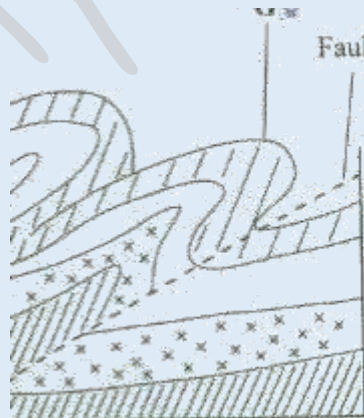
d.) Isoclinal folds

- These are series of close parallel overfolds with all limbs dipping at approximately the same angle and in the same direction.



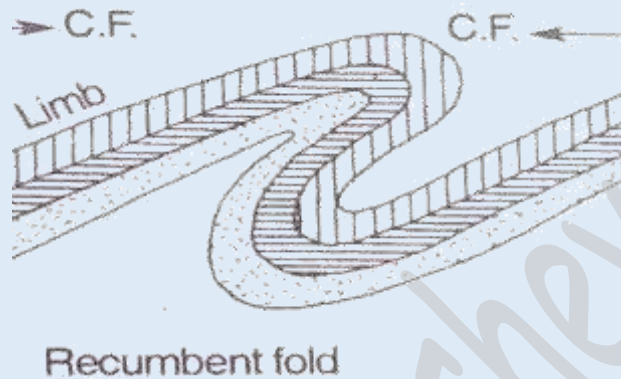
e.) Overthrust fold

- Crustal rock layers are subjected to compressional forces.
- Intense folding results into formation of an overfold.
- With increased pressure the over fold is compressed further to form a recumbent fold
- When pressure is very great, a fracture occurs along the axis producing a thrust plane to form an overthrust fold



f.) Recumbent folds

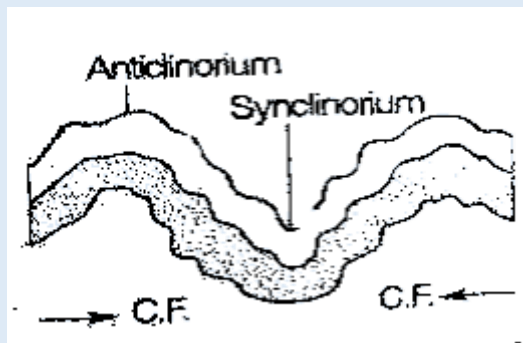
These are Fold Mountains which have been forced over into near horizontal positions with their axial surfaces nearly horizontal.



g.) Anticlinorium- synclinorium

These are anticlines and synclines on which minor up folds and down folds have been formed.

The anticlinal complex is the anticlinorium while the synclinal complex is the synclinorium



Features resulting from Folding

- ✓ The process of folding is responsible for the formation of various external landforms such as:

a.) Fold Mountains

- Some of the world's largest mountains were formed through folding.
- Various theories have been put in place to explain how these mountains were formed and they include the following:

The contraction Theory

After birth formation surface rocks cooled faster and contracted faster than those of the interior.

As the interior continued to cool the surface rocks wrinkled to fit on the contracting interior leading to Fold Mountains.

The Convection Theory

Conventional currents within the molten rock in the mantle move in circular motions towards the crust.

These currents exert a friction drag with the magma rock causing crustal rocks to move horizontally resulting into the formation of Fold Mountains.

Plate Tectonic Theory

When an oceanic plate meets a continental plate, the dense oceanic plate sinks beneath the higher continental one.

The higher continental plate due to compression crumbles to form Fold Mountains.

b.) Escarpments

When folding takes place on a rock mass the extended steep limb from the anticline forms an escarpment.

c.) Synclinal valleys

These are valleys formed as a result of folding.

d.) Depressions

These are deformation or depressions of the crust that have occurred over a large area.

World distribution of fold Mountains

- ✓ The processes of fold mountain building are known as **Orogenesis** while the period in which they were build is known as **orogeny**.

Classification of Fold Mountains according to the period or Orogeny

a.) Charnian Orogeny/pre-Cambrian period

- ✓ Precambrian mountains belong to the geological time prior to the Cambrian period.
- ✓ A period that extended for more than 4000 million years.
- ✓ The rocks have been subjected to upheaval and metamorphosis.
- ✓ Traces of fossils are found in some un metamorphosed rocks of Precambrian origin.
- ✓ Some of the examples are Laurentian Mountains, Algoman Mountains, Kilarnean mountains of Feno-Scandinavia, North-west highlands and Anglesey of Europe.

b.) Caledonian Orogeny

- ✓ Caledonian mountains originated due to the great mountain-building movements and associated tectonic movements of the late Silurian and early Devonian periods.
- ✓ The mountains have a northeast-southwest alignment in the north-western part of Europe.
- ✓ Caledonian mountains came into existence between approximately 430 million years and 380 million years ago.
- ✓ Examples are the mountains of Scotland, Ireland and Taconic mountains of the Appalachians, Aravallis, Mahadeo etc.

c.) Hercynian Orogeny

- ✓ Hercynian Mountains originated during the Upper Carboniferous to Permian Period in Europe.
- ✓ Some authors use the term Hercynian for the whole mountain systems belonging to central Europe.
- ✓ Whereas others use the terms Altaides, Variscan to identify the same mountains system.
- ✓ Hercynian mountains came into existence between approximately 340 million years and 225 million years ago.
- ✓ Some examples are the mountains of Iberian peninsula, Ireland, Spanish Meseta, Vosges and Black Forest, Variscan mountains of Europe and Altai, Sayan, Baikal Arcs, Khingan and Tien Shan mountains of Asia.

d.) Alpine Orogeny

- ✓ Alpine system had its origin in the Tertiary Period which consists of the Palaeocene, Eocene, Oligocene, Miocene and Pliocene epochs.

- ✓ The mountains were formed from about 65 million years to 7 million years ago.
- ✓ Examples are the Rockies of North America, the Alpine mountains of Europe, the Atlas mountains of north-western Africa, the Himalayas of the Indian sub-continent, mountains radiating from Pamir knot like Pauntic, Taurus, Elburz, Zagros and Kunlun etc.

Effects of Fold Mountains to human activities.

- i. windward side of fold mountains receive heavy precipitation which
- ii. Enhance agricultural activities / forestry.
- iii. Rivers which originate from fold mountains provide water which is used For generation of HEP/irrigation/domestic and industrial purposes.
- v. Some fold mountains have exposed minerals deposits which are exploited.
- vi. Fold Mountains are important tourist attractions/snow capped mountains encourage sporting activities.
- vii. Fold Mountains may act as barriers to transport and communication.

- viii. Topographic nature of the landscape may encourage/discourage agriculture/settlement

Ways in which Fold Mountains influence climate.

- The slopes of mountains which face the sun receive direct sunshine and are warmer.
- Mountain slopes cause the development of local winds due to variation in pressure between the mountain top and the valley bottom.
- The windward slopes of mountains receive high rainfall due to orographic effect.
- Atmospheric pressure reduces with increasing altitude along a mountain slope.
- Temperature decreases with increasing altitude along a mountain slope.

Name the countries in which the following fold mountains are found.

- (i) Atlas - Western Sahara/ Morocco/ Algeria

- (ii) Alps - *Austria/ Switzerland/ Italy/ France/ Reichstein.*
- (iii) Himalayas - *India/Pakistan/Afghanistan/ Bhutan/ Nepal/ China.*
- (iv) Andes - *Chile/ Peru/ Bolivia/ Argentina/ Venezuela/ Ecuador/ Colombia.*

Faulting

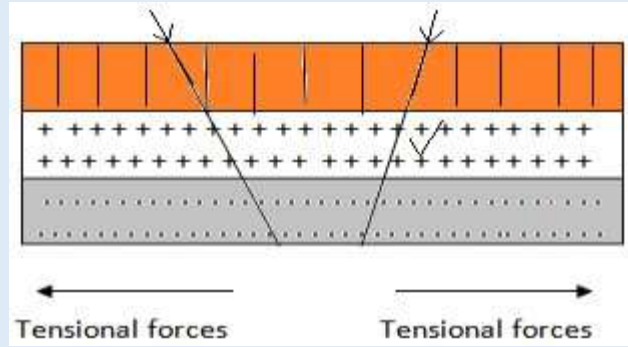
Faulting is the cracking or fracturing of rocks of the Earth crust/) process by which brittle crustal rocks fracture or break due to tectonic forces.

Processes of faulting

- ✓ Faulting processes is related to three main forces. They are:
 - i. Tension
 - ii. Compression
 - n.
 - iii. Shear
- ✓ Where these forces becomes intense, a line of weakness called a fault develops on the rock mass.
- ✓ Eventually the forces will result in the displacement of the two block masses from their original position either **vertically** or **horizontally**.

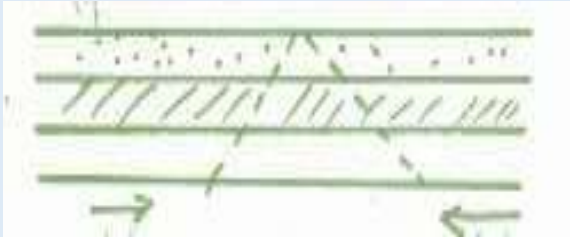
Tensional forces

- Causes the movement of land masses away from one another.
- They pull the landmasses apart, resulting in there, tearing as shown below.



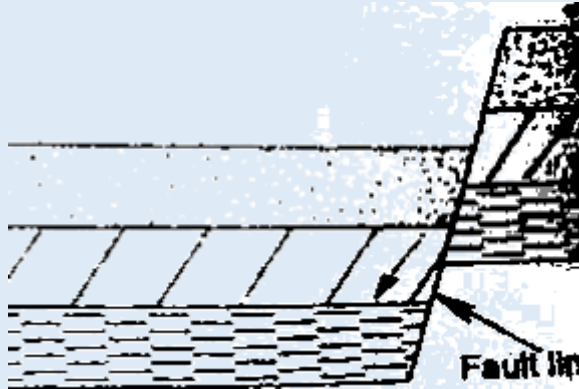
Compressional forces

- Cause the movement of land masses towards one another.



Shear forces

- Cause the movement of land masses alongside one another, usually along a crack or a line of weakness.
- The masses of land move in opposite directions as shown below.

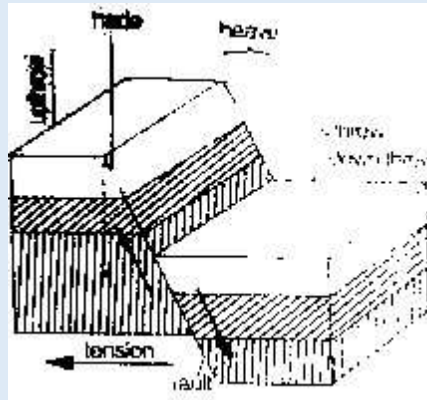


Types of Faults and Resulting Features

- ✓ Types of faults depend on the nature and direction of Movement of Rocks along the fault plane.
- ✓ There are five main types of faults that include:
 - a.) Normal faults
 - b.) Reverse fault
 - c.) A tear ,shear or slip fault
 - d.) A thrust fault
 - e.) An anticlinal faults

Normal Fault

- Result from tension force in a vertical or an inclined fault planes.
- The inclination of the fault plane and the direction of the downthrown are both to the left or both to the right.



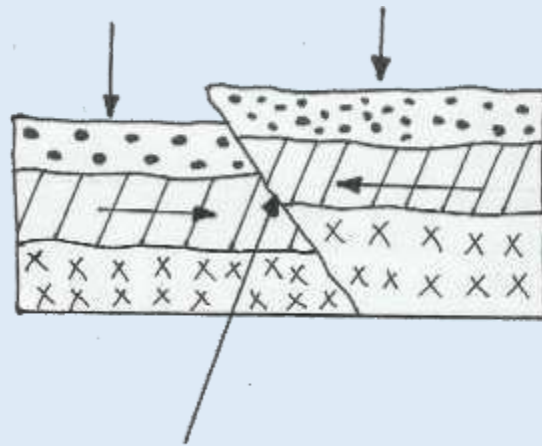
Heave is the lateral displacement

Hade is the inclination of the fault to the vertical

A Reverse fault

- A reverse fault is caused by compression where the rock bends on one side of the fault plane are thrust over those on the side.

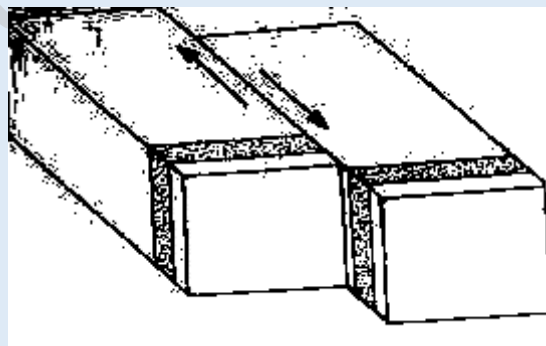
Downthrow



Upthrow

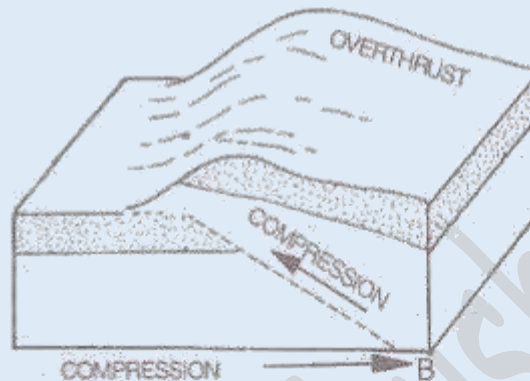
A tear/shear or Slip Fault

- Caused by two opposing parallel forces which result in slipping.
- The rock strata remain at the same level on the surface but their structural position is altered as two adjacent positions slide past each other.
- Sometimes actual crushing and shattering may take place on the line of tear, shear or slip.
- Examples are great Glen Fault of Scotland.



A Thrust Fault

- Caused by strong crustal compression forces.
- A block of land is forced to ride on top of another along a fault which is in a near horizontal position.



An anticline Fault

- Further compression causes gaping cracks to form at the crest of the anticline due to localized maximum tension there.

Features Resulting From Faulting

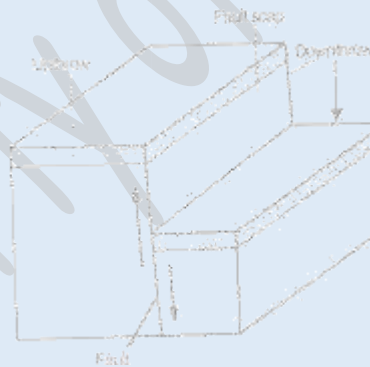
- ✓ Direct effects of faulting causes formation of physical features as follows:
 - a. Fault scarp
 - b. Block/horst Mountain.
 - c. Tilt block
 - d. Rift valley

Fault scarp

- ✓ A fault scarp is a steep slope formed by the vertical movement of the earth along a fault.
- ✓ It is the face of a fault plane facing the downthrow.
- ✓ It is also called an escarpment though not all escarpments are fault scarps.

Formation

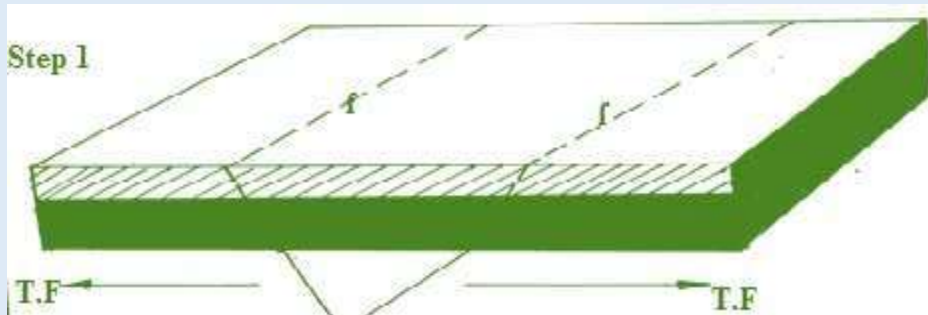
- Formed when two parallel faults occur on a land mass forming a central block as shown below.
- The two landmasses on either side of the central block are pulled away from the central block by tensional forces.
- Leaving room for the central block to subside /sink into Sima/molten rock.
- Examples of fault scarps are Mau,Nyandarua,Nyando<Kikuyu and Elgeyo Marakwet escarpments in kenya. - Manyara and Chunya scarps in Tanzania - Butiaba scarp in Uganda.



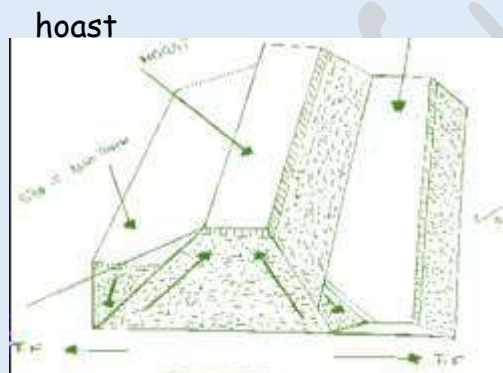
Block Mountain

- ✓ A block mountain is an elongated upland bordered by fault scarps on both sides.
- ✓ It may be formed in two ways:
 - i.) When block of land between two faults is uplifted due to compressional forces.
 - ii.) When land on either side of the central block sinks as a result of tensional forces.

Formation of Horst Mountains by tensional forces



Tensional forces act on layers of crustal rocks leading to the formation of parallel normal faults



Continued tensional forces make the side blocks to subside. The subsidence of the side blocks leaves the middle blocks standing as a horst mountain

(diagram = 2mks = text = 3mks)

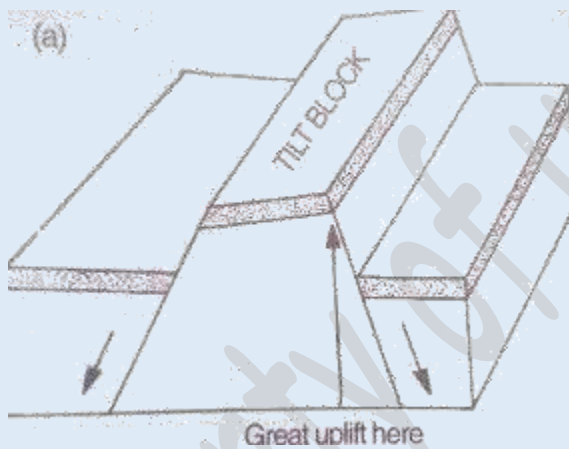
(ii) Examples of horst mountains in E.A

- Ruwenzori mountain - Uganda
- Usambara mountains - Tanzania
- Pare mountains - Tanzania

- Mathew Range ,Nyiru and Ndoto hills of Kenya.
- Vosges of France and the Black Forest Ranges of Germany.

Tilt Block

- ✓ If the middle block has greater uplift on one side, then the fault block is not flat at the top but tilted.
- ✓ It then becomes a tilt block.
- ✓ Examples ,the west Kenya tilt block, the Ruwenzori tilt



Rift valley

- ✓ This is a long narrow trough between more or less parallel faults with steep fault scarps on either side.
- ✓ Examples of major rift V alley in the world are the Great Rift Valley in Eastern Africa, The Rhine Rift Valley in central Europe and the Baikal Rift Valley System of Siberia.

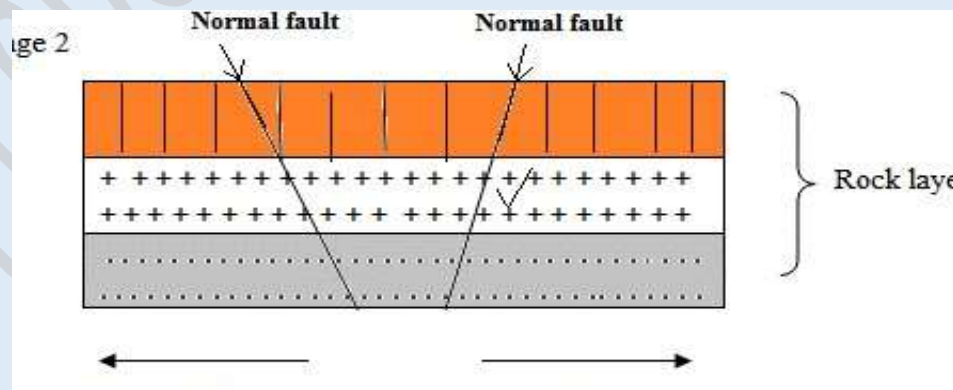
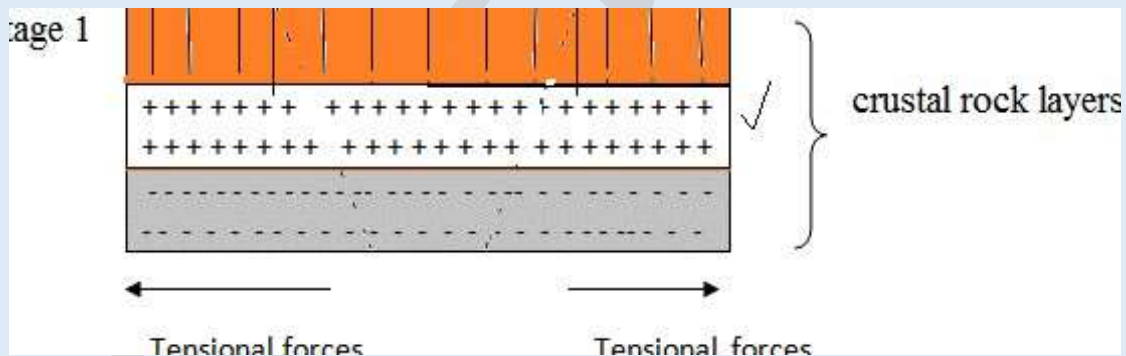
Formation of Rift Valleys

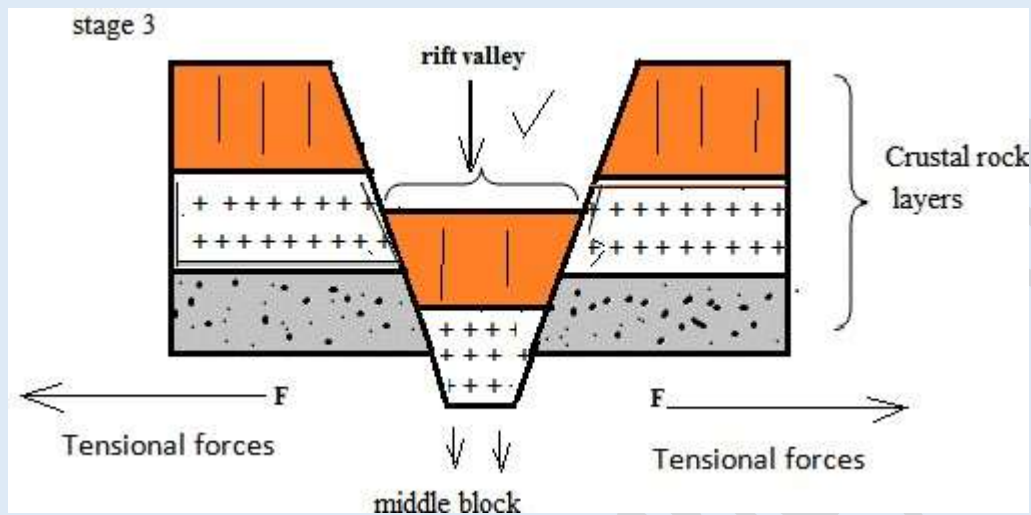
✓ Theories put in place to explain the formation of rift valleys.

- i.) Tension
- ii.) Compression
- iii.) Anticlinal arching

Formation by Tension

- Crustal rock layers are subjected to tensional forces due to instability within the earth's crust.
- Further tension leads to development of parallel normal faults / lines of weakness develop
- The middle block gradually subsides or sinks.
- The depression so created by the sunken middle part forms the Rift valley
e.g. ; The Great East African Rift valley and the Rhine Valley in Europe.





Formation by Compression

When the Rock layer are subjected to compressional force.

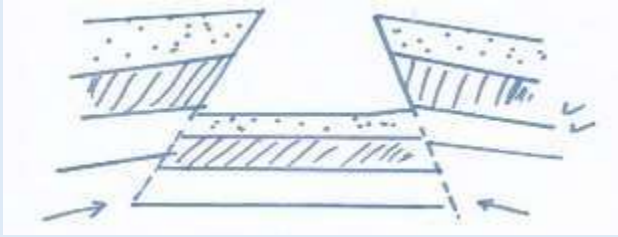


Cf

Lines of weakness occurs leading to Formation of adjacent Reverse faults



Cf Cf Outer block of land area thrust above the middle block along their fault plane



Cf

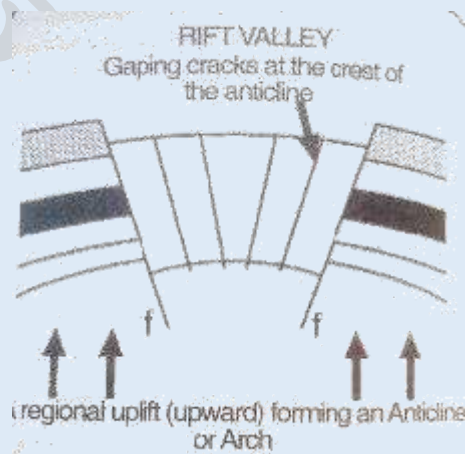
Cf

Protruding parts area removed by erosion or may collapse to form escarpments.



Formation by Anticline Arching

- ✓ A rift valley may also be formed as a result of upwarping.
- ✓ This is caused by forces pushing sedimentary strata upwards.
- ✓ This leads to the bending of rock layers into a big arch/an
- ✓ A gaping crack develops at the crest of the arch due to tension at the top.
- ✓ This because a valley.



Features associated with Gregory rift valley.

- Fault blocks
- Fault-steps
- Fault scarps (escarpment)
- Tilt block
- Basins

Effects of faulting on the physical environment

- Faulting across a river valley can cause it to change direction and start flowing along the fault or disappear into the fault
- Subsidence of land result into formation of depressions which are filled with water to form lakes.
- Weak lines within rocks allows magmatic water to reach the surface as geysers and hot springs
- Fault scarps expose the water table which forms springs that are sources of rivers
- Block mountains formed result in orographic rainfall that support the growth of forests on the windward side

State *three* effects of faulting on drainage of an area.

- i. Down warping due to faulting may lead to formation of depressions which may be filled by water to form lakes.
- ii. Fault lines due to fracturing of crustal rocks may change the course of river making the river to start flowing along the fault line forming faulting guided drainage pattern.
- iii. Fault scarps forming across rivers course may lead to formation of waterfalls.

- iv. Faulting may lead to formation of lines of weakness in earth's crust which becomes passages for hot water from the underground to the earth's surface to form hot springs and geysers.

State three positive effects of faulting.

- i. Faulting leads to formation of features that are tourist attraction.
- ii. Depression in the rift valley contain water that form lakes - for fishing / mining / water for domestic use.
- iii. Faulting exposes minerals which can be exploited by man.
- iv. Step faulting makes rivers have waterfalls for H.E.P generation. v.
Faulting leads to formation of rainfall which attract rainfall. vi.
Springs occur at the foot of the fault scarps creating settlement

Vulcanicity

- ✓ Vulcanicity is the process of eruption/escaping of magma/through which gaseous, liquid/molten and solid materials are intruded in to the earth's crust or are extruded onto the surface.

Types of Vulcanicity

- ✓ There are two types of vulcanicity:

Extrusive vulcanicity

- This is the process where the material actually breaks through the surface of the earth in a volcanic eruption.

Intrusive vulcanicity

- This type happens when the material does not have enough strength to break through the surface of the earth.
- The material forms rock bodies of various shapes and sizes, which may later be exposed at the surface because of the wearing down of the overlying rocks.
 - The features formed are referred to as intrusive landforms.
- ✓ The materials involved in volcanic activity originate from deep in the earth where temperatures are extremely high.
- ✓ Due to this temperatures the rocks deep below the earth crust exist in semi - solid state called **Magma**.
- ✓ Once the molten rock is ejected onto the surface, it loses its gases and is referred to as **Lava**.
- ✓ Both Magma and Lava are acidic, basic or intermediate.

Features Resulting From Vulcanicity

Extrusive Landforms

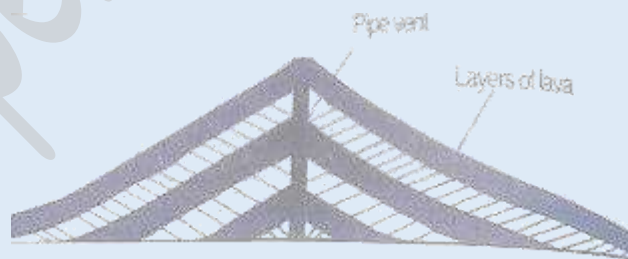
- ✓ Two ways in which volcanic materials reach the earth's surface.
 - i.) Through a vent(pipe)
 - ii.) Through a fissure(crack)

Vent Eruptions and Types of Features Formed

1.) Volcano

- ✓ Eruption through a vent results in the material piling up to build a cone-shaped hill called a volcano.
- ✓ Volcanoes built around one vent are called central volcanoes.
- ✓ They are built of lava or pyroclasts or a mixture of the two kinds of rocks.
- ✓ They vary greatly in size, shape and steepness of their slopes depending on whether the ejected material is acidic or basaltic (basic).

- ✓ Basalt is a basic lava with low silica content. It is therefore of low viscosity.
- ✓ Intermediate lava such as trachyte and phonolite has high viscosity meaning it is thicker and stickier when molten hence it does not flow far before it cools and hardens. As result the cones it builds up generally have steeper slopes than basaltic shield volcanoes.
- ✓ Most central volcanoes have an approximately circular depression known as crater at the summit.
- ✓ This depression represents the upper end of the vent through which eruptions have occurred.
- ✓ It is filled with rock that cooled from the last magma to move up the vent.
- ✓ Many volcanoes are **extinct** meaning that they have not shown any signs of volcanic activity in historic times.
- ✓ Examples of extinct volcanoes are Mts Kenya and Elgon.
- ✓ **Active** volcanoes show current volcanic activity. These volcanoes are said to have erupted in the recent past. Examples are Ol donyo Lengsi in Tanzania, Mt Cameroon ,Erte Ale in Ethiopia and Nyamalagira in Zaire.
- ✓ **Dormant** volcanoes are those which are not active but show signs of volcanic activity.
- ✓ Such volcanoes are not known to have had full activity in the recent past but likely to erupt again. Examples are mount Kilimanjaro, Longonot and Menengai.



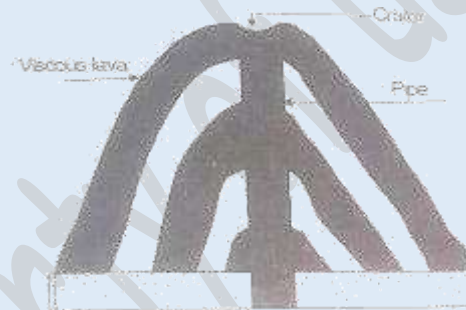
2.) Basic (Basaltic) Lava/Shield Domes

- ✓ This is a central volcano with a very wide gently sloping cone. Basic lava (basalt) due to its low viscosity, spreads and flows for a long distance before it cools and hardens.

- ✓ When it finally solidifies, it builds up a broad, gently sloping volcanic dome.
- ✓ This dome is very wide in proportion to its height and the angle of its slopes are quite low hence the name shield volcanoes.
- ✓ Examples of such volcanoes include Mt Marsabit in Kenya, Mts. Malle and Simien in Ethiopia, Nyamulagira on Zaire- Rwanda border and Tukuyu in Tanzania. Mt Mauna Loa in Hawaii, USA provides one of the best world examples.

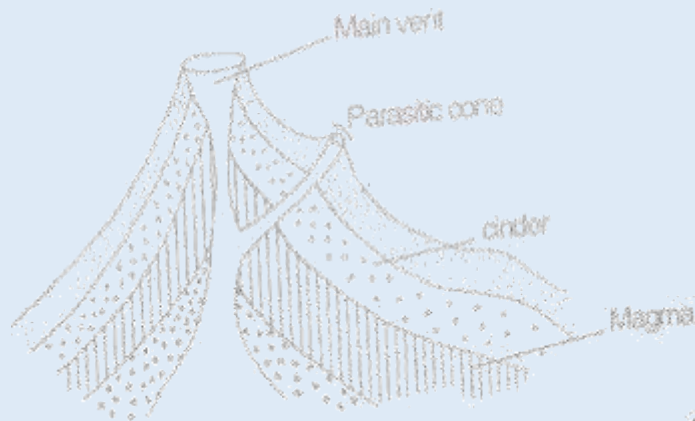
3.) Acidic Lava Cones

- ✓ Acid lava is viscous. It builds high volcanic cones since it does not spread over a wide area but cools close to the vent.
- ✓ Resultantly it has steep sided slopes. Examples include the East African Volcanoes such as Mt Kenya, Kilimanjaro, Elgon, Longonot, Suswa, Menengai and Oldonyo Lengai.



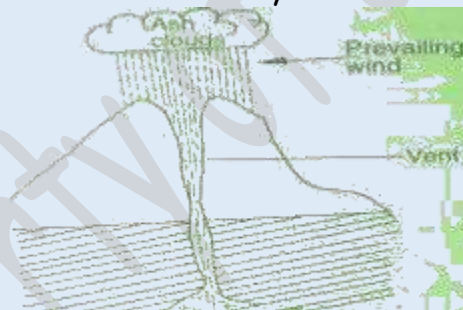
4.) Complex Cones (stratified and Parasitic)

- ✓ Vent type eruptions can build simple cones or complex ones in the sense that repeated eruptions can cause stratified cones with successive layers of ash, cinder and magma.
- ✓ Sometimes, however, the vent branches and results in the formation of parasitic cones.
- ✓ For examples, Mt Longonot.



5.) Ash and Cinder Cones

- ✓ These occur in vent type eruptions where the emitted materials consist of ash and pyroclastic materials which is very light and can be blown by the wind.
- ✓ Depending on the direction of the prevailing wind at the time of eruption, more volcanic material settles on the leeward side of the mountain than on the windward side.
- ✓ Examples are Mt. Teleki and Likaiyu near Lake Turkana.



6.) Plug-Dome Volcano, Spine Volcano, Plug Volcano

- ✓ When the viscous magma solidifies soon after extrusion and does not flow far.
- ✓ It may form a cumuloform plug dome.
- ✓ This means that it accumulates into a heap-like dome.
- ✓ Examples of these are the Hyrax and Fischer's Hills near Lake Naivasha.

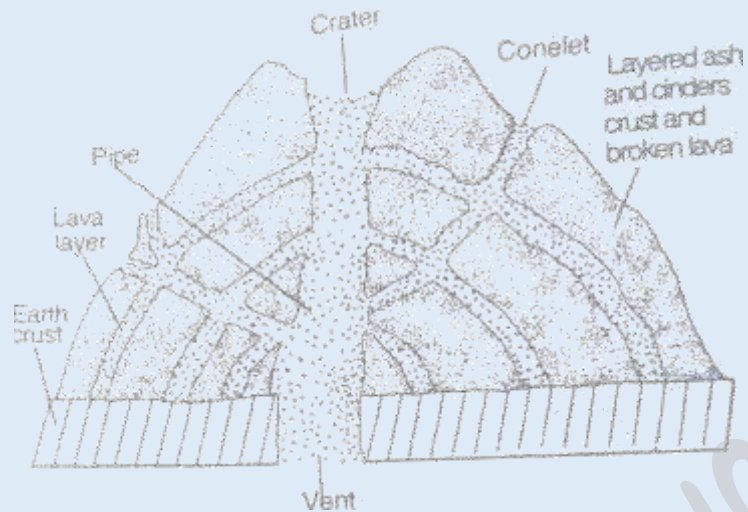
7.) Volcanic plug

- ✓ This is a lava that solidifies within the vent and is later exposed through denudation.
- ✓ Viscous lava may solidify in the vent.
- ✓ If the surrounding rocks are softer, they may be denuded (eroded) leaving a hard feature standing above the earth surface.
- ✓ This feature is called a volcanic plug or neck. Examples are Lenana and Batian Peaks on Mt Kenya and the Tororo rocks in Uganda.



8.) Composite Cone/strato Volcanoes

- ✓ A composite cone is built up of a mixture of lava and pyroclasts.
- ✓ The lava and the pyroclasts are arranged in layers or are stratified.
- ✓ The volcano begins each eruption 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.
- ✓ Examples include Mt. Kilimanjaro in Tanzania, Mt. Cameroon, Ol Donyo Lengai and Mt. Meru.



9.) Volcanic Depressions

There are two types of volcanic depressions.

- Crater
- Caldera

Crater

- ✓ It is rounded funnel shaped hollow at the mouth of a volcanic vent.
- ✓ It represents the upper end of a vent through which eruptions have occurred.

Examples

Ol Donyo lengai and Ngorongoro in Tanzania . Ol Donyo Nyoike near Magadi in Kenya.

Note

The openings through which hot springs,geysers and gas springs are emitted are also called Craters.

Caldera

- ✓ Large basin type hollow bounded by steep cliffs.
- ✓ It is formed due to subsequent volcanic eruptions in the crater when it blow off its top and enlarge the hollow/crater.

- ✓ Through subsidence where the weight of the cone collapse so into the underlying magma.

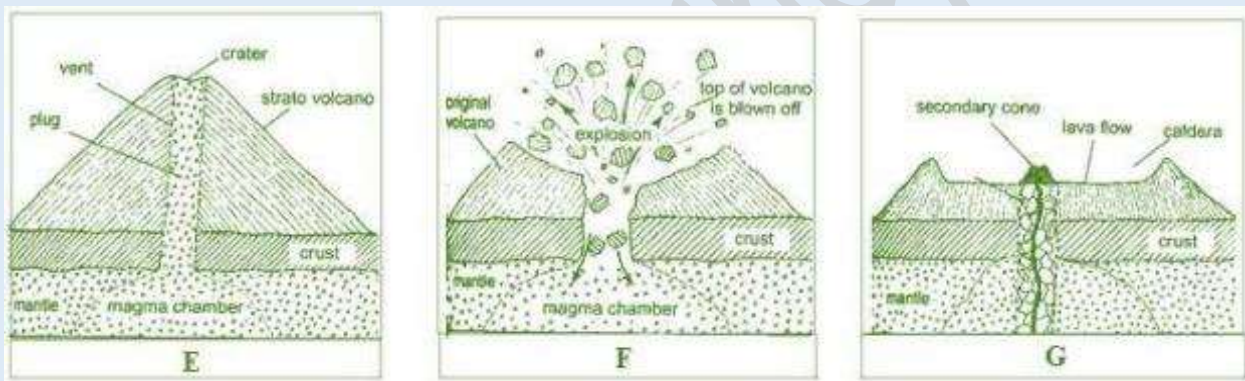
Examples

Longonot ,Manengai,Suswa,Pakka and Silai calderas.

- ✓ Craters may be filled with water to form lakes.Examples of such lakes include Lake paradise and Simbi in Kenya.
- ✓ The largest caldera lake in the world is Asosa in Kyushu ,Japan.

Example

The diagrams below shows formation of a caldera through volcanic explosion.
Study it and answer the questions that following



Describe the processes shown by the diagrams E, F and G

- **E** - After volcanic eruption and a volcano formed, magma in the vent settles cools and solidifies firmly sealing the vent/forming a volcanic plug. This suppresses subsequent eruption creating a buildup of pressure in the interior.
- **F** - Eventually, the pressure overcomes the resistance of the overlying rocks resulting in an explosive eruption. This eruption blows off the head of the volcano destroying the plug to open the vent.

- **G** - Broken rock debris falling back in the vent are melted in the magma chamber to leave a large basin shaped depression at the top of the old volcano called an **explosion caldera**.

10.) Hot springs ,Steam Jets and Geysers

Hot spring

- ✓ Spring with water that is warmer than the normal water temperature in a certain area.

Geyser

- ✓ It is a type of hot spring in which water bubbles gently in a pool and is often violently expelled from the surface into the air as a column of boiling water and steam.

A steam jet

- ✓ A mixture of steam and other gases (fumaroles) escaping from a small crack or hole in the ground.
- ✓ Water vapor is the most common gas, but small amounts of other gases are often mixed with it e.g Sulphur.
- ✓ Examples of places with hot springs in Kenya include Lake Turkana Basin, Lake Baringo, Eburu Volcano between Nakuru and Naivasha, Lake Magadi, Homa Hills and Mai Mahiu near Kijabe.
- ✓ The major volcanic peaks where steam jets are prominent are Kilimanjaro, Ol Doinyo Lengai and Longonot.

Fissure Eruptions and Types of Features Formed.

- ✓ Fissures eruptions occurs through fissures or cracks. As a result of the large vents through which magma reaches the surface, Lava spreads over large areas forming plateaus.
- ✓ In Kenya, Examples include Yatta, Laikipia and Uasin Gishuu.
- ✓ There are two features resulting from eruption.

These are:

- 1.) lava plateau
- 2.) Tuff plateau

Lava Plateaux

- ✓ Forms when lava escapes from different fissures and spreads over a wide area.
- ✓ The lava has low viscosity which makes it very fluid and hence flows for a long distance on gentle slopes before cooling and solidifying.
- ✓ The rocks build up evenly instead of piling around a single vent.
- ✓ The resultant landform is a relatively even surface with very gentle slopes.
- ✓ The lavas fills former valleys and covers most of the landscape with the exception of high hills.
- ✓ Lava plateaux are often quite fertile areas. Where there is adequate rainfall, basalt lava weathers down to form rich volcanic soils.

Tuff Plateaux

- ✓ These are wide areas of flat land similar to lava plateau that forms from the eruption of a volcanic rock called tuff.
- ✓ Tuff does not flow quietly out of the ground like lava.
- ✓ It is produced in a violent explosion which throws shattered fragments high in the air.
- ✓ These fragments cool and harden as they fly in the air.
- ✓ They eventually fall back on the ground further way from their point of eruption depending on their weight.

- ✓ On falling on the ground, they form volcanic rock particles called pyroclasts or Tephra.

The various kinds of tephra are:

Volcanic ash - The finest (smallest and lightest) particles, less than 4 mm in diameter.

Lapili - The small stones, the size of peas or beans.

Blocks - large lumps of rocks as big as motor vehicle.

Bombs - Usually large with a curved shape and twisted at the end.

Pumice - This is a rock with a frothy spongy and cellular appearance .it is light and floats easily on water. It is derived from acidic lava

Explain two ways in which the geysers and hot springs at Ol Karia are of significance to the economy of Kenya.

- The geysers are used to generate geothermal power for domestic and industrial uses.
- The hot springs and geysers and the Ol Karia geothermal project attract tourists thus earning the country foreign exchange.
- Geothermal power project at Ol Karia has created employment opportunities/source of income thus improving living standards.
- Through establishment of the geothermal power plant at Ol Karia, there has been an improvement in infrastructure through road construction, provision of water and electricity, etc.

Intrusive land forms

- ✓ When magma is unable to force its way out of the surface, it cools and solidifies in the crust.
- ✓ Depending on the viscosity of the magma and the nature of rocks through which the magma pushes, a variety of features occurs as follows:

Batholith

- ✓ This is a large-scale intrusion of magma so deeply seated that the root is often of unknown depth.
- ✓ It is dome-shaped when exposed to the surface by denudation.
- ✓ They are mainly made up of granite.

Laccolith

- ✓ This is an intrusive mass of magma which has forced up or domed overlying strata as shown below.
- ✓ The cooling is usually near the surface.

Dyke

- ✓ This is a mass of intrusive rock which cuts across the bedding plane of the existing rock.
- ✓ It can be vertical or inclined.
- ✓ When the rock around it is softer, it will be eroded and the dyke will stand as a ridge.
- ✓ An example of such dykes are found in North West Scotland.
- ✓ When the dyke is softer than the surrounding rocks, it will be eroded to form along narrow depression.
- ✓ An example of such a dyke is the Kaap Valley of South Africa.

A sill

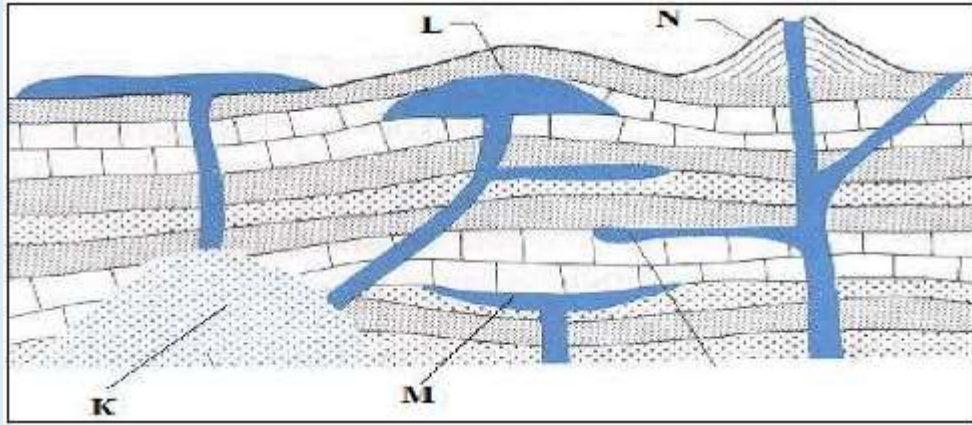
- ✓ This is a horizontal intrusion of magma between the strata the bedding plane.
- ✓ When exposed to the surface they form ridges or low escarpments.
- ✓ Example of sills are the Three Sisters of Cape Province and Sill cappings in parts of Morocco.
- ✓ The Kinkon Falls near Pita in Futa Jalon in Guinea are examples of Sill outcrops across river beds.

A Lopolith

- ✓ This is a larger scale saucer - shaped intrusion of igneous rocks lying concordant with the strata and forming a shallow basin.
- ✓ For example the Bushveld Lopolith in the Transvaal.
- ✓ Other intrusive volcanic forms include phacoliths and bismaliths.

Diagrams of intrusive landforms

The diagram below represents features of vulcanicity. Use it to answer the questions that follow.



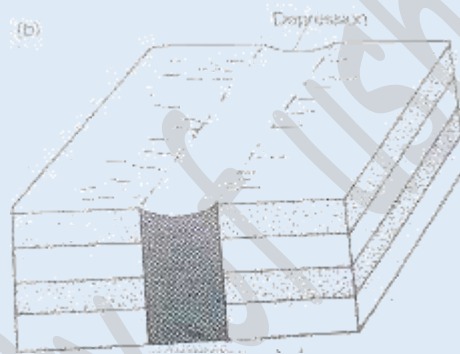
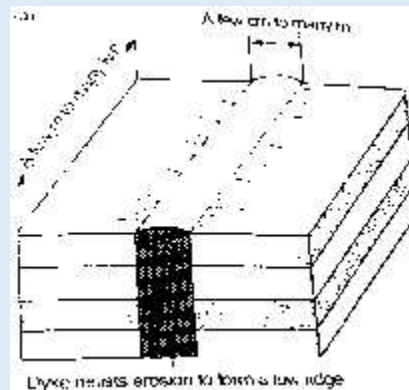
(i) Name the features labeled K, L and M.

- K - Batholith.
- L - Lopolith.
- M - Laccolith.
- N- volcanic mountain

(ii) Give two examples of the feature labeled N in East Africa.

N - Volcano/Volcanic Mountain

- Mount Elgon.
- Mount Meru.
- Mhavura.
- Mgahinga.
- Marsabit.
- Jukuyu.



World Distribution of Features due to Faulting

- ✓ The volcanic belts of the world are closely associated with the earthquake belts of the world.
- ✓ Three main types of volcanic belts occur:
 - i.) Along the extension boundaries for example, the mid ocean ridges.
 - ii.) Along the transform faults, for example, the ocean deeps and volcanic islands.
 - iii.) Along compression boundaries, for example, ocean trenches.

Significance of vulcanicity to Human Activities.

Constructive Consequences

- i.) Volcanic activities has resulted in large central volcanoes such as Mt.Kenya, Mt.kilimanjaro and Mt.Elgon.The lower slopes of these mountains are among the cool,well watered highland areas of high agricultural productivity.
- ii.) Volcanic activity has also contributed greatly to the scenic beauty of the landscape which attract tourists.
- iii.) Volcanic activity sometimes results in the formation of rich metallic minerals.
- iv.) Geothermal steam and power is resource that result from volcanic activity.
- v.) Production of Carbon dioxide which is used as a cooling agent or as dry ice.
- vi.) Volcanic rocks are valuable as building stone and road material.
- vii.) Volcanic mountains are catchment areas, sources of rivers and springs and are thickly forested.
- viii.) Pumice , a volcanic rock is used by human beings domestically as a scrubbing stone.

Destructive Consequences

- i.) Sometimes a volcanic eruption can be so violent that it can cause great loss of life and damage to property.
- ii.) Volcanic eruption results in the pollution of the environment and the emission of dust and pungent gases into the atmosphere.
- iii.) Volcanic eruption can cause great damage to infrastructure, buildings and livestock.
- iv.) The leeward slopes of volcanic mountains receives very little rainfall and prone to aridity which hinders agriculture.
- v.) The steep slopes produced through vulcanicity discourage settlement and are barriers to construction of communication lines.

Earthquakes

Definition of earthquakes

This is the sudden earth movement causing trembling vibrations with and below the earth crust.

Causes of Earthquakes

Natural causes

- i. Tectonic activities/movements/convergence & collision of plates/shifting of tectonic plates.
- ii. Isostatic adjustments i.e. relative movements between the continental and oceanic crusts during isostatic recovery may trigger off earthquakes as a state of balance is restored.
- iii. Vulcanicity/magma movement within the crust can cause tremors since the overlying crustal rocks are being displaced suddenly by the strong convectional currents/magma.
- iv. Gravitative pressure i.e. crustal rocks overlying the voids left behind by erupting magma are pushed inwards by force of gravity causing them to shake in the process hence earthquakes.

Human activities

- i. Construction of large reservoirs.
- ii. Explosives used in mines and road construction.
- iii. Movement of underground trains.
- iv. Explosions from underground nuclear tests

NOTE

All these may send shock waves to the crustal rocks and cause earthquakes.

Measurements of Earthquakes

- ✓ The instrument used for measuring earthquakes is called a seismograph or a seismometer.
- ✓ Three types of seismic waves are recorded on a seismograph. These are:
 - i. **Primary seismic waves/p-waves**
- ✓ They travel faster and therefore their vibrations reach the seismograph first.
- ✓ P- waves cause any rock in their path to compress and then expand in the same direction the waves are travelling.
 - ii. **Secondary seismic waves**
- ✓ These are known as S-waves.
- ✓ They are called secondary waves because their vibrations reach the seismograph later than the p- waves.
 - iii. **Long waves/L- waves**

- ✓ These are seismic waves with large amplitude wiggles.
- ✓ They are also known as L-waves.
- ✓ Their broadness makes them be referred to at times as large waves.

NOTE

Earthquakes are measured by their intensity and magnitude. The intensity of an earthquake refers to how hard or strong the earthquake shakes the ground. The Mercalli Scale is used to express the intensity of earthquakes with a scale running from roman I -XII.

Mercalli Scale

- i. **Imperceptible** -Recorded by instruments only.
- ii. **Very feeble** - Only felt by people at rest or at the tops of buildings.
- iii. **Feeble** -Sounds like a passing motor car, slight disturbances of loose objects.
- iv. **Moderate**- Rattling and roaring noises heard by people indoors, movement of seats and shaking of beds, considerable disturbance of those objects, some sleepers awakened.
- v. **Rather strong**-Most sleepers awakened, swinging of suspended objects, vibration generally felt in the open,slight movement of heavy.
- vi. **Strong** - overthrow or considerable movement of large and heavy objects,cracks in ceiling and crumbling of plaster.
- vii. **Very strong** - breakage of objects, slight damage to buildings.
- viii. **Destructive** - Gaping cracks in walls and some walls brought down.
- ix. **Highly destructive** - Sever damage to structures, some buildings completely wrecked.
- x. **Devastating** - Destruction of numerous buildings and their foundations.

- xi. **Catastrophic** - Hardly a stone structure remains standing.
- xii. **Major catastrophe** - Every building destroyed, a major geographic effect.

Note

Magnitude is the amount of energy off or produced by an earthquake. This is measured on a Richter scale, which ranges from 0 to 8.9.

The higher the scale, the more severe the earthquake. It is important to note that the intensity varies from place to place depending on how far a place is from the epicenter.

However the magnitude does not vary but remains constant.

Major earthquake zones of the world.

- i. Mid Atlantic Belt/Mid Indian Ocean Ridge.
- ii. The Great Rift Valley Region.
- iii. The Circum - Pacific Belt/Ring of Fire.
- iv. The Mediterranean Belt/Mid - South East Asian Region.
- v. In areas of volcanic activity.

Effects of Earthquakes

- i. It leads to loss of lives and destruction of properties.
- ii. Earthquakes in the oceans give rise to waves, which are known as tsunamis which are very destructive when they get to the shores.

- iii. Earthquakes tends to trigger fires hence the occurrence of fire after an earthquake is a common feature.
- iv. The shaking of the earth's crust triggers landslides. This is detrimental to both plants and animals.
- v. They can either lower or raise the sea floor. A sudden subsidence of land near the sea can cause flooding.
- vi. They restrict the development of towns.
- vii. Aftershocks, which are the small/minor tremors that follow major earthquakes tend to further weaken structures already weakened by major earthquakes.

Field work.

a.) Students from Mwaluvanga School intend to conduct a field study on volcanic features in the Rift Valley of Kenya.

(i) Other than Ol Karia, name two other places they are likely to visit for the study.

- Lake Bogoria.
- Eburru - between Lakes Naivasha and Nakuru.
- Menengai Crater.
- Longonot Crater.
- Marsabit.
- Around Lake Turkana.
- Around Mt. Elgon.
- Hell's Gate - Hyrax and Fischer's Hills.
- Mulot area in Bomet.

(ii) State two methods of data recording they are likely to use during the study.

- *Note taking.*
- *Photographing/taking photographs/video recording.*
- *Tape recording.*
- *Filling in questionnaires.*

(iii) What problems are they likely to encounter during the study?

- *Steep/rugged terrain difficult to climb thus delaying the study.*
- *Accidents in the terrain would delay/end the study abruptly.*
- *Sudden rainfall would stop the data collection temporarily or even end it prematurely.*
- *High temperatures from scorching sun would make data collection difficult.*
- *Lack of adequate data may bring the study to a premature end.*

End of topic

Did you understand everything?

If not ask a teacher, friends or anybody and make sure you understand before going to sleep!

Past KCSE Questions on the topic

Earth movements.

1. (a) Name the two types of earth movements that occur within the earth's crust (2mks)

(b) Describe the origin of the continents according to the Theory of continental Drift (3mks)

2. Explain what you understand by each of the following:

(i) Earth movements.

(ii) Internal land forming processes.

(iii) External land forming processes. (6mks)

3. Explain four evidences put forward to proof continental drift theory. (8mks)

4. Explain plate tectonic theory.

(4mks)

Folding

1. (a) In your answer booklet, draw a diagram to show a simple fold and on it

mark and name,

(i) An anticline. 1 mk

(ii) A limb. 1 mk

(iii) A syncline 1 mk

(b) Name two fold mountains in Africa. 2 mks

2. (a) Name one fold mountain in;

(i) Asia

(ii) North America

(iii) South America

(b) (i) Apart from Fold Mountains, name three other features resulting from folding.

(ii) With the aid of a labelled diagram, describe the formation of

an overthrust fold.

(c) Explain four effects of Fold Mountains on human activities.

(d) (i) How would students in your school prepare themselves for study of landforms in your district,

(ii) State two advantages of studying landforms through field work.

3. Define orogenesis. 2 mks

4. What is folding? 2 mks

5. Explain the meaning of compressional boundaries. 2 mks

6. Differentiate between limb and axis in relation to folding.

4 mks

7. Differentiate between foreland and back land. 4 mks

MAPWORK

Direction and bearing

- ✓ Direction and bearing are used to indicate a line along which something or an object is moving or facing.
- ✓ Direction or bearing may also denote a point of reference on which a particular object or place on a map or the earth is situated.
- ✓ We use compass to show direction or bearing.
- ✓ In indicating direction, reference to any of the points of the compass can be made. e.g. south of, East of e.t.c.
- ✓ While when stating bearing, only one point of the compass is referred to that is North. Bearing is read from north in clockwise direction.

Showing direction on maps

- ✓ There are two ways of indicating direction on maps: **a.) Traditional methods**
 - i.) Use of land marks
 - ii.) The heavenly body
- b.) Modern methods**
 - i.) The use of points of compass
 - ii.) The use of bearing.

Traditional Methods

i.) Use of landmarks

- ✓ Landmarks are familiar features on the surface of the earth that can guide the traveler in finding the way from one place to another.
- ✓ Examples are rivers, hills, roads and buildings

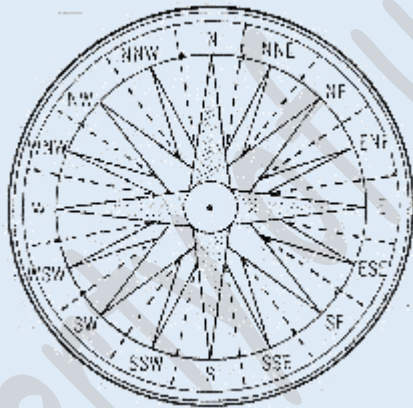
ii.) The use of heavenly bodies

- ✓ Where there are no land marks such as deserts and large water bodies. It is possible to use:
 - The North Star.
 - The Southern Cross and the South Pole.

Modern Methods

i.) The use of the compass

- ✓ A compass is a scientific instrument whose needle always points to the north.
- ✓ A compass has a total of 32 points as shown below.



- ✓ North, East, South and West are the four main points referred to as cardinal points.
- ✓ Modern maps do indicate three expressions of the north as follows:
 - True or Geographical North.
 - Magnetic North.
 - Grid North.

True or Geographic north

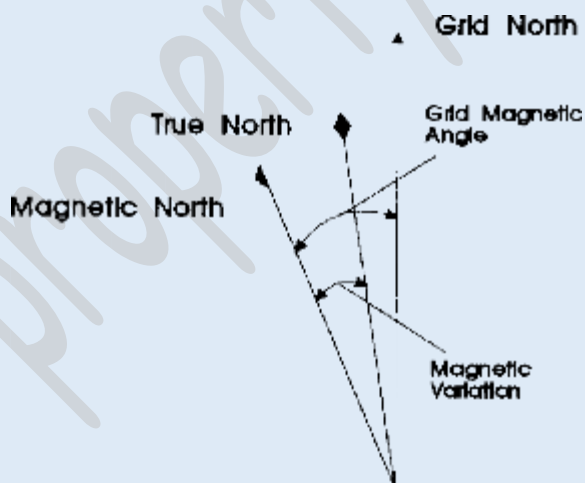
- ✓ This is the position of the North Pole as shown on the globe (the point where longitudes meet.)

Magnetic North

- ✓ This is the earth's Magnetic North Pole as determined by the earth's magnetic field.
- ✓ This is the direction to which the needle of a compass points when it comes to rest.
- ✓ The angular difference is known as magnetic variation.

Grid North

- ✓ It is in the same alignment as the north-south map grid lines on topographical maps.
- ✓ It is based on the national grid system. However each map-maker can draw a map and set his own grid north.
- ✓ It is usually as close to the true north as possible and coincides with it.



ii.) The use of bearing

- ✓ The starting point that is the North-South line is always taken as 0° .
- ✓ Bearings are always read in a clockwise direction from the North line through a full circle of 360° .



- ✓ Bearings are stated in three figures. For example, North is stated as 360° or of 000° and East as 090° .

Calculation of Bearing

- ✓ Bearing helps to determine the position of one place from another.
- ✓ The figure below illustrate how the position of A from B can be determined by means of bearing.

To measure the bearing of A from B accurately, the following procedure should be followed:

- Draw a light pencil link to A from B.
- Draw a North- south line through point B parallel to the North-South line given in the margin of the map. If the North- South line is not given, draw the line parallel to the grid lines or parallel to the sides of the map running North-South.

- iii. Intersect this North- South line with another perpendicular line East- West through Point B. The East -West line should be parallel to the horizontal grid lines or sides of the map due east - West.
- ✓ Measure angle NBA using a protractor reading degrees in a clockwise direction from the North line. The bearing of A from B in the diagram above is 225° . Now find the bearing of B from A.



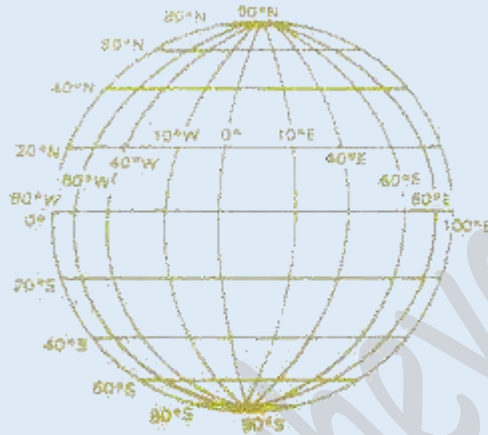
Locating places on a map

- ✓ The position of a place on a map or on the earth's surface can be expressed in any of the following ways:
- By use of direction, bearing and distance.
 - By use of a place name.
 - By use of latitude and longitudes.
 - By use of grid reference system.

Use of latitudes and longitudes.

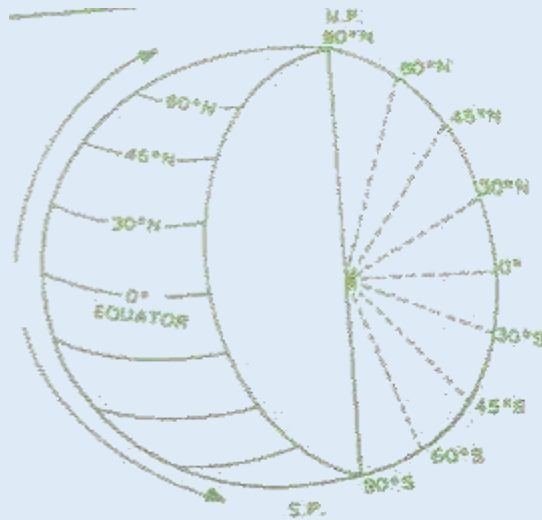
Latitude

- ✓ Imaginary lines drawn on the globe or on a map to show how far north or south a place is from equator.
- ✓ All latitudes are parallel to each other hence they are also called parallel.



The main lines of latitudes include:

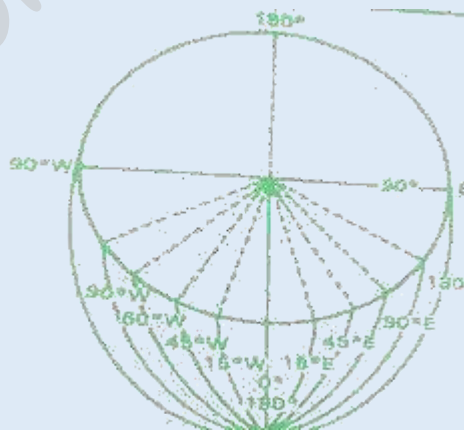
- 1.) The equator which is the longest also called green Circle.
 - 2.) Tropic of Cancer $23\frac{10}{2}$ ° N of the equator.
 - 3.) Tropic of Capricorn $23\frac{10}{2}$ ° S of the equator.
 - 4.) The Arctic Circle $66\frac{10}{2}$ ° N.
 - 5.) Antarctic Circles $66\frac{10}{2}$ ° S.
- ✓ Latitudes are measured from the centre of the earth towards north and south to a point of 90 as shown below.



- ✓ The distance between two lines of latitude 1° apart is approximately 111 km.

Longitudes

- ✓ These are imaginary lines drawn on the globe or on a map showing how far east or west a place is from the center of the earth.
- ✓ It is the shortest North-south line that joins any two places on the earth.
- ✓ The 0° longitude is the one that is conventionally known as the prime Meridian or The Green which Meridian.



- ✓ All longitudes to the east of the prime Meridian are numbered from 0° westward to 180° .

Note

- In either direction, the longitude 180 is the same line.
- All longitudes meet at the poles.
- They are all of the same length and the distance between them is widest at the equator and narrowest towards the poles.
- The distance between one longitude and the next one 1° apart at the equator is 111km.
- Since the distance between longitudes decreases polewards, the distance along any longitude away from the equatorial would be less than 111km.

To give the position of a place on a map using latitude and longitude's, the following steps are used.

- Identify the place whose location you want to give.
- Identify the nearest numbered latitude and longitude.
- Estimate the latitude and longitude to the nearest 1° . For example 7 Nairobi is about 1° S and 37° E

Note

- Because latitude and longitudes are angular measurements, they are made in degrees which are further sub-divided into minutes and seconds.
- This helps in locating a place accurately 1° is equivalent to 60 seconds

Example

When the local time is 2.00pm at longitude 45°E , what is the longitude of a place whose local time is 8.00pm?

Solution

45°E	X
2 pm	8pm
Time difference = 6 hrs	

$$15^{\circ} = 1\text{h}$$

$$= 6\text{h} \times 15^{\circ} = 90^{\circ}$$

$$= 90 + 45 = 135^{\circ}\text{E}$$

Example

- Differentiate between a latitude and a longitude.
(2mks)
- Find the time at town X on Longitude 20°W , if the local time at town W on longitude 27°E is 10.00am.
(2mks)

Solution

Differentiate between a latitude and a longitude.

A latitude is a line based on the angular distance North or South of the equator/it is an imaginary line drawn on the maps/globes from west to East measured in degrees North to South of the equator while a longitude is a line based on the angular distance of a place East or West of the prime meridian/Greenwich meridian (0°)/ an imaginary line drawn on maps/globes from north pole to south pole measured in degrees East or West of the prime meridian/Greenwich meridian(0°). ✓✓

Find the time at town X on Longitude 20°W , if the local time at town W on longitude 27°E is 10.00am.

-Longitudinal difference

$$20^{\circ} + 27^{\circ}\text{E} = 47^{\circ}$$

-Time difference. ✓

$$47^{\circ} \times 4\text{min} = 188 \text{ minutes} / 3\text{hrs } 8\text{mins.}$$

-X is 3hrs 8mins behind W

Time will be.

10.00

3.08

6.52 a.m ✓1

T = 2mks.

Grid References

- ✓ A grid is network of imaginary horizontal and vertical lines drawn on a map forming equal squares.
- ✓ The vertical lines are called Eastings because they are numbered eastwards while the horizontal lines are called Northings because they are numbered northwards.
- ✓ East grid line is given a number starting from the southwestern corner. This corner is called grid origin.

- ✓ All readings start from the south western corner.

How to Give a Grid Reference

- Read and give the figure for the Eastings /vertical grid line first and following this figure with the northings/horizontal grid line.
- Each eastings or Northings on a map represent a given number of metres from the point of origin.
- When giving a grid reference, both decimal points and commas are eliminated in the co-ordinates and a single continuous figures is given.
- All grid values are plain figure that is unit of length are not expressed.

Note

Grid can be given in four Figure Grid Reference or six figure grid reference.

Giving the six figure Grid Reference

- Write down the easting.
- Subdivide the eastings into 10 equal parts.
- Repeat the same for the northings.

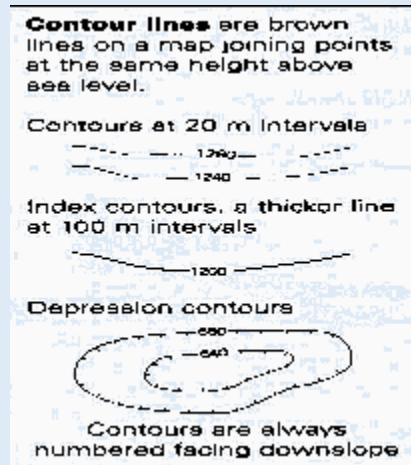
Method of Representing Relief on Topographical Maps.

- ✓ The term relief means the actual appearance of the earth's surface.
- ✓ Relief features include valleys,gullies,rolling or undulating plains and dissected landscape.
- ✓ Vegetation,seas,lakes and ponds and human - made features like buildings roads and runways do not form part of relief features of the earth's surface.

- ✓ Relief features may be represented by the use of the following ways:

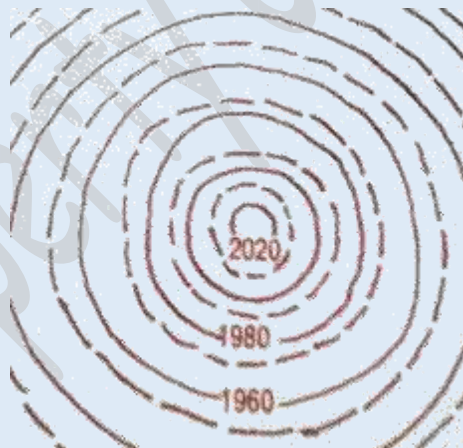
Contours/isohypses

- ✓ They are lines drawn on maps to join all points with the same height above the sea-level.
- ✓ Contours are drawn at fixed interval known as the vertical Interval (VI) the vertical interval is always kept constant.
- ✓ Where contours come too close this suggest that the land is steep and where the contours are far apart, it suggest that the land has a gentle slope.
- ✓ Contours have one advantage in that they are easy to understand and consequently can be used to interpret the features on the map effectively.
- ✓ However the effectiveness of the use of contours depends largely on the vertical intervals used.



Formlines

- ✓ These are lines drawn on a map which are not sufficiently mapped to estimate where actual contours would pass.
- ✓ This unlike contours form lines are not accurately surveyed.
- ✓ Formlines are indicated by a broken line.

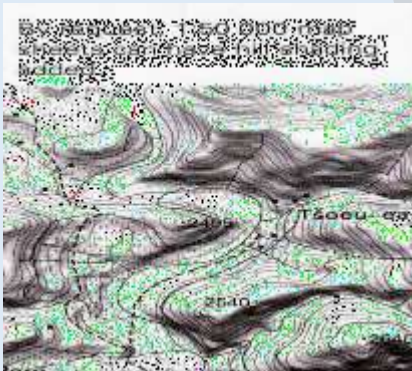


Pictorial Representation

- ✓ This method shows land appearance in pictures.
- ✓ Based on the artist impression of the land scale.
- ✓ The features are drawn on small convectional pictorial symbols.

Hill shading

- ✓ This is an attempt to show reliefs accurately by shading areas which would be in shadow when light is shining from a given direction.
- ✓ The rays of the light are either oblique or vertical depending on the source.
- ✓ The shading of the slope depends on its gradient. The steeper the slope, the darker the shade will be on the map.
- ✓ Plateaus, valley bottoms and plains are light shaded.
- ✓ In oblique lighting, the eastern and south-eastern slopes will be shaded. While north - western and western slopes are unshaded.



Disadvantages

- ✓ Does not give the heights of places unless spot heights are used.
- ✓ Does not distinguish uphill from downhill or spurs from valleys.
- ✓ Neither does it distinguish plateaus from plain land.

Colouring/Layer tinting

- ✓ In this method different colors are used to show different aspects of relief.
- ✓ For example light green can be used to represent low lying areas while brown maybe used to show high altitudes.
- ✓ In this method, the shades become darker with increased heights.
- ✓ One major advantage in colouring is that it is useful in representing landscapes of varied relief.

Disadvantages

- ✓ Dark colours tend to obscure details.
- ✓ The monotone of colours may not give a good visual impression of plains or plateaus.

Cliff and Rock Drawing

- ✓ On topographical maps, areas with steep cliffs and rock faces are shown by the use of wedge - shaped black lines.
- ✓ The thin ends of these black lines point downslope.
- ✓ This method of representing relief is referred to as cliff and rock drawing.
- ✓ On maps cliffs or rock drawing may take one or more of the shapes shown.

Depression (steep-sided hollow)



(Brown in colour in a map)

Steep slopes



Boulder rock



Crater



Rock outcrop



Cliff



Quarry



Hashures

- ✓ A method used to represent relief on mountains or hilly areas.
- ✓ It involves the drawing of lines down slope in the direction of the steepness gradient.

- ✓ The length and steepness of the hachures indicate the direction of the steepness of slope.

Advantages

- ✓ Effective in representing relief in mountainous or hilly areas.
- ✓ Gives a visual impression of the hilly landscape by showing ridges and valleys clearly.

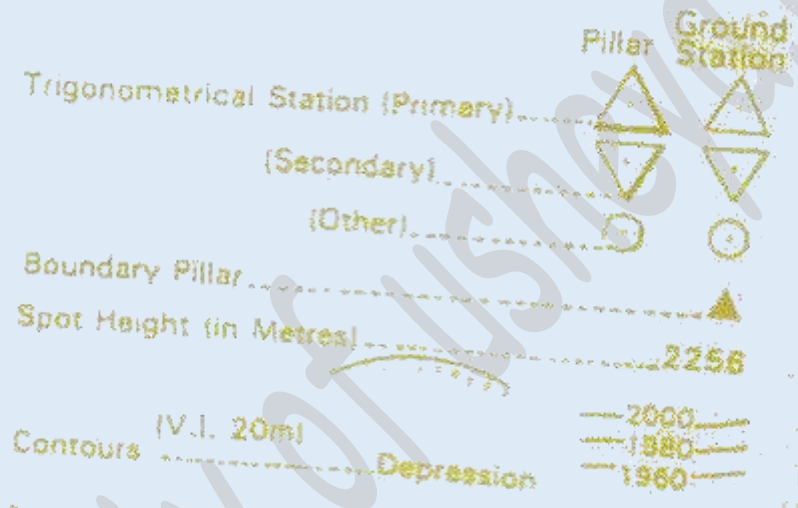
Disadvantages

- ✓ Difficult to draw
- ✓ Do not show the exact height of the land scape.
- ✓ Cannot be used to show flat ground on maps.

Spot heights and Trigonometrical stations

- ✓ On topographical maps, a spot height is shown as a dot with its height indicated next to it.
- ✓ The dot indicates the exact height of a particular point on the map.
- ✓ A trigonometrical station/a triangulation point is a survey point represented on a map by the use of a triangle with a dot at the centre.
- ✓ It may also be represented by a small circle with a dot at the centre.
- ✓ Trigonometrical stations may be shown as pillars or ground stations or others. These are distinguished by thickness of lines of the sides of the triangle.
- ✓ The position on which the apex of the triangle is placed will indicate whether the stations are either primary or secondary.

- ✓ The circular Trigonometrical symbols are referred to as others. The spot heights and trigonometrical stations are easier to locate on maps because they are boldly printed.
- ✓ Spot heights and trigonometrical stations on maps must be used with care for if crowded they give little or no visual impression on the general relief pattern.
- ✓ They also need to be used with other methods especially contours if their use on maps is to be more meaningful.



Interpretation of physical Features and Human Activities on Topographical Maps

- ✓ Physical features and human activities include:
 - Landforms
 - Drainage
 - Vegetation
 - Economic activities
 - Settlement on topographical maps.
- ✓ Interpretation of physical features and human activities depends on clues available on a particular map.

Precautions taken when describing physical features and human activities on a map. They include:

- i.) Avoid definite words but use words like "suggest that", "possibly", "likely indication of".
- ii.) One clue should not come out with a conclusive description.
- iii.) Avoid the following phrases when reading a map:
 - The top right corner of the map - but the south eastern area.
 - Top of the map - instead the northern part of the area.
 - Left corner of the map - instead the north-western part of the area.
 - Steep contours - instead use the area is steep as revealed by close contours shown on the map.
 - Bottom of the map -instead the southern part of the area.
 - The river flows towards left, upwards, downwards, or to the right- the river flows westwards, northwards, southwards, east wards.
- iv.) Study the map when looking at the key. Use the key to interpret the information you have got from the map.

CHAPTER FOUR

PHOTOGRAPH WORK

Specific Objectives

By the end of the topic the learner should be able to:

- (a) Identify types of photographs;
- (b) Describe parts of a photograph;
- (c) Estimate sizes of features appearing on photographs;
- (d) Draw sketches from photographs;
- (e) Identify and interpret features from photographs.

Content

- a.) Types of photographs.
- b.) Parts of a photograph.
- c.) Interpretation of photographs by estimation of actual sizes of features, sketching from photographs, studying and describing natural and human features and activities on photographs.

Definition

Photograph

- ✓ A photograph is an image or a picture of an object recorded by a camera on a light sensitive film or paper.

Types of Photographs

- ✓ Classified according to the viewpoint from which they were taken.
- ✓ The classes are:
 - a.) Ground photograph
 - b.) Aerial photographs

Ground Photographs

- ✓ These are photographs taken from the ground with the camera held level to the object.
- ✓ The person taking the photographs stands in a position where he can see the object directly in front of him/her.
- ✓ Objects far away from the camera are not always shown.
- ✓ The objects near the camera appear big and clear.
- ✓ An area hidden from the eye of the camera by an object is called **the dead ground**.
- ✓ Ground photographs are further classified into:
 - **Ground general view.**
 - **Ground close up (particular view).**
 - **Ground obliques**

Ground Close-up

- ✓ The camera is focused on one major object, such as an animal, a crop or a car.
- ✓ This object may block out the other things behind it.
- ✓ Close ups are the most common types of photographs.



Ground close-up photographs

Ground General View Photographs

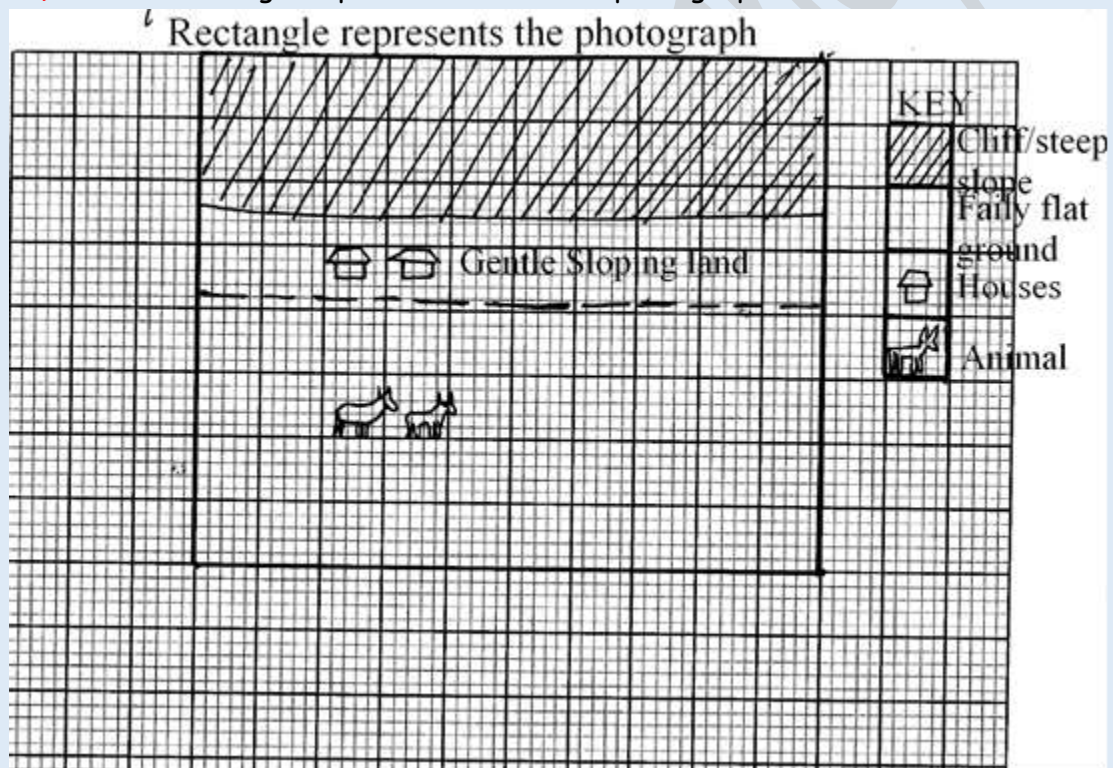
- ✓ These photographs are taken with the camera held horizontal to the ground facing the area focused on.
- ✓ The objects in the photograph become progressively smaller as the distance from the camera increases.

Examples

- a.) Identify the activity on the photograph below **pastoralism**
- b.) Name the type of photograph above ground **general view**



c.) Draw a rectangle representation of the photograph



Example

Study the photograph below and use it to answer question (a)



a) (i) Name the type of photograph shown above (1 mark)

- *Ground general view*

(ii) What time of the day was the photograph taken if the camera was held facing south? (1mark)

- *Evening*

(iii) Draw a rectangle measuring 16cm by 9cm to represent the area of the photograph. On it sketch and label the main features shown on the photograph (5 marks)



(iv) Describe the landscape of the area represented by the photograph.
(3marks)

- The land rises from the foreground towards the background
- The area covered with vegetation is slightly raised.
- The area in the background has bare rock surfaces/rock outcrops.
- The area in the foreground is gently sloping

Ground oblique

- ✓ This is taken while the photographer is standing on higher ground than the object.
- ✓ The camera is tilted downwards towards the object.
- ✓ Since it this photograph is taken from a raised point it tends to clearly bring out more details of features such as valleys and slopes.



A ground oblique photographs

Aerial Photographs

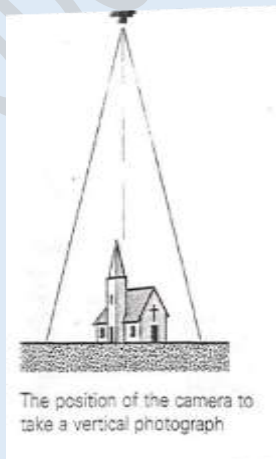
- ✓ Photographs taken from the air using aircrafts, balloons, parachutes and sometimes satellites.

Types

- i. **Vertical aerial photographs**
- ii. **Oblique aerial photographs.**

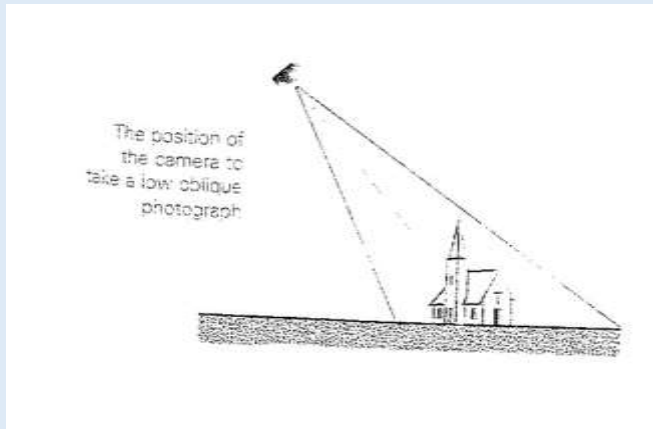
Vertical Aerial Photograph

- ✓ These photographs are taken from vertically above as illustrated in figure 3.5. The camera lense focuses vertically on the area to be photographed.
- ✓ As a result, only the tops of features like hills, trees and buildings can be seen as shown in below.
- ✓ These types of photographs are used for making maps.



Oblique Aerial Photograph

- ✓ These are photographs taken from a low flying aircraft with the camera tilted at an angle and cover a relatively large area as shown in below.
- ✓ The objects nearer the camera are larger than those far away. Although these photographs are similar to ground obliques, they cover large areas and the features on them appear smaller and more obscure.



Parts of photograph

- ✓ For the purpose of location and interpretation of features, a photograph is divided into three main parts namely:
 - a.) **Foreground:** This is the part nearest to the camera.
 - b.) **Middleground:** This is the part in the centre of the photograph.
 - c.) **Background:** This the part farthest from the camera.

Each of these parts is sub-divided into left, middle and right as indicated in below.

Left Background	Middle Background	Right Background
Left middle ground	Middle Middle ground	Right Middle ground

Left foreground	Middle Foreground	Right Foreground
-----------------	-------------------	------------------

Position of the camera.

Interpretation of Photographs

Estimating Actual sizes of Features on photographs

- ✓ Height of objects can be estimated by the use of other familiar objects shown in the photograph. For example, the height of a crop like tea can be estimated using a familiar object like an adult human being standing where the crop is growing.
- ✓ It is, however, not possible to accurately determine sizes of unfamiliar objects shown in a photograph.
- ✓ In photographs, images grow progressively smaller from the focal point outward, that is, from the foreground to the background.

Drawing a Sketch from a photograph

- ✓ To draw a sketch from a photograph, the following steps should be followed:
 - i. Draw a rectangular or square frame preferably of the same size as the photograph.
 - ii. Identify the required features and plot them in the frame appropriately. Use clear simple lines and avoid unnecessary shading.
 - iii. Label the required features and give your sketch a title. Interpretation of Physical

Features and Human Activities on a Photograph

- ✓ To interpret a photograph, it is important to study it in an orderly manner starting from the foreground through the middle of the background and then left to right.
- ✓ A photograph usually has different aspects of physical features such as hills, valleys, vegetation and drainage features as well as human-made features such as farms, bridges, roads and houses.

Relief

- ✓ Major relief features which can be deduced from a photograph include the slope, hills, plains, plateaus, ranges, escarpments and valleys.

- ✓ Several clues can be used to describe the relief of a given area in the photograph.

These clues include:

- i. Hilly landscapes may be a likely indication of a highland area, while dissected landscape in a hilly area indicates that the place has undergone heavy erosion. Undulating or gently rolling landscape, on the other hand may indicate that the area has undergone little or minimal erosion or may be used as an evidence to show that the landscape is young of recent origin.
- ii. The shape of hills can also give clues to the formation and age of such hills with smooth tops are a likely indication of young volcanic hills, which have been least affected by erosion. Rugged hills with protruding rock pillars, toes or plugs may indicate that the hills are old and have been heavily affected by erosion.
- iii. The human activities taking place in a photograph can also give clues to the nature of the landscape. For instance, presence of irrigation activities may suggest that the area shown in the photograph is a plain or is a gently sloping. Terraced landscape, on the other hand, indicates that the area represented in the photograph is steep and therefore vulnerable to erosion. Terracing is therefore meant to reduce or control soil erosion. Particular crops in a photograph can also suggest the relief of a place. For example, crops like tea indicate that the area covered in the photograph is a highland while presence of coconut plantations is evidence that the photograph represents a coastal area. Different human-made features in the farms can also give clues to the relief represented in a photograph. For instance, combine harvesters in a farm are likely indication of a plain or gently rolling terrain.
- iv. The type of drainage in a photograph can also provide a clue as to the nature of relief in an area. For instance, the presence of swamps may suggest that the area is flat and hence waterlogged. A lake on top of a hill is a likely indication of a crater lake and can hence also be used as a clue to show that there has been volcanic activity in the area. Long narrow lakes with a valley stretch running parallel to the hills or ranges in the adjacent vicinity are likely indications of faulting. Different forms of communication lines can be used to interpret the landscape. For instance, a road between two hills can be an indication that the hilly area is characterized by passes. A winding railway is an indication of a rugged landscape.
- v. Vegetation types shown in a photograph can also be used as a clue. In the tropics, cone-shaped trees with thin leaves can be used as evidence to show that the photograph represents a highland area.

Drainage

- ✓ The common drainage features that may appear on photographs include rivers, lakes, oceans, swamps, ponds, wells, boreholes and irrigation channels. On a photograph, water surfaces generally appear brighter than the surrounding features like vegetation and can easily be identified.
- ✓ When interpreting drainage, the following guidelines may be used:
 - i. Rapids and waterfalls would indicate a river that is flowing through a hilly landscape or is in its youthfull stage.
 - ii. Meanders indicate the middle stage of a river as the river enters less steep land or almost flat land. Some of the meanders may be cut-off from the main river and form ox-bow lakes (ox-bow lakes appear crescent shaped).

The presence of a flood plain in a photograph is an indication that the river is in the old stage. The presence of a delta may be identified by the river breaking into many channels before entering the sea.

Major rivers are joined by the tributaries. The main stream and all its tributaries form a river or drainage system. On some aerial photographs (especially those taken from near the ground surface), one may notice that drainage systems form different patterns on the surface. These depend on the general structure of that surface.

If part of a river is included in a photograph, one may determine the direction of flow by looking at the general relief. Rivers flow from higher ground (source) to lower ground.

Vegetation

- ✓ To describe the vegetation type from a given photograph, the following aspects need to be taken into account:
 - i. The type of vegetation: It is made of trees, grass, shrubs, swamps or thicket?
 - ii. The height and shape of vegetation, that is: Are the trees tall, short, cine shaped, umbrella shaped? Are the leaves broad, needle shaped or thorny? Are the stems bulky?

- iii. Density of vegetation, that is: Are the trees close together or scattered? Is there any undergrowth?
- iv. Vegetation species that is i.e: It is one type of vegetation? Are the trees of the same species? Is it possible to name or identify some vegetation species? Is the vegetation planted by human beings or natural?

Using the information gathered from a photograph, it is possible to identify different vegetation types such as tropical rainforest grasslands, woodland vegetation, scrubs and desert vegetation. It is also possible to differentiate between natural and planted vegetation. Planted vegetation usually appear in rows (patterns) with little undergrowth and have the same tree species of similar heights.

Climate

- ✓ Different aspects of climate may be deduced from a photograph in the following ways:

a.) Temperatures

These can be deduced from the kind of agricultural activities practiced in the areas shown by the photograph. For example, the presence of sugarcane plantations would suggest high temperatures while the presence of tea and dairy farms would suggest cool and temperatures.

The manner in which the people in the photograph are dressed can also be used to describe the temperature experienced in an area. For example, people in a hot place will wear light cloths while those in cold areas will dress warmly.

b.) Rainfall

Rainfall amount received in an area can be deduced from the kind of agricultural activities practiced. For example, dairy farming and the growing of crops like tea and coffee would generally suggest that in the area where they are grown is likely to have sufficient and reliable rainfall which is evenly distributed while short scrub or Bush land may be an indication of insufficient rainfall.

Human-made Features

A wide range of human-made features may be recorded in photographs. These may include:

i. Settlement

Thus is shown in photographs by houses. The houses may be arranged in different ways to give settlement patterns. For example they may be grouped together to form nucleated patterns. Settlement is indicated by the presence of people, population distribution and

density. Other indicators of settlement include social facilities such as schools, churches, health centers and playgrounds.

ii. Agricultural Activities

These include both crop farming and cattle rearing. Crop farming is indicated by crops seen in the photograph, people preparing land for crop planning, weeding or harvesting. Cattle rearing is indicated by the animals shown in the photograph, vast grazing land, cattle dips and ponds.

It is important to note the factors that favor an agricultural activity and the evidence for each factor. These factors include:

- ✓ High rainfall.
- ✓ Gentle topography.
- ✓ Availability of water for irrigation.
- ✓ Good transport network.
- ✓ Availability of markets.
- ✓ Availability of labour.

Livestock keeping may be favoured by availability of vast grazing lands

iii. Planted Forests

Planted forests are common in photographs. They may be identified by their appearance. They are of similar height, species and appear in rows.

iv. Fishing

Fishing is indicated by fishing vessels, people casting nets and fish traps.

v. Mining

This is indicated by a mine or quarry, people undertaking a mining activity or a mineral processing factory.

vi. Manufacturing

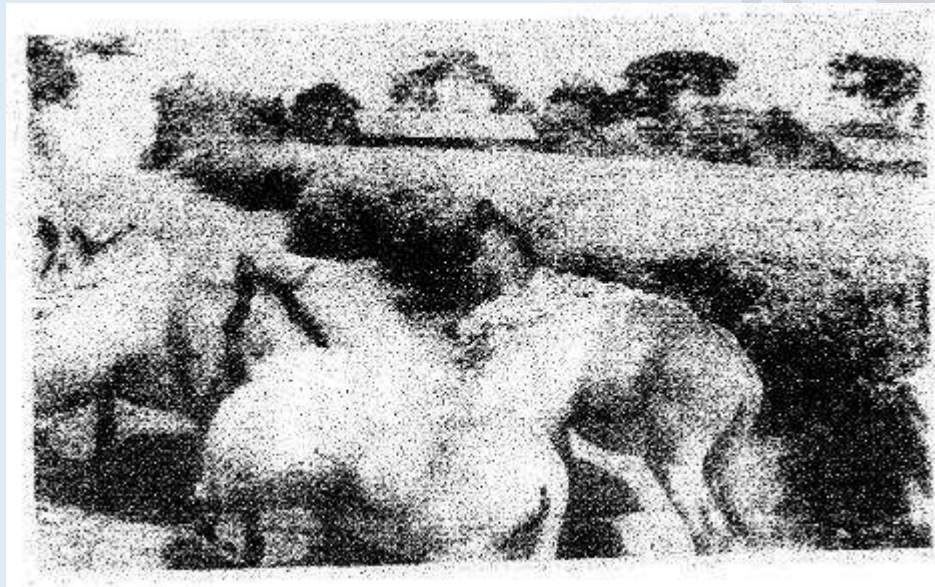
This is indicated by factory buildings with large chimneys or people engaged in a processing activity like jua kali artisans.

End of topic

Did you understand everything?
If not ask a teacher, friends or anybody and make sure you understand
before going to sleep!

Past KCSE Questions on the topic

1. The photograph provided shows a tea growing area in Kenya. Use it to answer questions (a) and (b)



- a) (i) What evidence in the photograph shows that this is a ground general-view type of photograph? (2mks)
- (ii) Draw a rectangle measuring 15cm by 10cm to represent the area of the photograph. On it sketch and label the main features shown on the photograph. (5mks)
- (iii) Identify two features from the photograph that show that this is a small scale tea farm. (2mks)
- b) Describe the stages involved in the cultivation of tea from land preparation to the stage shown on the photograph.

- a) (i) Name two districts in the Eastern province where tea is grown.

(2mks)

- (ii) Explain four ways in which the Kenya Tea development agency (KTDA) assists small scale tea farmers in Kenya (8mks)

2. What is the type of photograph shown?



3. Name each of the following:

- (i) Crop under cultivation (2mks)
- (ii) Type of farming (2mks)
- (iii) Other groups of crops in this type of farming. (2mks)
- (iv) The province in Kenya where this photograph was taken. (2mks)
4. Name five problems facing this type of farming in Kenya. 5mks
5. Name two major export destinations (countries) for farm produce shown. (2mks)
6. Name three physical features at the background of the photograph. (3mks)
7. Draw a rectangle of 12cm by 7cm to represent the area covered by the photograph.

Climate

Climate is the average weather conditions of a place which have been observe and recorded over a long period of time, usually 30 -35 years.

Distinction between weather and climate

Weather is the atmospheric conditions of a place over a short period of time, usually 24 hours while climate is the average weather conditions of a given place which have been observed and recorded over a long period of time, usually 30-35 years.

Factors influencing Climate

They are known as climatic factors and they include the following:

a.) Warm ocean currents

- ✓ When on-shore winds cross over a warm ocean current, the winds are warmed and carry the warming effect of the sea onto the land causing an increase in temperature on the adjacent coastal land.
- ✓ On-shore winds crossing over a warm ocean current are warmed up and pick moisture causing an increase in humidity on the adjacent coastal land.
- ✓ On-shore winds crossing over a warm ocean current are warmed up, pick moisture causing rainfall on the adjacent coastal land.

b.) Latitude

- ✓ Latitude influences temperature over the surface of the earth. Areas near the equator are warmer since the sun's rays are more intense within the tropics because the sun is almost overhead throughout the year/high latitudes

experience lower temperatures because the sun's rays strike the ground at a narrow angle and spread over a wide area.

- ✓ Latitude influences seasonal variation of rainfall. Some areas receive maximum rainfall when the position of the sun is overhead.
- ✓ Latitude influences the intensity of sunshine. Places near the equator receive more intense sunshine than those far away since the sun's rays are concentrated over a smaller area/the sun strikes the earth's surface at right angles/the sun's rays travel over a shorter distance thus less heat loss.

c.) Altitude

- ✓ Lowlands are usually warmer than highlands because the atmosphere becomes thinner as you go down hence the higher you go the cooler it becomes.
- ✓ This is because the sun's rays do not heat the air directly but heat the earth which in turn heat the atmosphere.

d.) Distance from the sea

- ✓ During hot seasons coastal lowlands are relatively colder than inland areas on the same latitude due to effect of sea breezes which bring cold air to the land.
- ✓ In winter land loses heat gained in summer faster than the sea. Sea breezes carry warmer air to the land making areas closer to the sea warmer than inland areas.

- ✓ Coastal lands receive more rainfall than the interior of continents .This is because the coasts receive moist winds from the sea and by the time the winds reach inland areas they are usually dry.

e.) Configuration of the Coastline

- ✓ This is the alignment, appearance or nature of the coastline.
- ✓ Irregular coastlines tend to receive more rainfall because the prevailing winds blow on-shore carrying moisture inland.
- ✓ The shape of the coastline/alignment of the coast also affects the size of the land area that comes into contact with the water. Areas with more water bodies' experiences sea and land breezes which leads to lowering of temperature during the day and raising of temperature at night.

f.) Air Masses

- ✓ An air mass is a widespread body of air with uniform properties such as temperature and moisture content and moves in one direction.
- ✓ When an air mass moves out of its region of origin /source, it affects all areas it transverses over in terms of temperature and moisture conditions.

g.) Aspect

- ✓ This is the general alignment of the slope to the sun's isolation.
- ✓ The slopes of high areas which do not receive direct sunrays have lower temperatures.

- ✓ The influence of aspect on temperature is more significant in the mid and high latitude areas than in the tropics where the sun is always overhead.

h.) Human Activities

The human activities influencing climate include the following:

- Settlement and agricultural activities
- Development of urban centers
- Construction of Dams

Settlement and agricultural activities

- ✓ Before people settle in a given area, they clear natural vegetation to make room for settlement.
- ✓ They also clear vegetation to be able to grow crops.
- ✓ When large areas of vegetation is cleared the effect on climate can be very significant.

Development of Urban Centres

- ✓ Smoke from factories and vehicles can lead to formation of fog which reduces visibility and also likely to cause an increase in temperature.
- ✓ The presence of buildings and planned roads within an urban set- up can also change the direction of wind by making it blow along the streets.

Construction of dams

- ✓ When dams create large human made lakes, they tend to have a modifying effect on the temperatures of the surrounding land.

- ✓ They also lead to an increase in the amount of moisture in the atmosphere through evaporation leading to an increase in the amount of rainfall received.

Classification of Climate

Climatic zones may be classified based on the following:

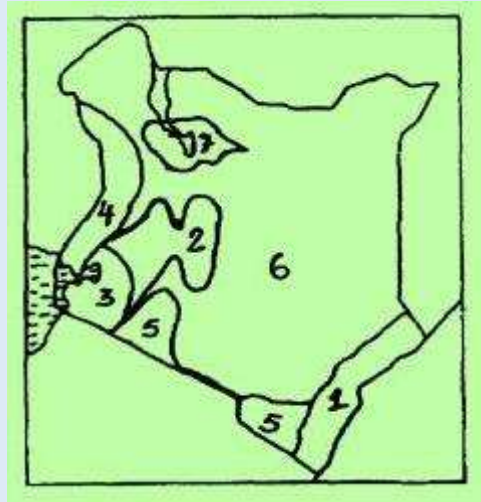
- Temperatures
- Physical components using measurable quantities such: net ,radiation, temperature, precipitation.
- Soil types.

Using these physical components three major climatic classifications have been advanced. These are:

- The thornwaite classification
- The koppen climatic classification
- The miller's classification

Distribution and characteristics of Climatic Regions of Kenya

- ✓ seven climatic types have been identified in Kenya as shown in the figure below.



Key

- 1- Modified Equatorial climate of the Coast.
- 2- Modified Tropical climate of the Highlands.
- 3- Modified equatorial climate of the lake basin.
- 4- Modified equatorial climate of the north western margin.
- 5- Tropical climate —Narok and Kwale.
- 6- Tropical semi desert climate - central and northern areas.
- 7- Desert climate of the central northern areas

Modified Equatorial climate of the Coast

It covers the coastal belt of Kenya extending from Vanga in the south - east to Lamu in the north coast. It is due to the presence of the Indian Ocean.

Characteristics

- ✓ No real dry month but rainfall is low than Equatorial.
- ✓ Rainfall is heavy 1600 mm/year.
- ✓ Temperature ranges between 20°C to 27°C.

- ✓ It has double maxima rainfall, mostly afternoon.
- ✓ Relative humidity is high between 1500 and 2000mm all the year round. ✓ Has a double maxima rainfall regime i.e. two rainy seasons

Modified Tropical climate of the Highlands

It is found mainly in the highlands east and west of rift valley. Modification is due to the relief. It is also referred to as highland sub-tropical climate.

Characteristics

- ✓ Temperatures are much cooler than expected of tropical climate because of the high altitude.
- ✓ Receives rainfall through the year.
- ✓ It has double maxima rainfall regime.
- ✓ Relief/orographic rainfall is common.
- ✓ Annual rainfall totals ranges from 1000 - 1500 mm.
- ✓ The average temperatures ranges between 17°C to 24°C.
- ✓ Experiences moderate humidity.
- ✓ Mean annual range of temperature is 3°C to 5° C.

Modified Equatorial climate of Lake Victoria basin

It is located within the lake region of Kenya and mainly covers Nyanza and Western Provinces. Modification results mainly from the varied relief and the influence of the Lake Victoria.

Characteristics

- ✓ Rainfalls throughout the year / no dry month.
- ✓ Rainfall ranges between 1,000 - 1600 mm.
- ✓ Rainfall is mainly conventional in nature.
- ✓ Double maximum of rainfall regime.
- ✓ High humidity.
- ✓ High temperature(s) throughout the year.
- ✓ Small annual range of temperature.

Modified Equatorial climate of the North Western Borders

It is best seen in the Kara Suk areas and is mainly considered to be a continuation of the climate of western and Northern Uganda.

Characteristics

- ✓ Rainfall totals are lower than in typical equatorial climate averaging 850 mm per year.
- ✓ Most of the months are dry.

- ✓ It receives convectional rainfall between June and September. Temperatures are generally high throughout the year.

Tropical climate of the Narok and southern Taita/kwale Areas

It is located in areas around the Loita hills, Taita hills and Shimba hills.

Characteristics

- ✓ Rainfall comes in March to May and October to December with maxima in April and November.
- ✓ High relief of hills such as Loita exerts a cooling influence on the climate making it more tolerable than the semi-desert climate of Eastern Kenya.

Tropical continental/Semi -Desert Climate of Eastern Kenya

It is found mainly in Eastern Kenya in areas such as Isiolo, Garissa, and Tana River and in Southern Kenya in areas such as Kitui, Machakos, Kajiado and parts of Northern Kenya in areas including Mandera, Moyale and parts of Turkana.

Characteristics

- ✓ It is generally dry with less than 500mm of rainfall which is unreliable.
- ✓ It has large diurnal and annual ranges of temperatures.
- ✓ The skies are generally clear.
- ✓ Temperatures are high with mean between 22°C and 27°C.

Desert Climate of Central Northern Area

Covers the northern Kenya. Wajir and Lodwar are in this climate region.

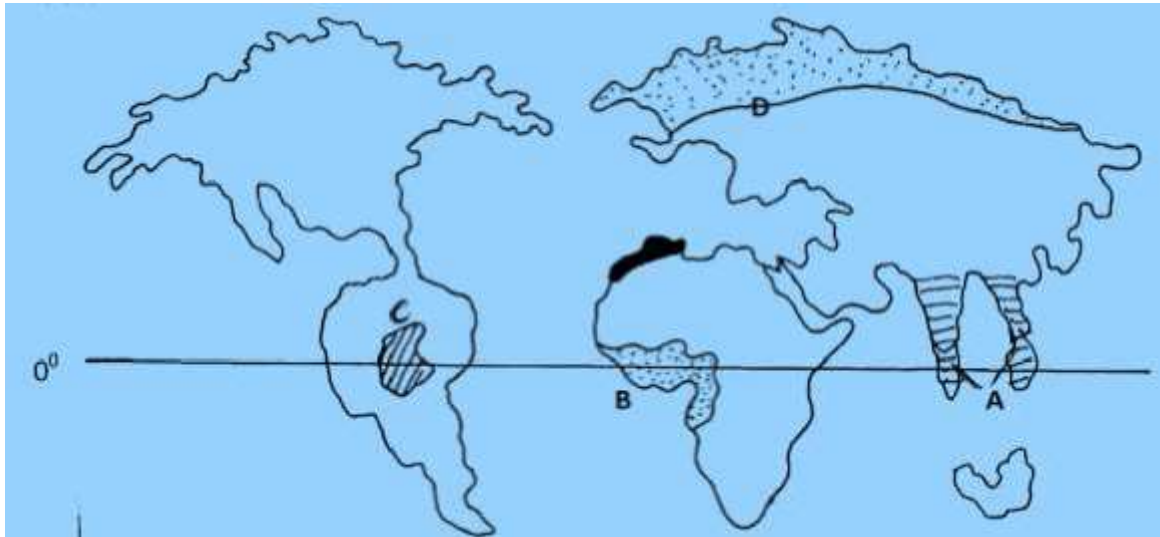
Characteristics

- ✓ Has low rainfall — less than 250mm p.a.
 - ✓ High temperatures throughout the year.
 - ✓ Night temperatures are extremely low.
 - ✓ Low humidity.
 - ✓ High temperature range.
 - ✓ Sandstorms are common.
- Occasional floods covered by sporadic rain

Distribution and characteristics of Climatic Regions of the world

According to the Miller's classification, the world climatic regions can be classified into four broad climatic belts. These are:

- Hot climates
 - Warm temperate climates
 - Cool temperature climates
 - Arctic/tundra climates (very cold climates)
-
- Mountain climates.



Key

- A. Tropical monsoon climate.
- B. Mediterranean climate
- C. Equatorial climate.
- D. Tundra climate

Hot climates

These are found approximately 20° N and S of the equator. The zones are most extensive in Africa and South America.

It can be subdivided into the following climatic sub -types:

- a.) Equatorial climate
- b.) Tropical monsoon and tropical maritime
- c.) Savannah (continental interior)/Sudan type
- d.) Tropical desert

Equatorial Climate

It is mainly found in the following regions:

- ✓ South America - Amazon Basin, the West Coastlands of Ecuador and Colombia.
- ✓ Along the coast of West Africa from Guinea to Cote de Ivoire and the Western parts of the Ghanaian coast.
- ✓ In Equatorial Africa from the southern part of Nigeria through Cameroon, Gabon ,Central African Republic of Congo.
- ✓ Southern East Asia - Malaysia and Indonesia and also the stretch between Burma and Vietnam.

Characteristics of Equatorial climate

- ✓ Experience high temperatures (24 - 27 °C).
- ✓ Experience the small annual range of temperatures of 3°C.
- ✓ Mean annual rainfall exceeds 1500 mm and is evenly distributed throughout the year.
- ✓ It receives double maxima rainfall regime after the equinox.
- ✓ Low diurnal range of temps of approximately 6°C.
- ✓ High humidity due to high rainfall and high evaporation rates.
- ✓ Major winds due are trade winds.
- ✓ Rainfall mainly conventional but orographic is common in Mt areas.
- ✓ Thick cloud cover throughout the year.

Tropical monsoon

This climate is experienced in the tropical and temperate latitudes that are heavily affected by seasonal land and sea winds. The countries that experience tropical monsoon type of climate outside Africa are Mexico, India, Bangladesh, Burma, Vietnam, Indonesia and North of Australia. In Africa they are Guinea and parts of Sierra Leon.

Characteristics

- ✓ Temperature range from 15°C in the cool season to 32° C in the hot seasons.
- ✓ It experiences moderate temperature ranges between 9°C and 18° C.
- ✓ High rainfall during the summer.
- ✓ It has a marked dry season during winter.
- ✓ Low pressure during summer hence winds blow onshore bringing heavy rains.
- ✓ High pressure on the land during winter hence blow offshore 🏠

- ✓ Cloudy skies in summer and clear skies in winter.
- ✓ Seasonal reverse of winds.

Note:

A typical monsoon climate has three seasons which include:

- Cool, dry season (November to February) when the offshore North - East monsoon winds blow.
- Hot dry season (March to May) when temperatures are very high because of the overhead midday sun and when winds are almost absent.
- Hot wet season (June to October) when the onshore south- west monsoon winds blow and when the rainfall is very heavy in onshore winds.

Tropical desert climate

It lies between 15° and 35° and of the equator on western margins of continents that are washed by cold ocean currents. Examples include: the Sahara, the Kalahari, Namib, Iranian Desert, Mexican Desert, the Great Austrian Deserts, Arabic Deserts, Atacama Desert and Thar Desert in Asia.

Characteristics

- ✓ Low rainfall approximately 250 mm per annum.
- ✓ The rainfall is unreliable.
- ✓ The solar radiation is intense.
- ✓ The winds are warm and dry, hence bring no rain.
- ✓ Skies are always cloudless hence temperature often go over to $32^{\circ} C$ ✓ No real defined season.
- ✓ Flash floods and thunderstorms are common when it rains.
- ✓ Humidity is low and the evapotranspiration rate is low.
- ✓ Large diurnal ranges that go up to $20^{\circ} C$ in some areas.

Warm temperate climate

They lie in regions that are affected by the divergence of winds. There are three types of climate based on rainfall distribution namely:

- a.) Warm temperate western margin/Mediterranean climate.
- b.) Warm temperate interior /warm temperate continental climate.
- c.) Warm temperate eastern margin/humid sub -tropical/china climate.

Warm temperate western margin/Mediterranean climate.

The main areas experiencing this type of climate are:

- Central coast of California - North America
- Southern tip of Africa - Cape town
- Around Mediterranean sea
- Central Chile - South Africa
- South West and Southern Austria

Characteristics

- ✓ Hot summers with temperatures of approximately 21⁰c and mild winters of temperatures approximately 10⁰c.
- ✓ Moderate annual range of temperatures approximately 10⁰c.
- ✓ Mean annual rainfall of between 500-900-mm.
- ✓ Cyclonic rainfall caused by depressions falls in showers in winter.
- ✓ Offshore trade winds in summer causes a dry season.
- ✓ Hot and cold local winds are common
- ✓ Has distinct seasons - spring, autumn , summer and winter

Warm temperate interior/warm Temperature Continental Climate

It is also known as the steppe type climate. It is found in the interior of continents between 30°N and 50°S of the equator.

Main areas where it is found include:

- Prairies of Canada and USA.
- Pampas of Argentina in South America.
- The veld of South Africa.
- The towns of New South Wales and Victoria in Australia.

Characteristics

- ✓ Temperatures range from 2°C to 6° C in winter.
 - ✓ Long and cool winters.
 - ✓ The summers are warm and short with temperatures ranging between 18°C and 21° C.
 - ✓ It experiences extreme temperatures due to its continentality.
 - ✓ Summer rainfall is caused by convection and depression.
 - ✓ There is moderate rainfall with an annual mean of about 500 mm.
- Humidity is high.

Warm temperate Eastern Margin Climate

- ✓ It is also known as China type or humid subtropical climate. It lies between 23° and 35° N and S of Equator on the eastern margins of continents.

The main areas where it is found are:

- South Eastern states of U.S.A
- Southern Brazil, Paraguay and Uruguay.
- The coastal belt around Durban in South Africa.
- Central China.
- Coastal regions of Australia.

Characteristics

- ✓ The area has a moderate annual range temperature of about 13°C .
- ✓ Presence of warm Ocean currents has a moderating influence in winter in coastal areas.
- ✓ Winter temperature are low due to the influence of the local winds.
- ✓ Typhoons or hurricanes or tornadoes are common and they lead to heavy rainfall.
- ✓ In winter the trade winds are offshore resulting in very little rain.
- ✓ Convectional rainfall is common in summer.
- ✓ Trade winds are onshore causing heavy rainfall in the coastal lands and highlands.
- ✓ Summers are hot at 26°C whereas winters are mild at 13°C .

Rainfall is moderate between 760 and 1500 mm in some areas and is well distributed all year round.

Cool Temperate Climates

Found between latitudes 35° and 60° north and south of equator. Cool temperate climates can be divided into the following three types:

- a.) Cool temperate Western margin.
- b.) Cool temperate continental
- c.) Cool temperate Eastern margin

Cool temperate Western margin

It is also referred to as cool temperate west coast, European type or British type. It is found on Western sides of continents between latitudes 45° and 60° North and South of the Equator.

Main areas where this type of climate is found are:

- North West Europe, covering northern Spain through France, the Benelux countries, West Germany, British Isles, Denmark and Norway.
- North West U.S.A and British Columbia in Canada.
- Tasmania in Australia and South Islands of New Zealand.
- Southern Chile.

Characteristics

- ✓ Warm summer between 13°C and 15°C and cool winters between 2°C and 7°C.
- ✓ Small annual range of temperature (3° to 11°C) due to maritime influence.

- ✓ Rainfall is well distributed throughout the year ranging from 760 mm to 2000 mm.
- ✓ In the lowlands at the coasts, cyclonic rainfall occurs while in the mountainous areas, relief rainfall is dominant.
- ✓ Humidity is high in winter
- ✓ Summer days are long and generally warm with irregular thunderstorms.
- ✓ Winds blows onshore during winter hence heavy rainfall in winter. Winters are mild.

Cool temperate Continental

It is sometimes referred to as Siberian type or cool temperate interior type. It extends between latitudes 35° North and 60° North.

Main areas where it is found include:

- Alaska and most of Canada.
- Eurasia covering Sweden, Finland, Poland, Germany and across former U.S.S.R up to Kamchatka peninsula in the East.

Characteristics

- ✓ The winter temperatures are extremely cold.
- ✓ Winters are long with longer nights.
- ✓ Summers are generally short and warm with maximum temperature of about 19° C in July.
- ✓ The annual temperature range is very high especially in the interior.
- ✓ Precipitation is mainly in the form of snow, which falls during winter.
- ✓ Convectional rainfall accompanied by thunder is experienced.

- ✓ The annual precipitation ranges from 400mm to 500 mm and varies from place to place.
- ✓ Relatively high humidity.

Cool temperate Eastern Margin

This type of climate is also known as laurentian type or cool temperate east coast or humid continental warm summer type. It is found on the eastern margin of continents of North America and Asia between latitudes 35° N and 50° N.

Main areas where it is found

- The north Eastern parts of U.S.A and Southern Canada.
- North Korea, Northern China and Eastern part of Siberia.

Characteristics

Winters are very cold with temperature ranging from -40° C and 0° C.

- ✓ Long summers.
- ✓ Annual range of temperature is large.
- ✓ Humidity is high during summer.
- ✓ There is precipitation all year round.
- ✓ In winter precipitation is in the form of snow.
- ✓ Annual precipitation varies from 600 to 1000mm.
- ✓ In summer winds are on shore.
- ✓ Rainfall is both conventional and cyclonic.
- ✓ Destructive typhoons are frequent in September.

Polar climates /Tundra and Ice Cap (very Cold Climates)

These climates are found above $66\frac{1}{2}^{\circ}$ North and South (arctic and Antarctic Circles).

The main areas where it is found include:

- Northern parts of America from Alaska through Northern Canada to Greenland.
- Eurasian from Northern Norway, Finland Greenland and Northern former U.S.S.R Antarctica.

Characteristics

- ✓ Winters are very cold and last for 8 months in a year with temperatures ranging from -58°C to 0°C .
- ✓ Summers are cool but short.
- ✓ The annual temperatures range is very large sometimes going up to 73°C .
- ✓ Permanent cover of snow and ice.
- ✓ The area is generally dry with low annual precipitation ranging from 100mm to 250 mm.
- ✓ Precipitation occurs mainly during summer.
- ✓ During the long cold winters, polar winds are dominant.
- ✓ Snow storms known as blizzards are common.

Mountains Climate

This type of climate is best developed in great mountain ranges of the world such as the Alpine Ranges of Europe, the Himalayas and Tibet Plateau of Asia, the Ethiopian Highlands, the east African Highlands, Drakensberg Mountains, The Adamawa and Cameroon Ranges of Africa.

Examples of Mountains with well-developed mountain Climate are:

- Mt Everest (8,848 m)
- Mt Kilimanjaro (5,895 m)
- Mt Kenya (5199 m)
- Mt Ruwenzori (5,109 m)

Characteristics

- ✓ Temperature decreases with increase in altitude.
- ✓ Temperatures range from cool to very cold.
- ✓ Some mountains peaks are ice capped.
- ✓ Diurnal range of temperature is small.
- ✓ Pressure on the mountain top is low due to rarefaction of air.
- ✓ Rainfall is predominant in these zones.
- ✓ Rainfall is mainly relief/orographic.
- ✓ Rainfall intensity depends on aspect.

Identify any three types of cold climates.

- I. Tundra climate
- II. Cold temperature eastern margin.
- III. Cold temperature continental
- IV. Polar climate

Micro-climate. (Local Climates)

Micro climate is a climate which is experienced within a small or localized area and slightly modified or different from the general climate of a region. It mainly arises from the differences in slopes, aspect, and nature of the surface, color and texture of the soil and vegetation cover.

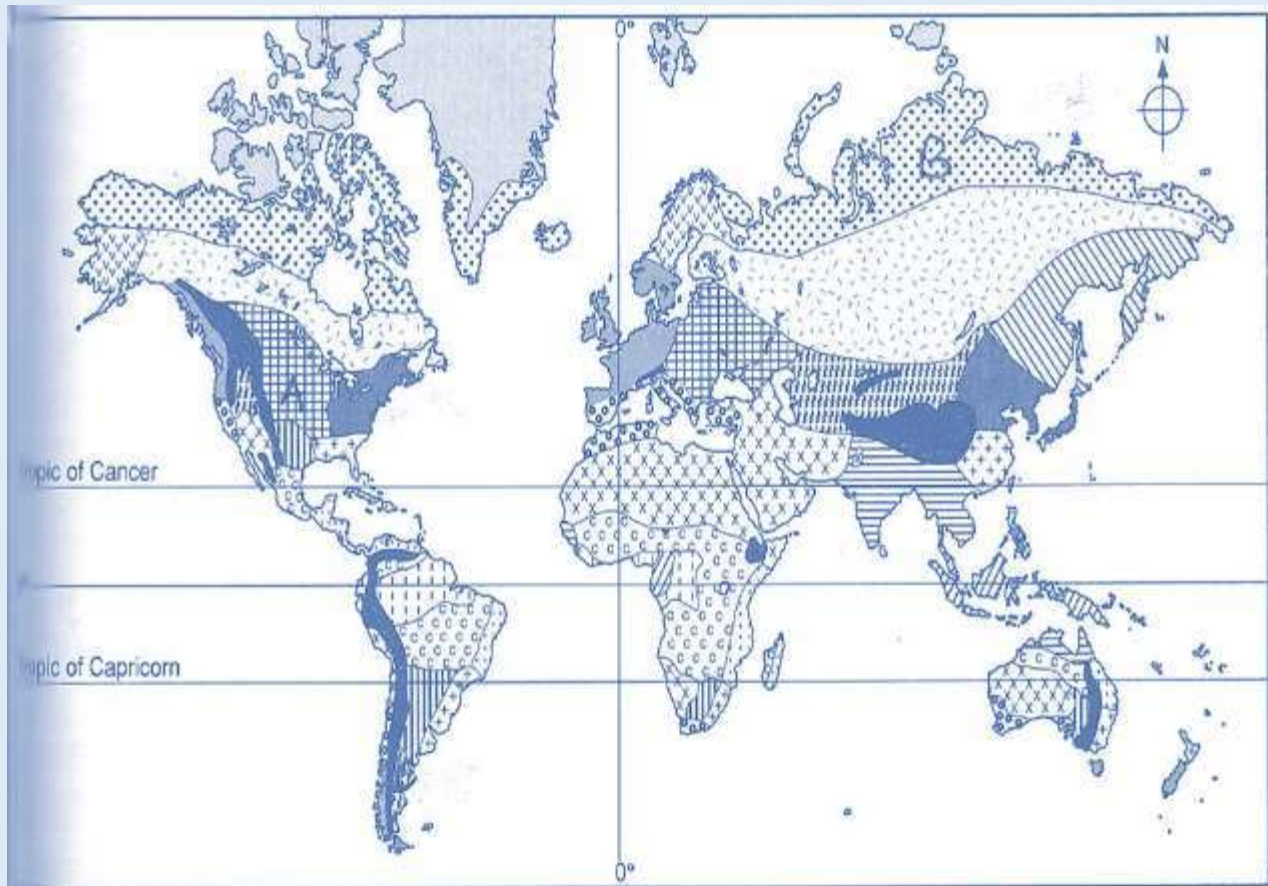
Human activities such as building of cities, dams and industrial plants produce micro - climates. In large cities micro - climate is also referred to as urban climate.

Examples of areas experiencing micro- climates include:

- Dammed areas - Aswan High Dam, Kariba Dam, Masinga Dam.
- Heavily built up areas- Nairobi, New York and Johannesburg.
- Forested areas such as Kakamega and the Aberdares forest.

Activity !

Using an atlas locate all the climatic zones of the world in the following figure.



Aridity and Desertification

Aridity is a state of land being deficient in moisture leading to scanty or lack of vegetation and deficiency in soil fertility.

Desertification is the encroachment of large areas of barren land which are covered with sands.

Causes of aridity and Desertification

The causes are divided into:

- Natural factors
- Human factors

Natural factors

a.) Rainfall

Insufficient Rainfall of less than 250mm which makes it difficult for natural vegetation to grow or thrive

b.) Temperature

High temperatures which leads to high rates of evaporation.

c.) Ocean currents and winds

Cold Ocean currents being a chilling effect on areas that they wash on shore hence cold desert conditions. Dry winds transfer dry conditions to the areas where they blow.

d.) Location on leeward sides

On leeward sides of mountains, rain shadow effects causes aridity. Onshore wind, on crossing mountain barriers, deposits moisture on the windward side hence crosses such barriers as warm dry winds which absorbs moisture rather than causes rain.

e.) Continentally/distance from the sea

Places that are located in the interior of continents are not influenced by the effects of wet winds compared to places located on the shores.

f.) Pressure systems

Areas of the world where high pressure system exist with low humidity have no rainfall because there is no moist air to rise before condensation takes place.

Human activities

- i. Poor farming methods for example: Overgrazing, Monoculture, Ploughing on slopes Deforestation. Poor irrigation practice.
- ii. Industrialization leading to emission of various gases in the atmosphere which causes pollution and Global warming.
- iii. Population pressure leading to replacement of rangeland with cultivation.
- iv. Where nomadic pastoralism is practiced, large parts of the land have been overgrazed.
- v. Destruction of vegetation so as to increase land under cultivation, build industries, acquire building materials and fuel.

Effects of aridity and desertification

- i. Desertification lowers the fertility of the soils, hence lowering the productivity of the land.
- ii. Reduced food production leading to famine.

- iii. Desertification leads to the destruction of the water catchment areas.
- iv. Causes destruction of vegetation which consequently exposes land to erosion.
- v. People from the affected areas migrate to the unaffected areas thus causing population pressure.
- vi. It can result in the extinction of plants and animal species and therefore contribute to the loss of biodiversity.

Possible solutions to Aridity and Desertification

- i. Controlled grazing of animals.
- ii. Afforestation and deforestation programs.
- iii. Irrigation of dry land.
- iv. Introduction of suitable farming method.
- v. Controlling soil erosion.
- vi. Use of alternative source of energy other than wood fuel.
- vii. Public education on environmental management and conservation

Climate Change

Climate change is the establishment of a new climatic state or continuous changes in climatic state such as temperature and precipitation over time.

Causes of climatic change

Causes can be classified as either **external** or **internal**

External causes

These are causes which operate from outside the particular climatic system for example from outer limit of the atmosphere.

Internal causes

These are causes which operate from within the particular climatic system for example factors operating from within the earth's atmosphere. It is mainly concerned with the accumulation of specific gases, which absorb infrared radiation leading to rising temperatures on the earth's surface and vulcanicity which also lead to emission of gases.

Global warming/Greenhouse Effect

This is an increase in Carbon IV Oxide levels in the atmosphere leading to an increase in surface temperatures.

Causes of Global warming.

- ✓ Depletion of ozone layer exposing the earth to short energy radiation rays e.g. ultra violet.
- ✓ Deforestation

Greenhouses gases.

- ✓ The green houses gases in the atmosphere are transparent to light but absorb infrared radiation.
- ✓ They allow sunlight to penetrate the atmosphere and be absorbed by the Earth's surface.

- ✓ This energy is reradiated as infrared radiation which is absorbed by the greenhouse gases.

The gases include:

- i. Carbon dioxide into the atmosphere.
- ii. Chloro-fluorocarbon in the atmosphere.
- iii. Methane

Consequences of climate change

- i. Global warming / increased temperature may lead to increase evaporation of ocean water which may cause heavy rainfall in some areas.
- ii. Increased temperature may lead to the melting of ice caps / ice sheets and glaciers leading to rising sea level. Increased temperature may also lead to high evaporation causing drought.
- iii. Climate change may cause changes in rainfall pattern in different parts of the world.
- iv. In temperate regions, winters are likely to be wetter and summers drier.
- v. Wetter and warmer conditions may increase pests and diseases which will affect humans, crops and livestock.
- vi. Disruption of the natural ecosystems, through adaptation and extinction of various plants and animals species.

- vii. Flooding from rising sea level due to melting of ice.

Evidence of the effects of climatic change in the recent Past

- ✓ The heat waves in Greece due to increased temperature which led to the death of many people.
- ✓ The receding of the ice -cap on Mt.Kilimanjaro and the disappearing of glaciers on Mt Ruwenzori.
- ✓ The melting of polar glaciers have resulted into rise in the sea level.
- ✓ The increase I rainfall causing flooding in some parts of South East Asia and Central Europe.

End of topic

Did you understand everything?

If not ask a teacher, friends or anybody and make sure you understand before going to sleep!

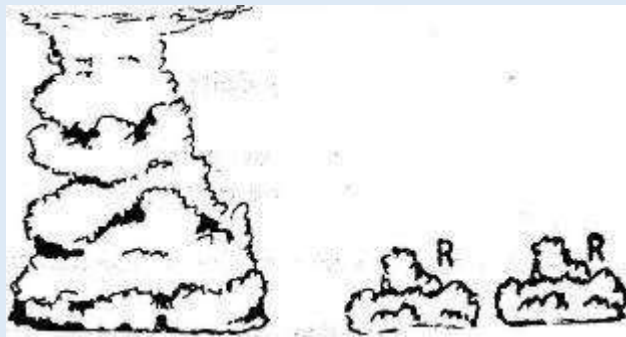
Past KCSE Questions on the topic

1. a.) How does a sea breeze occur? (2 mks)
2. a.) Name two theories of the origin of the earth (2 mks)

(b) Name four layers of the earth's atmosphere (4 mks)

3. a.) State two conditions that are necessary for the formation of fog.

(b) The diagram below shows some types of clouds. Use it to answer the questions that follow.



(i) Name the clouds marked R

(ii) Give two weather conditions associated with cumulonimbus clouds

4. a) the tables below represent rainfall and temperature of stations X and

Y.

Use them to answer questions (a) and (b)

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
TEMPERATURE IN °C	30	31	31	31	30	29	29	28	28	29	29	30
RAINFALL IN MM	250	250	325	300	213	25	25	25	100	275	380	200

MONTHS	J	F	M	A	M	J	J	A	S	O	N	O
TEMPERATURE IN °C	21	20	20	17	15	13	12	13	15	16	18	20
RAINFALL IN MM	12	12	15	50	90	110	87	87	50	35	20	15

a) (i) For each of the two stations calculate the mean annual temperature.

X -

Y -

(ii) Calculate the annual rainfall for station Y

(iii) On the graph paper provided, draw a bar graph to represent rainfall for station x. Use vertical scale of 1cm to represent 50mm

b) Describe the climatic characteristics of station Y.

5. a) The table below shows climatic data of a station in Kenya.

Use it to answer question (a)

Month	Jan	Feb	Mar	Apr il	May	Jun e	Jul	Aug	Sep	Oct	Nov	Dec
Temp in °C	28. 9	29. 7	30. 3	29.9	29. 7	29.2	28. 4	28. 7	29. 6	30. 1	29. 2	28. 7

Rainfall in mm	9.0	8.0	21.0	49.0	25.0	9.0	20.0	10.0	4.0	10.0	17.0	11.0
----------------	-----	-----	------	------	------	-----	------	------	-----	------	------	------

- i) What is the annual range of temperature at the station?
 - ii) Calculate the total rainfall for the station.
 - b) State three factors that influence climate.
6. (a) Name two elements of weather that can be recorded at a school weather station
- (b) Give three reasons why the recording of data at a school weather station may be inaccurate
7. (a) Describe a suitable site where you would locate a weather station in your School (2 mks)
- (b) Give reasons why a Stevenson's screen is:

(i) Painted White (2 mks)

(ii) Has louvers (2 mks)

8. Define relative humidity. (2 mks)

9. (a) Identify four characteristics of convectional rainfall. (4mks)

(b) State the difference between radiation fog and advection fog.

(4mks)

10. (a) Briefly describe how the six thermometers operate.

(5mks)

(b) Three ways in which clouds are classified.

(3mks)

11. (a) Give three precautions to be taken when citing a weather station.

(3mks)

(b) State three factors determining the amount of solar radiation reaching the earth's surface.

(3mks)

12. Define the following terms:

- (i) Climate
- (ii) Relative humidity
- (iii) Weather forecasting
- (iv) Absolute humidity
- (v) Weather lore

(5mks)

13. State the advantages of studying weather through field work.

(5mks)

14. (a) Describe how you would use the following apparatus during a field study.

Rainfall, maximum and minimum thermometers.

(3mks)

(b) Identify and explain the formation of the type of rainfall found in the

Lake Region or Kenya.

(8mks)

(c) Briefly write down two problems associated with the type rainfallabove.

(4mks)

15. (a) What is weather forecasting?

(2mks)

(b) List four problems of weather forecasting.

(4mks)

(c) State four ways in which weather forecasting is important to the human activities. (4mks)

16. (a) Explain three ways in which clouds influence weather.

(3mks)

(b) Use the data below to answer questions that follow.

Month of the year	J	F	M	A	M	J	J	A	S	O	N	D
-------------------	---	---	---	---	---	---	---	---	---	---	---	---

Temp in °C	25	26	26	24	23	22	21	21	22	22	22	22
Rainfall in mm	42	40	73	171	90	89	163	160	71	68	64	42

(i) Calculate mean annual temperature

(ii) Calculate annual rainfall

(iii) Calculate annual range of temperature.

(iv) Calculate the mean annual rainfall

(v) Which is the wettest month? (10 mks)

17. (a) Define 3 air mass. (2mks)

(b) Name types of air masses.

(3mks)

(c) A mass of air at 15°C can hold 20gm/cm³ of moisture. The same air at

the same temperature has 6gm/cm³ of moisture. What is its relative

humidity?

(4mks)

18. Name two instruments placed in the Stevenson Screen.

(2mks)

19. Why does sea breeze flow at night time?

(3mks)

CHAPTER

VEGETATION

Specific Objectives

By the end of the topic the learner should be able to:

- (a) Define vegetation;
- (b) Discuss the factors that influence the distribution of vegetation;
- (c) Identify and describe the characteristics of major vegetation regions of Kenya and the world;
- (d) Discuss the significance of vegetation;
- (e) Identify different types of vegetation and explain their uses within the local environment.

Content

- a.) Definition of vegetation.
- b.) Factors that influence the distribution of vegetation.
- c.) Characteristics of major vegetation regions of Kenya and the World.
- d.) Significance of vegetation.
- e.) Fieldwork on identification of different types of vegetation and explanation of their uses within the local environment.

Introduction

Definition of vegetation

- ✓ All the plants that grow together in any area form its vegetation.
- ✓ The vegetation of an area is defined as a community of plants such as trees, shrubs, herbs and grasses that cover a place and give it a distinct character.
- ✓ Plants that grow together in a particular habitat are referred to as a plant community.
- ✓ A plant community is defined as an assemblage of plants that grow together in a particular physical habitat or site.
- ✓ A distinction is frequently made amongst natural semi-natural (derived or secondary) vegetation and cultivated vegetation.

Natural (climatic climax) vegetation

- ✓ **Natural vegetation** is a plant cover that grows and spreads through natural means of seed dispersal without interference of external modifying influence.
- ✓ The term **climax vegetation** describes the vegetation that has established itself without interference in relation to the particular physical environment of climate, relief and soils.
- ✓ Therefore, climax vegetation describes a state of equilibrium (balance) having been attained. This climatic climax community will be dominated by plants, which of all those available, can complete most successfully in the existing physical conditions.

Derived (Semi-natural) Vegetation

- ✓ This type of vegetation that is in process of recovering from man's disturbance but has yet to reach a new climax.
- ✓ Derived vegetation is also referred to as secondary or semi-natural form of vegetation.

- ✓ This is because it owes origin to the interference of the previous natural or climax vegetation but man.
- ✓ Semi-natural vegetation is wild in the sense that it has not been planted by humans, yet its characteristics are attributed to such influence.
- ✓ In fact, much of what was formerly thought to be natural vegetation is semi-natural.
- ✓ For instance, if a tropical rainforest is cleared then neglected, it rapidly turns into a secondary forest where the species are similar to the original but are less luxuriant and less developed in form.
- ✓ For example, the savanna, the savanna grassland may be the result of forest clearance by shifting cultivation.

Cultivated Vegetation

- ✓ This is the type of vegetation planted by people.
- ✓ Examples of cultivated vegetation include some forests in the Kenya highlands, crops, hedge plants such as euphorbia, cypress and key apples. Cultivated crops and forest plantations form the principle components of the vegetation cover over significant percentage of the Earth's surface.

Factors influencing vegetation Distribution

- i.) The factors that influence vegetation distribution can be grouped into four main classes: Physiographic or geomorphic factors (altitude, terrain, drainage and aspect)
- ii.) Climatic or atmospheric factors (light, temperature, humidity, wind et cetera).
- iii.) Edaphic and pedagogical factors (soil properties which affect vegetation growth such as soil organisms, soil nutrients, air of the soil, soil water and soil texture).

- iv.) Biotic and anthropogenic factors (effects of other plants animals and people such as competition, seed dispersal, cross-pollination, grazing and trampling, cultivation and burning.

a.) Physiographic (Geomorphic) factors

- ✓ The major physiographic factors that affect vegetation growth and distribution include altitude, terrain and drainage.

i.) Altitude (Height above sea level)

- ✓ Temperature decreases with increasing altitude.
- ✓ Altitude affects the temperature and rainfall that in turn affect vegetation.
- ✓ For instance, the red mangrove is typical sea level vegetation while the bamboo is typical vegetation on highlands and mountains.

ii.) Terrain and drainage

- ✓ Terrain is the physical appearance of an area. It is denoted by the steepness and ruggedness of the land.
- ✓ Gentle slopes are more conducive to stable development of vegetation than steep and rough slopes.
- ✓ On the other hand, aquatic plants due to poor drainage can only characterize flat lands that are waterlogged.
- ✓ Steep rugged slopes are exposed to rapid erosion and mass wasting.
- ✓ For example, sometimes plants bend - up slope due to soil creep. Such slopes are also more vulnerable to vegetation destruction by agents such as human beings.
- ✓ Steepness of land has indirect influence on vegetation since it directly influences the rate at which precipitation is drained from the surface.
- ✓ On steep slopes, runoff is rapid and water dose not remain available to plants for a long time.
- ✓ On gentle slopes however, much of the precipitation can penetrate the soil and become available to the plants longer, hence more luxuriant vegetation can grow on such slopes.

iii.) Aspect

- ✓ This refers to the direction of a slope.

- ✓ The influence of aspect upon plants is direct through increasing or decreasing the exposure to sunlight and prevailing winds.
- ✓ Slopes facing the sun have warmer and drier environment than slopes facing away from the sun and thus lying in the shade for longer periods of the day.
- ✓ This effect is more pronounced in mid-latitudes than within the tropics.
- ✓ The influence is so strong that quite different plant formations are found on the slopes facing north from the slopes facing south.
- ✓ For instance, in the Alpine region of Europe, the south-facing slopes have thick and deciduous woods with varieties like the elm, poplar, alpine maple, birch, apples and pears, while the colder north-facing slopes are covered with coniferous species like spruce, silver fir, larch, scotch, pine, yew, juniper and the hardly arolla pine.
- ✓ This is because the slopes facing north are colder and more arid.

b.) Climatic or atmospheric factors

- ✓ Plants depend directly on the atmospheric for certain fundamental materials and conditions, necessary for their successful growth and reproduction.
- ✓ The climate influences vegetation in a number of ways particularly through its various elements namely sunlight, precipitation, temperature, humidity and winds.
- ✓ These elements have both direct and indirect influence on vegetation. Sometimes, they interact in their influence but some of them have strong direct influence in isolation.

i.) Sunlight

- ✓ Light is necessary for photosynthesis, the process which provides the energy for all other plant functions. Other requirements being satisfied, the amount of solar radiation that the green plants can utilize will set the limit for the maximum quantity of plant growth and production.
- ✓ Light, however, varies in quality, intensity and duration. That part of the solar spectrum absorbed by chlorophyll is the visible white light.
- ✓ Infra-red and ultra-violet light are not utilized in photosynthesis. Ultra-violet light is known to be harmful to bacteria and is believed to exert a retarding effect on vegetation development.

- ✓ All plant life is inevitably subject to alternating periods of light and darkness. For some plants, this is a factor of significance.
- ✓ A particular length of day (or night) or a given photoperiod is an essential requirement for the production of flowers and seeds.
- ✓ Additionally, leaf fall from many deciduous trees of temperate latitudes in autumn is thought to be determined by day-length. The response of plants to duration of daylight is called **photoperiodism**.
- ✓ The significance of photoperiodism emerged as a result of long periods of experimentation, particularly with plants of economic value, under controlled laboratory Conditions.
- ✓ It has implications on the horticulturalists who can regulate the photoperiod artificially in their green houses to produce short-or long-day blooms all year round.
- ✓ Furthermore it has been realized that certain crops, such as onions and potatoes when deprived of optimum day-length for flower and seed production show increased vegetative development.
- ✓ Obviously, for those plants that exhibit photo-periodism, the length of day may be the critical factor limiting their latitudinal distribution and their spread into areas where all other conditions might otherwise be quite suitable for their existence.

ii.) **Precipitation**

- ✓ The influence of rainfall on vegetation is quite obvious. The processes of germination, photosynthesis, growth, flowering and fruiting require some water.
- ✓ Areas that receive heavy and reliable rainfall have luxuriant vegetation growth.
- ✓ Areas that have little unreliable rainfall have poor and scanty vegetation.
- ✓ The vital processes of photosynthesis, growth and flowering activated by light, can, however, only take place in the presence of water.
- ✓ Water is the medium by which mineral nutrients enter and are transported through plants.
- ✓ Water is also necessary for the maintenance of leaf turgidity without which photosynthesis cannot operate efficiently.

iii.) Temperature

- ✓ Temperature determines the rate at which plant processes of germination, growth, photosynthesis, transpiration, flowering and fruiting take place.
- ✓ Each plant species requires specific temperature associated with each of these functions.
- ✓ The temperature in a given area determines the rate of growth of plants.
- ✓ For instance, plants of the same species in tropical lands grow faster than the ones in temperate lands.
- ✓ In colder climates, fewer numbers of plant species are capable of surviving.
- ✓ A large number of tropical species cannot survive below the freezing point.
- ✓ Whether a plant will be able to grow in a certain area or not will depend on whether the requisite amount of heat is available for a period long enough to allow the completion of its life cycle.
- ✓ An early and broad classification of plants according to the temperature conditions distinguish the following:

Megatherms: Plants of tropical and sub-tropical regions with at least four months averaging over 20c.

Mesotherms: Temperatures between 10c and 20c

Microtherms: In regions with eleven to eight months averaging less than 10c and

Hekisotherms: of the polar belts where all months have average temperatures of less than 10c

iv.) Wind

- ✓ Wind is another climatic factor, which though not essential for plant growth, can exert a considerable influence on the form of plant.
- ✓ Increased wind force, particularly when combined with low atmospheric humidity, can through its effects on evaporation greatly increase the rate of transpiration.
- ✓ Even under conditions of plentiful soil moisture, it may put a strain on the plant's water balance as severe as that in completely arid regions.
- ✓ In areas exposed to high wind force, such as along coastlines and at high altitudes, the height to which plants grow may be limited by their ability to absorb and transport water upwards rapidly enough to replace that lost by transpiration.

- ✓ Plants in exposed habitats are subjected to wind-shearing which may lead to retarded growth or may be inhibited by excessive transpiration.
- ✓ It may also cause the curvature and malformation of branches and trunks of trees, as well as physical damage.
- ✓ In addition wind is an important factor in dispersal of seeds and pollination.

c.) Edaphic and pedological factors

- ✓ Edaphic and pedological factors are those soil properties that affect plant growth and distribution.
- ✓ For the majority of land plants, the soil is the medium, that part of their habitat, in which they are anchored and from which they obtain, by way of their root systems, the water and most of the mineral nutrients necessary for their existence.
- ✓ The main edaphic and pedological factors that influence vegetation growth and distribution include:
 - Inorganic or mineral material.
 - Organic matter content.
 - Soil texture and Soil pH.

i.) Inorganic (Mineral Material) and Organic Matter

- ✓ Inorganic nutrients produced mainly by rock weathering are necessary for vegetation growth.
- ✓ Inorganic minerals together with organic are the major determinants of soil fertility.
- ✓ The main sources of nutrients are either rocks or organic matter. In this case they exist as complex insoluble compounds.
- ✓ They are released by weathering in the former and decomposition in the latter, as simple soluble forms making them available for plant use.
- ✓ Plant roots can only absorb these nutrients from the soil solution. Plant growth can be regarded, or the presence of a particular species excluded from a given habitat because these nutrients:
 - Lacking from the soil.

- become available for use by plants too slowly or
- Exist in incorrect proportions and are therefore not adequately balanced in the soil.

ii.) Soil Texture

- ✓ In any soil, the proportion of the various soil fractions present determine the physical property known as its texture.
- ✓ The texture of a soil is one of its most important and basic properties.
- ✓ It determines the relative ease with which roots can penetrate into the soil.
- ✓ It affects the nutrients supplying ability of the soil. It influences, too the water content, aeration and temperature, all of which are essential for the living organisms of the soil, plants included.

iii.) Soil pH

- ✓ The pH of a soil also affects the relative availability for plant growth of those mineral nutrients present.
- ✓ At approximately pH 6.5-when the reaction of the soil solution is just about neutral-all minerals are sufficiently available to satisfy plant requirements and there is enough calcium to counteract acidity, maintain the stability of the clay/humus complex, and promote crumb structure.
- ✓ Under conditions of increasing alkalinity, however, certain minerals may be rendered insoluble or their absorption by the roots of certain plant species inhibited in some way.

d.) Biotic and Anthropogenic Factors

- ✓ The biotic or the biological factors which influence plant growth and distribution are those which result from the action of living organisms. The main biotic and anthropogenic factors influencing plant growth and distribution include:
 - Competition.
 - Effects of animals
 - Effects of human beings.

i.) Competition

- ✓ The establishment of a given plant species in an accessible and physically favorable site will depend on its ability to compete for space, light, water and soil nutrients with other potential occupants.
- ✓ Competition, or 'the struggle for existence ' between plants of the same or different species arises because the resources of a habitat are insufficient to meet the demands of all the plants available and capable of growing there.
- ✓ The relative success of individual plants or species in this competitive struggle will dependent upon their ecological requirements, their life forms, their vigour and density of growth and their seasonal development.
- ✓ Competition is most intense between individuals of the same or different species, which make similar demands on the same supply of light, nutrients or water at the same time. Competition is the principal biotic factor which under natural conditions, determines those plants that will be able to co-exist in a given habitat.
- ✓ Whereas the physical factors of soil and climate are permissive, that of competition is selective.

ii.) Effects of animals

- ✓ Biotic factors also include those related to the activity of the animals that live among and are dependent upon the plants growing in a particular area.
- ✓ In contrast to those of plants, the effects of animals are primarily direct; in some cases they may be necessary for, in others antagonistic (against) to, the successful growth of certain plants.
- ✓ Many plants are dependent on animals for seed dispersal and for cross-pollination of their flowers.
- ✓ In the latter instance, animals-and more particularly insects-may be absolutely essential for the survival of a plant species in an area; it will not be able to exist if the pollinating agent is scarce or absent.
- ✓ The most outstanding and conspicuous effects of animals however, tend to be antagonistic rather than beneficial. Plants are the basic food producers and are therefore, naturally inevitably fed on by animals.
- ✓ In any habitat, a close relationship exists between the types and numbers of plants and those of the animals that can be supported directly or indirectly by them.

iii.) The effects of human beings

- ✓ There are relatively few areas left where the vegetation cover is completely natural, in the sense of being the result solely of the interaction of the physical and non-human biotic factors.
- ✓ Humans actions have been both direct and indirect. They include:
 - Modification of the physical environment in such a way as to encourage or discourage the presence of certain plants in particular areas.
 - Creation of new habitats such as quarries, coal bings, railway cuttings or bomb sites.
 - Alteration or modification of habit through the addition or extraction of minerals and water to and from the soil.
 - Pollution of soil, air and water which has been responsible for making certain physical habitats more or suitable for particular plants.
 - Accidentally or deliberately introducing plants to areas where formerly they did not exist for example e.g the water hyacinth in Lake Victoria and salvinia molesta in Lake Naivasha.
 - Clearing and cultivation giving preference and protection to some plants at the expense, or to the exclusion of others.
 - Being directly instrumental in identifying the destructive, antagonistic effects of animals on plants. For example he has drastically increased the numbers of certain types of animals at the expense of others and there are many animals whose numbers he has reduced almost to the point of extinction.
 - Increasing the numbers of domesticated grazing animals such as sheep, cows, goats and horses and reducing the number of animals that would normally compete with them for food.
 - Accidentally and deliberately starting fires as a means of either modifying or destroying natural vegetation cover.

Characteristics of the major vegetation regions of Kenya

- ✓ Other than in a few protected areas, such as the forest reserves and national parks, very little of the origins natural vegetation cover of Kenya still remains. What we see today is the secondary or derived vegetation.

- ✓ Relief, especially altitude, in conjunction with rainfall and soils have produced several different types of vegetation in Kenya, which can generally be identified as:
 - a.) Forest vegetation
 - b.) Savannah vegetation
 - c.) Arid and semi-arid vegetation and
 - d.) Heath and moorland.

Characteristics of forest vegetation in Kenya

- ✓ In Kenya, the forest vegetation consists of evergreen and deciduous trees.
- ✓ The evergreen forest are found at the higher altitudes and consists of various plant species such as bamboo, olive and podo trees.
- ✓ The forested areas of Kenya can be sub-divided into :
 - i.) Plateau and lowlands forests, which are found in some parts of the Lake Victoria region and at the coast around river Sabaki and Arabuko Sokoke. Mangrove forests are common in areas affected by tides.
 - ii.) Mountain or closed forests found on the mountainous and highland areas of the country. These are characterized by such trees as podo, cedar and camphor. Mountain forests occur in areas with an altitude above 1,800 metres. At about 3,000 metres, mountain forest gives way to dense thickets of bamboo and this zone in turn gives way to heath and moorland zone described below. It is important to note that apart from classifying forests on the basis of altitudinal zonations as done above, the forests of Kenya can also be classified according to their growth habit; that is according to the different types of trees and how these trees are grouped and grow together. On this basis the following types of forests can be recognized:
 - Closed forests such as the Kakamega and Aberdare forests.
 - Woodland fit example the Nyika woodland.

- Bamboo for example on high mountains like Mt. Kenya and the Aberdares.
- Mangrove forests, like those along the coast.

a.) Characteristics of savanna vegetation in Kenya

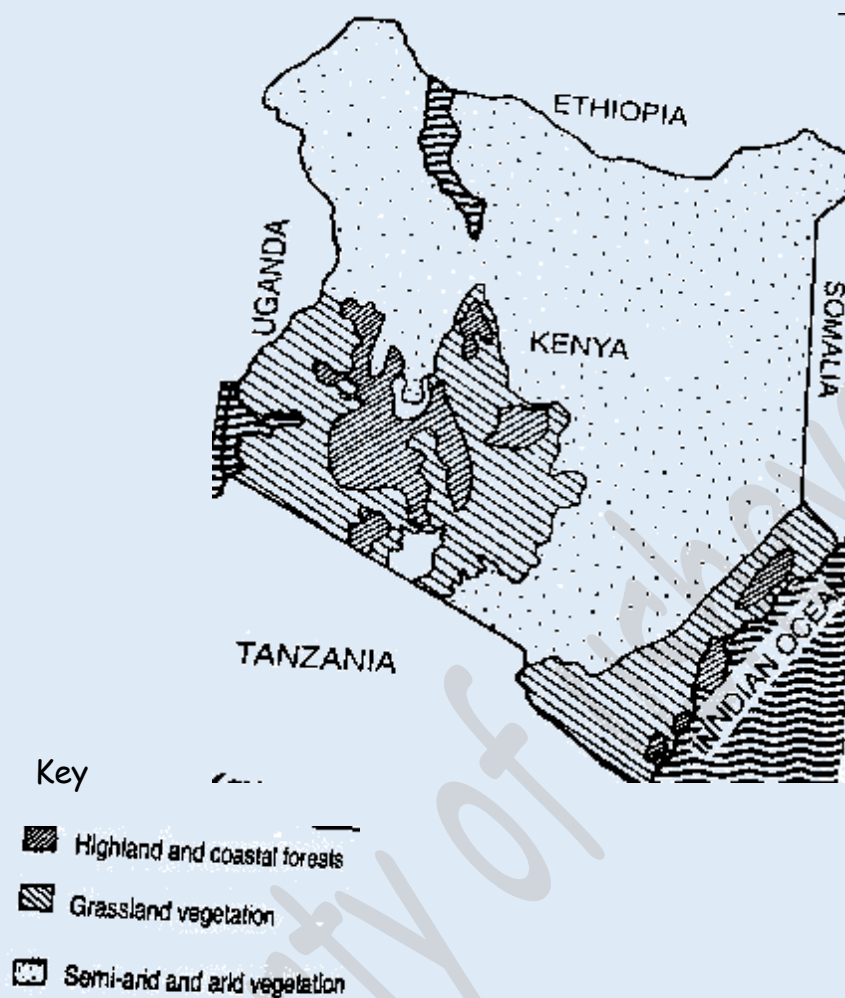
- ✓ The word savanna usually describes open grasslands with scattered woodlands or bushes. This type of vegetation occupies large areas of Kenya especially in the lake Victoria region as well to the south and east of Mt. Kenya.
- ✓ Grasslands are also found in parts of the coastal region and southern Kenya. The savanna vegetation can be divided into two sub-types namely:
 - i.) Savanna woodland which has a more or less continuous cover of trees with spreading canopies. The commonest trees in this sub-category are the thorny and drought resistant acacia. Also common in the baobab, a tree characteristics of the Nyika region.
 - ii.) Savanna grassland which is characterized by being more open and by having fewer trees dotted or scattered over the landscape. In some literature, this sub-type is often referred to as scattered tree grassland. Savanna lands support a great variety of trees including many which are of economic importance. These trees include shea butter nut, baobab, acacia, silk cotton tree (kapok), borassus palm and locust bean tree. The acacia trees are common throughout the savanna lands. They gave an umbrella shape with Thorny branches and small leaves. The dominant grass species include the elephant grass (hyparrhenia) and cymbopogon afronardus.

b.) Characteristics of Arid and semi-arid vegetation in Kenya

- ✓ A vast area of Kenya consists of plains which have very little rain and very high temperatures. For this reason, these areas support arid and semi- arid vegetation.
- ✓ The arid and semi-arid lands that receive less than 625mm of rainfall annually carry their own characteristic vegetation. This dry-land vegetation is of two types :
 - i.) Bushland and thicket which is dominant in areas that receive about 375 to 625 mm of rainfall annually. This sub-type consists of bushy, thorny and often tall acacia trees, separated by thorny shrub growing between them. It is unusual to find grass growing within the bushland and thicket type of vegetation.

- ii.) Semi-desert and desert scrub vegetation. In areas that receive below 375mm rainfall annually, the the vegetation becomes short (stunted). Scrub and bush are more common, often separated by wider areas or spaces of bare ground. Grass is rare except in areas with depressions where the water table is closer to the surface.

In the drier northern and north-eastern parts of Kenya, hard and short grasses are most dormant. Spiny shrubs, cactus and short thorny trees are characteristic of semi-arid and arid vegetation of Kenya. The arid and semi-arid vegetation has developed special mechanisms that enable it to survive and reproduce under the severe condition of limited moisture supply, high day temperatures and low humidity.



c.) Characteristics of heath and moorland vegetation

- ✓ This vegetation type is found on the highest mountains above the tree line, generally about 3,500 metres above sea level.
- ✓ The vegetation here is characterized by afro-alpine plants which are adapted to extreme cold and strong winds.
- ✓ Heath vegetation is of the scrubby type.
- ✓ It consists of low-growing evergreen shrubs with small bell-shaped pink or purple flowers.
- ✓ The term moorland describes hand area covered with heath vegetation, coarse grass and mosses.

- ✓ In Kenya, the heath and moorland vegetation is dormant on the upper slopes of Mt. Kenya and the Aberdare Ranges.

Characteristics of major vegetation regions of the world

On the basis of the quantity and quality of plants in a place, the world's major vegetation types can be identified as:

- i.) Forests (tropical rain forests, tropical monsoon forests, deciduous forests, coniferous forests, mixed forests).
- ii.) Grasslands (tropical savanna, temperate grasslands, arid and semi-arid grasslands montane grasslands).
- iii.) Desert vegetation (hot and cold desert vegetation).
- iv.) Alpine or montane vegetation.

i.) Forests

a.) The equatorial forests

- ✓ These are also called tropical rainforest.
- ✓ These forests are found within a belt that extends roughly 4 to 5 north and south of the equator.
- ✓ Due to the hot and wet conditions that prevail, these forests have attained a very rich and luxuriant growth.
- ✓ This is because the area has average annual temperatures ranging between 24 to 27 and heavy rainfall well distributed throughout the year.

Characteristics

- ✓ The rainforests have closely set trees with three distinct canopies or layers.
- ✓ The crowns of the trees form a continuous canopy of foliage which provides a dense shade for the lower layers.
- ✓ The highest canopy rises to about 40 metres protruding above the second canopy which is 30 metres high.
- ✓ This in turn towers above the lower canopy ranging from 5 to 15 meters high.
- ✓ The lowest canopy consists of young trees of different stages of growth and some stunted tree species.
- ✓ The trees are tall, smoothed barked and with no branches at the lower sections.

- ✓ The trunks are commonly buttressed at the base by radiating wall-like roots.
- ✓ Some trunks bear fruits and flowers, for example, cacao (*Theobroma Cacao*), lianas and other climbers such as the thick wooded vines are supported by the big trunks of the tall trees.
- ✓ These climbers rise to the top canopy to receive light. Such climbing plants are known as **epiphytes** because they grow on others and depend on them for support.
- ✓ Examples of epiphytes include orchids, mosses, lichens and ferns. Some epiphytes are partial parasites, for instance, the stranglers like the strangling fig (*Ficus*).
- ✓ The stranglers start off as epiphytes in earlier growth but eventually conquer their hosts in their stages where upon they grow into giant trees on their own.
- ✓ Trees found in these forests have broad leaves to protect them from collapsing during the intense midday isolation and high temperature, a factor that would render them useless for photosynthesis. The leaves are generally drip-tip in shape.
- ✓ This shape is probably to permit the leaf to shed water easily, thus dry more quickly after rain.
- ✓ The dry leaf discourages excess epiphyte population and also enables maximum transpiration efficiency in the humid conditions of the rain forests.
- ✓ Other low growing plants that have special adaptation to the equatorial forest are the saprophytes.
- ✓ These are completely devoid of chlorophyll and so depend on nutrients from the soil.
- ✓ They are therefore closely associated with fungi which decompose humus for them.
- ✓ They enter a symbiotic relationship with a fungi as a survival technique.
- ✓ The fungi benefit from this symbiotic existence.
- ✓ Equatorial forests have a varied number of plant species within a small portion.
- ✓ For instance, as many as 1,500 species may be found in square kilometer.
- ✓ This makes it difficult to exploit them for economic purposes as they are not found in uniform stand.
- ✓ The typical species of the equatorial forests in Kenya are camphor, mvule, Elgin teak and plateau bamboo in the western parts of Kenya and ebony and mahogany.

- ✓ The thick canopy cuts out the sunlight so that there is little ground cover of vegetation growing in the gloomy shade at ground level. However, along rivers and where man has cut down the vegetation, dense scrub quickly grows and less luxuriant secondary forests develop.
- ✓ The rain forest trees are very straight with smooth trunks, which helps to make them a valuable source of timber.
- ✓ Lianas hanging from the branches get longer as the trees grow taller, and epiphytes such as fern and orchids grow attached to the branches.
- ✓ The roots of trees in the tropical rain forests tend to spread sideways rather than penetrate down, and massive buttress roots develop which help to support these tall trees.
- ✓ Tropical rain forests have many different hardwoods exploited for commercial purposes.
- ✓ Important hardwoods include; mahogany, ebony, iroko, sapele, okoume, samba, teak, and greenheart.
- ✓ Tropical rain forests are found in the Amazon and Zaire basins, west African coast, New Guinea, Burma, Vietnam and Malaysia. The world distribution of tropical rain forests in the figure below.

b.) Tropical Monsoon Forests

- ✓ The tropical monsoon forests are in many respects structurally similar to the equatorial forest.
- ✓ They occur on windward coasts roughly stretching from 10° North and south of the Equator to the Tropics of Cancer and Capricorn respectively.
- ✓ They occur along monsoonal coasts where seasonal variation in rainfall is marked climatic feature.
- ✓ During the intensely wet season, monsoonal winds are onshore while during the dry season, the winds are offshore.
- ✓ The monsoonal forests are clearly adapted to this seasonal change since many species in it are deciduous.
- ✓ The most widely distributed formation of the tropical or monsoonal forests is the Indo-Malaysian formation.
- ✓ It extends outside the tropic of cancer in northern India around Assam and beyond the tropic of Capricorn in south-east Australia.

- ✓ This belt contains broad areas of the tropical monsoon forests. It covers Bangladesh, Burma, Vietnam and the Philippines.
- ✓ It extends over the islands of Sri-Lanka, Java and some of the pacific islands, the tropical monsoon forests have been nearly completely cleared to give way to human activities.
- ✓ They are also found on the east facing slopes in Asia. These forests are also found on the east African coasts and the southern parts of the west African coast.

Characteristics

- ✓ The true monsoon forests are mainly deciduous(shed their leaves during dry season) and less dense due to the long dry season.
- ✓ They have a variety of tall equatorial forests. Some of the species in the tropical monsoon forests include camphor, ebony, sapele and pinkado, teak and bamboo.
- ✓ Plants of particular tree species predominate an area for example teak in Burma, Sal in India and eucalyptus in Queensland.
- ✓ The trees grow fast due to abundance of sunlight and moisture. The trees are tall, rising up to about 30 meters.
- ✓ However, they lack a continuous canopy.

c.) Coniferous Forests/boreal forests

- ✓ They only occur between 45-75 north and south of the equator.
- ✓ They are mainly found in the north American and the Eurasian continental belts.
- ✓ The southern continents have only limited tracts on mountain sides such as the Andes and limited formations in New Zealand and Tasmania.
- ✓ This is probably due to the narrowness of continental masses in the Southern Hemisphere.

Characteristics

- ✓ Coniferous forests are conical in shape to combat the snow fall during winter.
- ✓ They also have needle-shaped leaves, a characteristic that enables the trees to reduce water loss by transpiration during winter when all the moisture is frozen in the soil.
- ✓ A quick receiver and pick up of the processes is possible when spring time comes.
- ✓ Coniferous trees can only withstand the winter cold to a point beyond which they cannot survive.
- ✓ This is especially towards the poles. The tree species are found on uniform stands. The major species are spruce, fir, pine and larch.
- ✓ Tough coniferous forests are common in low latitudes, these forests are also found on high altitudes such as high mountain sides of the tropical areas.
- ✓ In most coniferous forests, a thick carpet of mosses occurs.
- ✓ The forest species are generally few and large tracts of forests can consist of only one or two species of trees.
- ✓ The needle-leaf forests of North America, Europe and Siberia, where they are known as the Taiga, are composed of evergreen conifers such as the spruce, fir and pine.
- ✓ The eastern and north-central Siberia and the Asiatic boreal in northern Japan and Manchuria is dominated by the larch and the dwarf pine in drier places where they shed their needles in winter.
- ✓ In the western Caucasus range of central Europe, the oriental spruce and fir are found.
- ✓ On the Atlas ranges, the larch is common. Similar forests are found on the Himalayas in Kashmir and Nepal.
- ✓ In Burma and southern China or tropical mountains, coniferous forests exist on rugged terrain.

d.) Deciduous Forests/summer greens

- ✓ They are found in the middle latitude landmasses of the northern Hemisphere.
- ✓ In America, they stretch from the Appalachian Mountains to the Mississippi across Minnesota, Michigan, Pennsylvania and New England. Riverine,

deciduous forests are found along Missouri, North Platte, South Platte and Arkansas.

- ✓ In Asia, a deciduous forest zone occurs around the yellow sea in west Korea, Shantung and Kwatung Pensular in China extending into the lowlands of Hopeh, Manchuria and the extreme South East of former U.S.S.R.
- ✓ In the Southern Hemisphere, deciduous forests only occur in inland valleys such as on the leeward slopes of the Chilean Patagonia and Terradel Fuego in south America.

Characteristics

- ✓ The trees are tall and have broad leaves which give them a continuous, dense canopy in summer making the forest very thick.
- ✓ In winter, the trees remain dormant but build up wood in summer.
- ✓ There are lower layers of weak shrubs and small trees between the tall trees.
- ✓ The main species are hardwood and include the oak, birch, ash, sycamore, basswood, maple, chestnut, hickory hornbeam and beach.
- ✓ The native oak of Shantung was used to feed silkworm to produce wild silk.
- ✓ Trees shed their broad-leaves in autumn and remain bare in winter to minimize loss of water by transpiration.
- ✓ As water availability improves on the onset of spring, the trees regain their leaves and remain green in summer. Many trees grow in stands of the same species.

e.) Mixed Forests

- ✓ Conifers between latitude 45-75 north and south give way to broad-leaved summer green deciduous forests in warmer well watered localities.
- ✓ In a zone of transition, two formations exist side by side. This transitional zone is therefore referred to as the mixed forests.
- ✓ The trees species are not necessarily intermingled on individual basis.
- ✓ Areas rich in mixed forests include Alberta and Saskatchewan Provinces in Canada and Central Siberia in Russia, where the birch, aspen and the willow are common.
- ✓ The European Russia has clear mosaics of spruce and oak stands in Estonia.

- ✓ In Europe, mixed forests are found on the Scottish highlands, the central Massif and the Cantabrian mountains in northern Spain.
- ✓ There is also a continuous stretch extending eastwards from northern Alps, Alsace, Central and Northern German and South and Central Sweden. Pine, spruce, silver, fir, oak, birch and beech are present in the mixed forests of Germany.
- ✓ In Eastern Asia, mixed forests occur in the midst of the boreal forests especially in the middle Amur valley, northern and eastern Manchuria, North Korea and southern Hokkaido and northern Kyushu Islands of Japan. Native species are the maple, birch, beech, poplar and oak.
- ✓ The native ash and the keyaki are still common in these areas. Associated conifers in these are Japanese cypresses and Japanese cedar and fir.
- ✓ In North America, a zone of mixed forests stretches from Minnesota through Wisconsin and southern Michigan to northern parts of Pennsylvania and New York.
- ✓ In New Brunswick and Nova Scotia in Canada as New England in U.S.A., mixed forests were dominant before economic activities such as industrialization, urbanization and agriculture changed the landscape.
- ✓ Before that, the sandy out wash plain areas in Minnesota, Wisconsin and Michigan were occupied by stands of white and red pine while the richer soils were mainly occupied by stands of oak, hickory, maple and the beech.
- ✓ The Mediterranean forest communities include the maquis(French) or Macchia (Italian).
- ✓ They occur in the Mediterranean lowlands which are partly coniferous and partly broad-leaved.
- ✓ In the southern Hemisphere, such formations are found in limited portions in Chile, New Zealand, Tasmania and South Africa. Here, the coniferous forests are not extensive enough to give noticeable transition to mixed forests and deciduous formations.

Characteristics

Mixed forests may take on characteristics of either the coniferous or deciduous forests.

Grasslands

- ✓ Grasslands can be categorized into the following classes.
 - Tropical Savanna
 - Temperate grasslands.
 - Arid grasslands.
 - The mountane grasslands

Tropical Savanna

- ✓ Tropical savanna occurs in tropical continental areas approximately between latitudes 10 North and South of the Tropics.

Characteristics

- ✓ The tropical savanna is a mixture of trees and grass at varying degrees.
- ✓ The more the rainfall, the denser the trees and the taller the grass.
- ✓ Therefore, the tropical savanna can be sub-classified into tall grass and woodlands, parklands, thornbush and scrub in the order of decreasing rainfall.
- ✓ The tall grass and woodlands consists of trees spaced widely apart permitting the growth of grasses and shrubs at a lower level.
- ✓ This type of vegetation in Africa has been variously described as 'dry forest,' or 'miombo woodland' (in Tanzania) and tree steppe (in Zambia, Malawi, and Angola).
- ✓ No actual stratification or formation of canopies is observable in the woodland communities as in the rainforests.
- ✓ The dominant trees hardly exceed 20 metres in height and are mainly flat topped and spreading.

- ✓ The grasses dominate the undergrowth and are mainly tall and belonging to many genera (species).
- ✓ Thus vegetation type experience a prolonged seasonal drought for four to seven months.
- ✓ However, a definite dry period lasting between four to five months is always experienced.
- ✓ The rainfall hardly exceeds 800mm on average.
- ✓ Most of the trees and shrubs therefore, assume special adaptation to his harsh condition.
- ✓ Some shed their leaves during the prolonged dry season to check evapotranspiration. Some have wax bark and spiky leaves and thorn. The grasses dry up completely.
- ✓ Annual grass fires are frequent. These grass fires periodically destroy the vegetation cover.
- ✓ This has led to the contention that savannah woodlands are but a secondary form of vegetation derived from the former more luxuriant climax vegetation.
- ✓ The tree species in the woodlands are dominated by the combretum variety in Kenya and most of Eastern Africa. The dominant tall grasses include the elephant grass (*Hyparrhenia*). *Cymbopogon afronardus* is predominant in the high grass areas of the Lake Victoria Basin, where it is called Osinde.
- ✓ In the highland areas like M.t Kenya, Kikuyu grass dominates.
- ✓ The parklands are dominated by grass with a few isolated trees that are lower in height than those of the woodlands.
- ✓ The parklands are generally treeless except along the rivers where water is available.
- ✓ Red oat grass (*Themeda triandra*) dominates the Kenya parklands such as the Maasai Mara and Amboseli. Short acacia trees (1.8 to 2.4 m) are the dominant trees.
- ✓ The taller acacia are found in the watered areas like along river valleys. Acacia is a high, flat topped tree and is well adapted to the drought-prone areas. Star grass is found on the riverine sections.
- ✓ Thornbrush and scrub are found on the rainshadow areas in the tropical region.
- ✓ They have drier vegetation, consisting of dry desert scrub and desert grass.
- ✓ In these areas, rainfall is usually less than 650mm annually and is very unreliable.

- ✓ The zone is dominated by acacia and euphorbia varieties.
- ✓ This type of vegetation is typical of the Nyika plateau of Kenya.
- ✓ Many tree species are stunted and have scaly barks. Drought resistant plants such as the baobab, euphorbia, commiphora and acacia can survive under the harsh environment created by poor soil, wind, aridity and a high rate of evapotranspiration.
- ✓ Such vegetation type is evident in Makueni District.
- ✓ During the unusually wet seasons, a rich growth of quick growing grass occurs.
- ✓ The seeds from this grass are capable of sprouting for many years after the rainy season.
- ✓ The cycle of germination, growth, flowering and seeding is extremely short (1 to 2 months).

Temperate Grasslands

- ✓ These are also known as mid-latitude grasslands.
- ✓ Five main zones of temperate grasslands are recognized over the world these are:
 - The prairies of North America
 - The Pampas of Argentina
 - The Veld of South Africa
 - Downs of Australia and New Zealand.

a.) The Prairies of North America

- ✓ The prairie grasslands in North America cover a big portion of south central Canada in the province of Alberta and Saskatchewan.
- ✓ It stretches to the Gulf coast in south-eastern Texas (U.S.A).
- ✓ They also have extensive formations on the plateaus and basins to the west and in central Valley of California, in Kentucky's Blue Grass region and the Nashville Basin to the Tennessee.
- ✓ They also stretch to the Mid-west plains in Illinois and western Indiana.
- ✓ The prairies formation is sub-divided into three categories namely:
 - i.) The true prairie

ii.) Mixed prairie and

iii.) The pacific and Palouse prairies.

- ✓ The true prairie is found in a great area from south-central Alberta and Saskatchewan through southern Manitoba and middle west to the east central Texas, Oklahoma, central Kansas and Nebraska across the Dakotas into south Saskatchewan.

Characteristics of the Prairies

- ✓ The dominant grasses would attain a height of 1 to 1.2 metres before human interference.
- ✓ A mixture of sword-forming grasses occur in these areas as well as bunch grasses like the common stipa grass.
- ✓ In spite of general 'tussocky' appearance, particularly in winter, the true prairie forms a continuous sward or widespread sward-forming dwarf grasses include the buffalos grass and gramma grass while the mid-height grasses include stipa grass.
- ✓ The mixed variety gives way to xerophytic type of grasses in drier zones, for example South West Texas, Southern New Mexico and Arizona where dwarf species alone dominate.
- ✓ These cover the 'desert plains.' Cactus and sage brush are also found.
- ✓ The mixed prairies is found in most of the Great plains.
- ✓ It is mixed in the sense that it is composed of grasses of two distinct life-forms;
- ✓ Those growing to a height of one metre and the dwarf grasses whose fruiting stems reach only a few centimetres high.
- ✓ These are similar to the Palouse Prairie which was found over extensive areas of basin and plateau country in east Washington and Oregon, south Idaho and northern Utah as well as the Palouse itself.
- ✓ These areas are dominated by bunch grasses while the true prairie and the mixed prairie have turf or sward grasses.
- ✓ The blue bunch wheat grass is dominant on the Palouse prairie.
- ✓ Grazing has also interfered with the original vegetation and sagebrush invasion has been rampant.

b.)The Steppe of Eurasia

- ✓ The same steppe has been applied to the wild grasslands of Europe and Asia (Eurasia).
- ✓ The life forms are on the whole identical to the prairies of North America.
- ✓ The areas include the semi-deserts of Caspian Sea area and Central Asia.

Characteristics

- ✓ The species are very similar to the prairies. Sod-forming grass (a piece of slice of earth together with grass growing on it) are common.
- ✓ In the Eurasian steppes, tussocky grasses are also found.
- ✓ These form tufty grass or clumps of grass.
- ✓ The grasses grow luxuriantly over one metre high.
- ✓ Numerous broadleaved herbs were associated with them, providing flowery natural meadows in summer.
- ✓ Today, these are still found in the riverine zones such as the Dniester and Dnieper river bends in the former U.S.S.R.
- ✓ The dwarf, turf-forming grasses are dominant in the northern end of the Caspian Sea.
- ✓ A similar type of vegetation was indigenous in the lowlands of Manchuria (northern China).
- ✓ Today, short grass steppes are still very extensive in the eastern part of inner and outer Made Mongolia.

The Pampas of Argentina

Characteristics

- ✓ The Pampas of Argentina were predominantly grass covered.
- ✓ The Pampas are dominated by species of feather grass and melic which are similar to the tall prairies of North America.
- ✓ North of Buenos Aires along River Uruguay, however, are found forests of a considerable extent.
- ✓ The dominant species of the moist pampas were bunch grasses where a large percentage of the soil surface lay bare between individual tussocks.

- ✓ In lower areas south of Bahia Blanco in Argentina, there was grass but towards the north and the Andean foothills, xerophytic shrubs occurred.

The veld of South Africa

- ✓ The South African grasslands are known as the veld. These are confined to the eastern parts of South Africa interior.

Characteristics

- ✓ The grass here is fairly extensive with little or no mixture of trees or shrubs.
- ✓ Treelands are found on the 'Sand Veld' south of the Kalahari and Griqualand.
- ✓ The true grassveld in the eastern slopes of the high plateau of South Africa is dominated by the red oat grass which forms a level sward.
- ✓ Thus natural vegetation has however, been reduced to rangeland.
- ✓ Grass fires have destroyed the red oat grass and so the wire grass and blousaad grass are gradually becoming dominant.
- ✓ The two may oust the red oat grass completely in the long run.
- ✓ In better watered areas, taller grasses of Andropogon genus make a formation locally known as "Tambookie."
- ✓ The southern grasses are similar to the grass species in the savanna grasslands of the Eastern Africa with only a slight variation in species.

The Downs of Australia and New Zealand

- ✓ In Australia, a tree savannah belt extends to the coast of the south eastern part of the sub-continent.

Characteristics

- ✓ There are tall grasses dotted with isolated trees.
- ✓ The areas of shrub and semi-desert of western Victoria and Southern Australia have patches of dominant grass.
- ✓ Both mid-latitude and tropical species are represented in the Australian "savannas."
- ✓ These grasses in Australia are never nourishing pasture grasses and the ranching has been a consequent human activity.
- ✓ The Canterbury plains in the south islands of New Zealand have extensive grasslands.
- ✓ The grass is tussocky and very uniform in structure and appearance.

- ✓ Occasionally, this sea of waving bunch grass is dotted sparsely with cabbage trees, sedges and herbs due to micro-climates.
- ✓ Almost the whole of this grassland has been replaced by cultivated vegetation.
- ✓ Heavy grazing by rabbits and other domesticated animals has altered the vegetation immensely.

Arid Grasslands

- ✓ Thus is a grassland formation limited to sandy areas, salt pans and limestone areas in mid-latitudes areas.
- ✓ The lime-accumulating horizon is close to the surface.
- ✓ Since the rainfall is very low, a rock-like crust of the lime (CaCO_3) or gypsum (CaSO_4) called Caliche in North America and tosca in Argentina forms near the surface.
- ✓ In Russia where humus content is higher, such habitats are referred to as Solonchaks or Solonchaks.

Characteristics

- ✓ In the bog areas of Britain, heath is found where the dominant plants are present.
- ✓ The herbaceous dwarf shrubs, like the ling, occur in some parts while Blanket bog formations occur in Western Ireland.
- ✓ Bog moss is also dominant in N.W. Scotland.
- ✓ In wet bog areas, lofty hygrophytic and halophytic grasses grow.
- ✓ On the chalk areas of S.E. England, the calcareous heath occurs.
- ✓ The Mediterranean area around Mediterranean Sea and Chaparral in America, is dominated by shrubs, spiny plants which are near-leafless with leathery drought-resistance foliage known as maquis.
- ✓ Tropical species include the wild olive, the oak and the broom.

Montane Grasslands

- ✓ These grasslands occur on mountainous areas of the world.
- ✓ They are most extensive in places such as Sri Lanka, East Africa and Europe where the length of the growing period allows.

Characteristics

- ✓ They generally occur in irregular patches of grass.
- ✓ In higher latitudes, they are commonly found above the tree line where they grow and mature within a short vegetative period.
- ✓ On the Alpine mountains of Europe, they occur as rich grasses that form pastures which allows the farmers to practice transhumance.
- ✓ On East African mountains, these grasses occupy the mountain slopes up to 3,000m where the bamboo begin, to dominate.
- ✓ They form thick tufts of grass.
- ✓ In Sri Lanka where the grasslands are called Patana, they grow above 1,800m.

Desert Vegetation

There are two types of desert vegetation:

a.) Hot desert vegetation

b.) Cold desert vegetation

Hot Desert Vegetation

- ✓ Covers major tropical deserts such as the Sahara, Namib and Kalahari in Africa.
- ✓ The Arabian, Iranian and the deserts in Asia. Atacama and Chilean deserts in South America and Arizona and Mexican region in North America.

Characteristics

- i.) Scarse vegetation cover varying from short bushes to bare sandy grounds.
- ii.) Xerophytic plants of various types survive in this area. This plants are highly tolerant to drought and can survive in dry area
- iii.) Deciduous bushes and shrubs like acacia are common.
- iv.) Salt- tolerant plants called halophytes grow in areas with poor drainage, saline and alkaline soils.

- v.) Stomata of the leaves of these plants are protected from excessive exposure to evaporation by being sunk in pits below the level of the leaf surface.
- vi.) The reduction in the size and volume of leaves which in many deserts plants may be reduced to mere vestigial spines or scales.

Cold Desert Vegetation

- ✓ Cold deserts are found in polar regions and on extremely high mountains where it is very cold and frigid.
- ✓ It is arid because the water available to plant life is scarce due to freezing.
- ✓ Cold deserts of the world are most extensive in the Northern Hemisphere in Eurasia and North America on high latitudes (66.5 to 90N).
- ✓ This region is called the Arctic Tundra as it is close to the Arctic Circle and North pole.
- ✓ In the Southern Hemisphere, such vegetation is found in the Antarctica and sub-Antarctica tundra around the latitude 70 south.

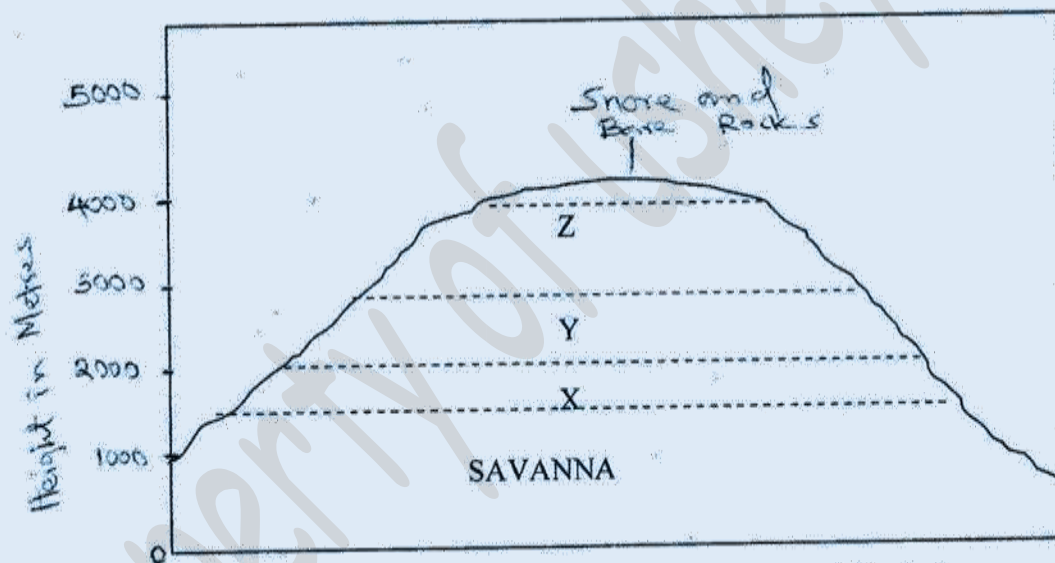
Alpine or Montane Vegetation

- ✓ On high mountains, vegetation varies with altitude, soils, aspect, shelter, winds and other local physical variations.

Characteristics

- ✓ Immediately below the snow line is a zone of alpine tundra vegetation.
- ✓ Below the alpine zone is the sub - alpine vegetation zone which gradually changes into the montane forests.
- ✓ Lower down, grasslands and even semi-deserts scrubs are found.
- ✓ The height of the snowline and therefore the tundra zone, on mountains varies with latitude.
- ✓ It is higher up the mountains in the hot - tropical region but lower down in temperate lands.

- ✓ In east Africa and Mexico, below the snowline is the alpine tundra vegetation which occurs at about 4500 metres above the sea level.
- ✓ Such alpine vegetation is found on mts Kilimanjaro, Meru, Kenya Aberdares and Elgon.
- ✓ This vegetation occurs at 3,600 metres in Western Himalayas, 3,000 metres in Sierra Nevada, 2,100 metres in the Swiss Alps and the Caucasus and at only 1,200 metres in Alaska.
- ✓ The variation is due to differences in latitude.



X - Rainforest

Y - Bamboo forest

Z - Heath and moorland

- ✓ On both mid-latitude and tropical mountains, below the snowline a tundra vegetation zone is well developed.
- ✓ The conditions and formations are very similar to those of the Arctic tundra.

- ✓ The zone changes into more luxuriant growth of forests then grasslands towards the base of the mountains especially in the tropics.
- ✓ For example, considering the favorable slope aspect of the high mountains in East Africa, it is possible to encounter vegetation types ranging from the rainforests right up to the tundra type from the mountain foot to the top.
- ✓ In North America, the rocky Mountains alpine formations is well developed.
- ✓ The species below the snowline are similar to those found in Canadian Arctic tundra.
- ✓ The leeward sides of mountain ranges have a poorer vegetation than the windward sides.
- ✓ The transitional zone of shelter on mountain slopes have transitional vegetation.
- ✓ For instance, the north facing slopes of the central Asian mountains contain richer alpine vegetation with cushion-like rosette plants along with alpine sedges and grasses.
- ✓ Alpine vegetation, especially in the tropical and mid-latitude areas, experience high light intensities with consequent day-time warming throughout the year.
- ✓ These characteristics explain more luxuriant forms such as tree heathers that are giant varieties of the dwarf counterparts in the arctic tundra. On undulating sections of mid-latitude high mountains, bogmoss dominates.
- ✓ In north west Scotland, the deer's hair grass, the ling, the bell-heather, bog myrtles rushes and sedges are found.
- ✓ Although the mountains of East Africa form a relatively small area, they support a wide range of world vegetation types.

Three main altitudinal belts have been distinguished:

- i.) The uppermost alpine belt, that is the tundra counterpart.
 - ii.) The sub-alpine ericaceous belt, that is the flower belt.
 - iii.) The forest belt which includes the mountain bamboo.
- ✓ The alpine belt and sub-alpine belts occur between 3,000m to 4,200m above sea level.
 - ✓ These include heath and moorland. Due to a wide diversity of conditions caused mainly by aspect, the alpine belt varies from short alpine grass such as alchemilla to stands of giant senecia and lobelia.

- ✓ The sub-alpine ericaceous belt below is dominated by heathers, for example, the tree heather and flowers. Tussock grasses are also found.
- ✓ In general, vegetation in this zone varies from mixed shrub and grass moorland to a dense growth of tree heather and from short Erica (flowers) heathland to thickets of up to 10 metres on wetter mountains such as Mt. Kenya, Aberdare and the Ruwenzoris.
- ✓ At about 3,000 metres on wetter mountains, the bamboo belt occurs. This may mix with other trees that become dominant lower down.
- ✓ Such forest trees become a dominant formation on the wetter lower slopes.
- ✓ The higher forest mountains include rain forests varieties such as the pencil and the dry cedar.
- ✓ The leeward lower slopes have grades of the savanna that become poorer to semi-desert scrubs, for example, the masai steppe on the slopes of Mt. Kilimanjaro.

Economic significance of Vegetation

- Medicinal value
- For aesthetic value/beauty
- Habitat for wild animals
- Sources of building /construction materials e.g timber
- Source of fodder/feeding of animals/food for man
- Control of soil erosion
- Influence of rainfall formation
- Source of raw materials for industries e.g pulp and paper industries
- Forests protect water catchments area

End of topic

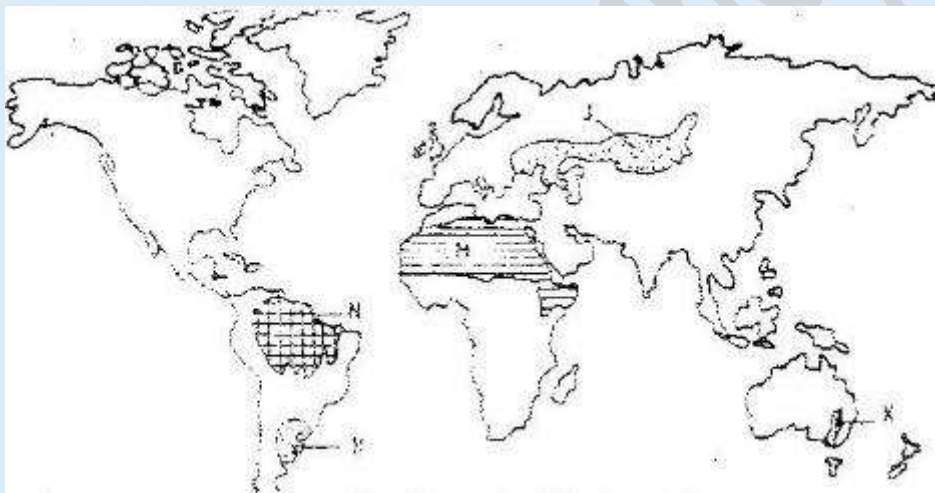
Did you understand everything?

If not ask a teacher, friends or anybody and make sure you understand before going to sleep!

Past KCSE Questions on the topic

1. The map below shows some vegetation regions of the world.

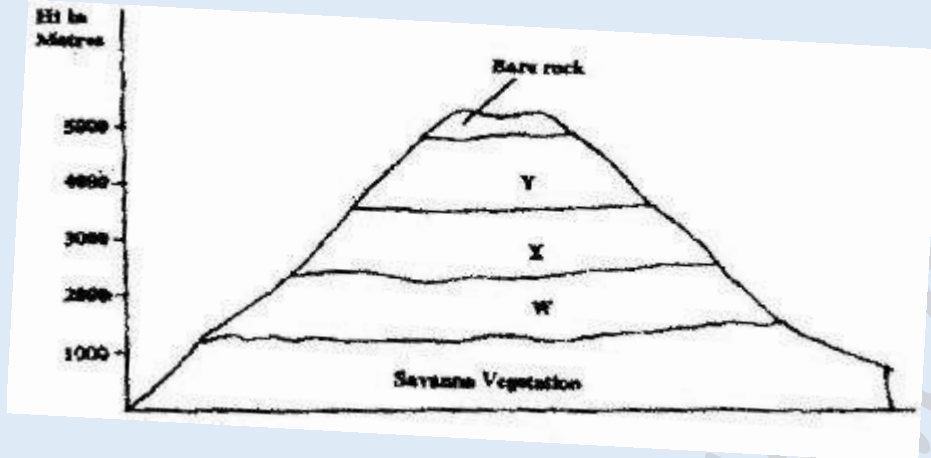
Use it to answer questions (a) to (c).



- a) Name the temperate grasslands marked H, J and K.
- b) Describe the characteristics of the natural vegetation found in the shaded area marked N.
- c) i) Explain four ways in which the vegetation found in the area marked M adapts to the environment conditions of the region.
- d) You are required to carry out a field study of the vegetation within the local environment:
- i) A part from identifying the different types of plants, state three

other activities you will carry out during the field study.

- ii) How will you identify the different types of plants?
- 2. The diagram below represents zones of natural vegetation on a mountain in Africa. Use it to answer question (a) (i) and (ii)



- a) (i) Name the vegetation zones marked W, X and Y. (3mks)
- (ii) Describe the characteristics of the savanna vegetation. (6mks)
- (iii) Name the temperate grasslands found in the following countries:
- Canada (1mk)
 - Russia (1mk)
 - Australia (1mk)
- b) Explain three causes of the decline of the areas under forest in Kenya. (6mks)
- c) You are supposed to carry out a field study on the uses of vegetation in the area your school.
- (i) State three reasons why it would be necessary to visit the area before the day of the study. (3mks)
- (ii) Give four uses of you are likely to identify during the study (4mks)
3. (a) What is a natural vegetation? (2mks)
- (b) State three characteristics of Mediterranean vegetation (3mks)

4. Explain three measures that the Kenyan government has taken to reduce the Decline of natural vegetation cover. (6mks)
5. How do the following factors influence distribution of vegetation in Kenya.
(i) Variation in rainfall
(ii) Variation of temperature
(iii) Variation of altitude/relief.
(iv) Aspect
(v) Soil
(vi) Human activities
(10mks)
6. State two reasons why mountain tops have no vegetation. (2mks)
7. Define vegetation. (2mks)
8. Name areas where coniferous forests are found. (3mks)
9. State characteristics of temperate grassland. (5mks)
10. Distinguish between secondary vegetation and planted vegetation.

CHAPTER THREE

Specific Objectives

By the end of the topic the learner should be able to:

- (a) Define forest and forestry;
- (b) Discuss the factors that influence the distribution and types of natural forests;
- (c) Discuss the significance of forests and forest products to Kenya;
- (d) Identify and explain the problems facing forestry in Kenya;
- (e) Discuss ways and means of managing and conserving forests in Kenya;
- (f) Compare and contrast softwood forests in Kenya and Canada;
- (g) Demonstrate the ability to manage and conserve forests and forest resources.

Content

- a.) Definition of forest and forestry.
- b.) Factors influencing the distribution and types of natural forests.
- c.) Importance of forests and forest products to Kenya.
- d.) Problems facing forestry in Kenya.
- e.) Management and conservation of forests - with specific emphasis on Kenya.
- f.) Related study on softwood in Kenya and Canada.

Definitions

Forest

- ✓ A forest is a continuous and extensive land covered with a closed stand of tall trees, usually of commercial value.

Forestry

- ✓ Is science of planting caring and using trees/forests and their associated resources or the practice of managing and using trees/ forests and their associated resources

Factors influencing the Distribution and types of Natural Forests

a.) Climate

- ✓ Very cold conditions discourage the growth of forests.
- ✓ In tropical areas where temperatures are high, forests grow faster than in temperate regions.
- ✓ Forests requires heavy precipitation throughout the year hence they will not grow in areas where precipitation and relative humidity are low.

b.) Altitude

- ✓ Altitude affects temperature and rainfall.
- ✓ Low tempreture results in slower forest growth and small size while high temperatures produce more luxuriant growth.
- ✓ With an increase in either latitude and altitude there is generally a decrease in the size, luxuriance and the rate of growth of forests.

c.) Soils

- ✓ Deep, well-drained and fertile soils supports plant life hence having variety or dense forest cover.

d.) Human activities

- ✓ Human have cleared forests to give room to farming and settlement.
- ✓ Some trees have been cut to provide timber for fuel and building materials.
- ✓ This has led to destruction of many forested areas.

e.) Topography

- ✓ Forests do not grow on steep mountains where the surface is bare rock, the soils are thin and temperatures are low.
- ✓ Windward slopes of high mountains like Kilimanjaro and Kenya usually receive higher rainfall amounts and therefore are forested.
- ✓ The leeward slopes are covered with scrub vegetation.

Types of Natural Forests and Their Distribution

The major natural forests of the world are:

- a.) Tropical hardwoods forests.
- b.) Temperate hardwood forests.
- c.) Coniferous forests.

Tropical hardwood forests

- ✓ They are part of the rain forests which occur in equatorial lands between latitudes 5° North and South of the equator.
- ✓ Examples are the African equatorial lands from Guinea to the Democratic Republic of Congo, Amazon Basin and South East Asia lowlands.
- ✓ The main hardwoods in West Africa are mahogany, iroko, sapele, ironwood, rosewood and ebony.
- ✓ Meru oak and elgon olive are hardwoods found in Kenya.

Characteristics

- ✓ The forests is evergreen because they have variety of species which shed their leaves at different times of the year.
- ✓ The trees are tall with straight smooth trunks and form extensive canopies.
- ✓ The trunks are large in size and bulky with protruding giant buttress roots, which make trees difficult to cut and hull.
- ✓ They take a very long time to mature compared to soft softwoods.

Temperate Hardwood Forest

- ✓ They mainly occur between latitudes 30° and 50° north of the equator.
- ✓ These include areas like the eastern part of North America, western, Southern and Central Europe, northern China, Japan, northern and Eastern Australia.
- ✓ Examples of temperate hardwoods include oak, beech, poplar, elm and ash.

Characteristics

- ✓ Trees are deciduous, that is they shed their leaves in autumn and remain leafless in winter.
- ✓ Have trees with broad leaves.
- ✓ The number of species per tree is less as compared to those in the tropics.
- ✓ Deciduous redwoods are durable and strong like tropical hardwoods, but are not so bulky and difficult to exploit as tropical hardwoods.

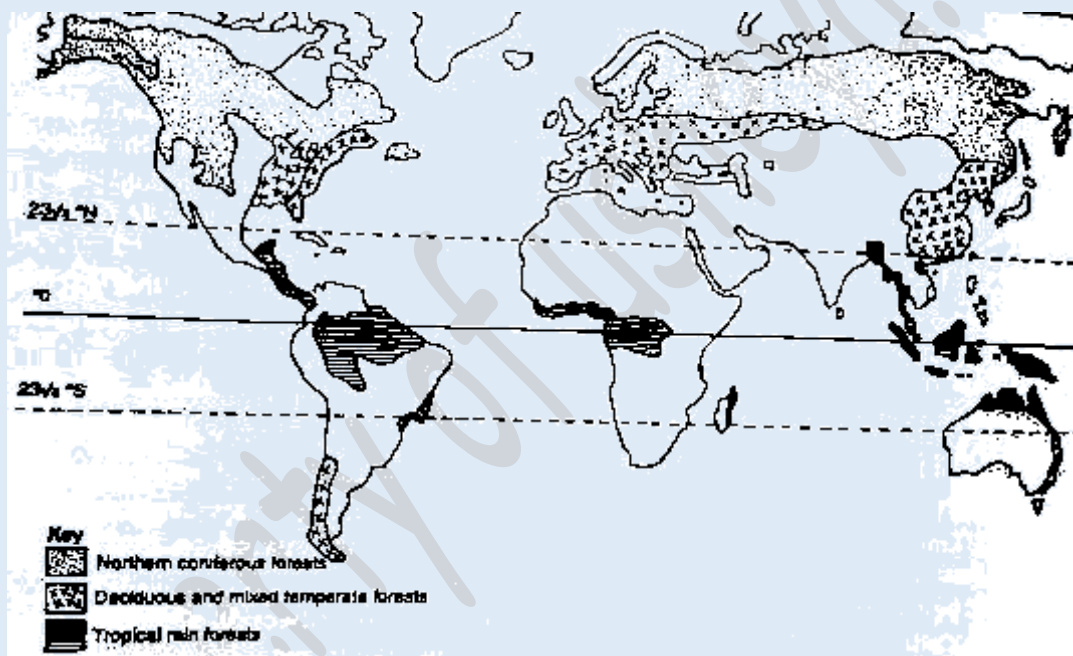
Coniferous Forest

- ✓ These forests are found between latitudes 50° to 70° North of the equator.
- ✓ Covers most of the Scandinavian countries, the northern part of the former U.S.S.R especially Siberia and the western, central and eastern parts of North America.
- ✓ The major species include pines, spruce and fir.
- ✓ They are mainly softwoods.

Characteristics

- ✓ Trees are light in weight.
- ✓ The trees are evergreen.
- ✓ The trees occur in pure stands.
- ✓ The trees are tall about 30 metres in height and have straight trunks.
- ✓ The trees have conical shape, which prevents accumulation of snow upon the branches, thus allowing snow to slide off easily to the ground.
- ✓ The trees have thick barks, which protects the trunks and branches from frost.
- ✓ The trees have hard needle-shaped leaves which help reduce evapotranspiration during the summer.
- ✓ Coniferous trees in temperate lands take a long time to mature because of the extreme cold conditions.

Distribution of world's natural forests



Note

Forests can be categorized as either **natural** (exists without the effort of man) or **planted** (created by man through Afforestation and Re-afforestation programmes).

Difference between Natural and Planted Forest

Natural Forests

- i. Has thick undergrowth
- ii. Trees are not in pure stand
i.e. trees are of mixed species
- iii. Trees grow close to each other
- iv. Trees are not taken care of
- v. Trees don't grow uniformly
i.e. mature at different times
- vi. Trees grow without a pattern
- vii. Timber exploitation is difficult due to dense undergrowth and inaccessibility

Planted Forest

- ☐ Little or no undergrowth
- ☐ Trees are in pure stand
- ☐ Trees are spaced
- ☐ Trees are taken care of
- ☐ Trees grow uniformly and mature at the same time
- ☐ Trees grow in a linear pattern
- ☐ Timber is easy to exploit.

Importance of Forest and Forest Products in Kenya

1. Protection of water resources - forests play a crucial role in protecting the catchments areas for rivers.
2. Modification of climate - Forests prevent excessive evaporation from bare ground and add moisture to the atmosphere by transpiration thereby creating a micro-climate through higher humidity and lower temperatures.

Trees also trap rain-bearing clouds making forested areas to receive higher precipitation amounts.

3. Forest break the speed of winds i.e. act as windbreakers. Trees are planted at the edge of farms for this reason.

4. Preservation of wild and indigenous genetic resources - Forests provide natural habitat for a wide range of wildlife thus aid in Biodiversity conservation.

5. Reduction of soil erosion - The forest canopy breaks the force of falling rain before it reaches the ground; trees roots bind soil particles preventing loss of soil through surface run-off. Also prevent siltation of rivers and water reservoirs thus assist in controlling floods.

6. Improvement of soil quality - The decaying leaf litter add humus to the soil thereby improves soil structure (water retention ability).

Other functions of forests are:

- ✓ Forests help in the purification of air.
- ✓ Forest are a source of wood fuel - Biomass.
- ✓ They are a source of industrial raw materials e.g. Pulp and paper; rubber latex, gums and resins (used in machine belting, electrical insulation and casing of golf balls); wax, cork, Tannin for leather tanning.
- ✓ Source of food - fruits and nuts root tubers.
- ✓ A wide variety of medicinal plants are found in the forest e.g. Cinchona tree for quinine.
- ✓ Forest are of aesthetic value and useful in recreation and tourism.
- ✓ Fibres production - many different kinds of fibre are gathered from forests are used in making of stiff brushes.
- ✓ Forests are used in scientific research.
- ✓ Honey - forests are ideal sites for bee keeping which is a source of revenue to the farmers.

- ✓ Help in preservation of cultural heritage (e.g. the Kenya shrines).
- ✓ Employment opportunities for those engaged in lumbering as well as exploitation of other forest resources, carpenters, forest guards and officers, timber merchants.
- ✓ Forests are a source of timber used in building and construction.
- ✓ Forest exploitation has stimulated development of infrastructure thereby open up such areas.

Primary forest resources that may be exploited

- i. Timber
- ii. Poles
- iii. Firewood
- iv. Grass
- v. Honey
- vi. Wax
- vii. Mushroom
- viii. Bamboo
- ix. Fruits and nuts
- x. Tubers
- xi. Resins
- xii. Gum
- xiii. Fibre
- xiv. Pulp and paper

- ✓ Wood products obtained from lumbering include; timber, bark, sawdust, plywood, fibre boards, pulp and paper.

Reasons why hardwood tree species in Kenya are in danger of extinction

- i. High demand for hardwood has led to over exploitation.
- ii. Population pressure on land has led to increased logging of trees to provide land for settlement and farming
- iii. Hardwoods take a long time to mature and this affects their regeneration after being exploited.

Problems facing the commercial exploitation of Tropical Rain forest in Africa.

(i) Species diversity

The trees rarely grow in pure stands of the same species. The occurrence of very many species make it difficult and expensive to locate the valuable species and to remove them from the forest once they have been cut.

(ii) Thick undergrowth

This creates a jungle environment which makes haulage of logs very difficult.

(iii) Inaccessibility

Some forests are located in remote areas with poor transport network. Numerous waterfalls along river courses make river transport impossible.

(iv) Existence of buttress roots

Makes the felling of trees bothersome.

(v) Harsh climate

The hot humid climate makes working conditions unfavorable. The heavy rainfall all year results in muddy roads which become impassable.

(vi) Habitats

Forests are habitats for dangerous wildlife, biting insects which discourage their exploitation.

(vii) Lack of capital

This makes the lumbermen to use poor techniques of extraction instead of modern methods.

(viii) Slow growth of trees

This makes replacement to take long time.

(ix) Less elastic demand for hardwood.

Tropical rainforests also face problems of pests and diseases, fire outbreaks and indiscriminate felling. This has led to a reduction in total land coverage as well as a decline in the quality of timber.

Stages of timber extraction from a natural forest.

- a.) Lumbering is the extraction of timber from forests for economic purpose.
- b.) Preparation - The area to be exploited is surveyed to locate the needed species.
 - Routes to these areas are planned and constructed to open up the forest.
 - Camps for the lumbermen are established
- c.) Felling - Trees are cut down by axes, power saws and the branches removed.
 - Trunks are then cut into suitable lengths.
- d.) Extraction - Logs are moved to collection points on the network access roads, water ways and rails. Logs are then transported to the mills.
- e.) Replanting - New seedlings are planted in places of felled ones to ensure forest regeneration.

Note

Order should be sequential.

Problems facing Forestry in Kenya

- (i) Encroachment due to population pressure and need for more land for settlement and farming.

(ii) Pests and diseases e.g. Aphids outbreak (1990's) destroyed large areas of cypress forests.

(iii) Forest fires especially during the dry season destroy bamboo and conifers which ignite easily.

(iv) Game damage - Increasing population of grazers such as elephants, overgrazing by wild animals cause damage to young forest trees.

(v) Over exploitation through logging, charcoal burning, wood fuel lead to scarcity of forest products.

(vi) Excisions refer to the allocation and conversion of forest land into private land. Tracts of land have been excised to create room for agricultural show grounds and Nyayo Tea Zones.

(vii) Poor management of forest resources for example delay in replanting trees after logging leads to harvesting of immature trees or may necessitate importation of timber and other forest products. Kenya Power and Lighting Company imports poles from Tanzania.

Measures being taken to conserve forest in Kenya

- ✓ Forest management refers to the effective planning and control of forests and forest resources.
- ✓ Forest conservation - refers to the protection of forests against interference and destruction by people.

Forest may be conserved by the followed measures.

- i. **Afforestation** is the planting of trees in order to establish a forest where none existed before.

Afforestation is encouraged in Kenya for the following reasons;

- To ensure continuous supply of wood fuel, timber and raw material for pulp and paper industry.

- To reduce importation of forest products hence save foreign exchange expenditure.
- To expand the habitat for wildlife.
- To create scenic beauty for recreation and tourism
- To protect the water catchments areas hence maintain hydrological cycle.
- To create micro-climates
- To prevent soil erosion
- To create employment opportunities

- ii. **Re-afforestation** - refers to the planting of trees in areas where forests have been cleared e.g. Abardares, Ngong, Kabarnet, and Mt. Kenya.
- iii. **Setting up of Nyayo Tea Zones** - begun in the 1990's where edges of some forests were cleared and tuned into tea plantation.

Aims

(i) To create a kind of protective buffer belt between the settled area and the forest. The zone made it difficult for people to cross the tea zone in order to reach the forest as this amounted to trespass.

(ii) Discourage squatters and neighboring communities from encroaching on the forests.

(iii) Alleviate poverty by providing employment to the local communities.

- iv. **Legislation** - e.g. The forest Bill 2000 required private energy generation companies to invest in forest conservation since they benefit from forest resources.

- v. **Creation of forest Reserves** - The government has gazetted some forests and neighboring areas as forest reserve e.g. in Mau, Aberdares, Arabuko Sokoke.

vi. Community Participation

- ✓ Certain communities use forest as their Shrines e.g. the Kaya forest of the Kenyan coast.
- ✓ Certain traditional cultural practices assist in forest conservation e.g. taboos on some forest products.
- ✓ The shamba system seeks to involve landless communities in forest conservation. They provide unskilled labor in the tree plantation and in return are allowed to interplant the trees with food crops. As they tender for their crops the trees are also taken care of. The community is also allowed to utilize some forest products e.g. Honey Butterfly farming in Arabuko Sokoke.

Shortcomings of the shamba system afforestation program in Kenya

- It encourages arbitrary cutting/uprooting of trees.
- Leads to interference of forestland by human settlements/squatters.
- Leads to poaching of forest products by farmers.
- Leads to browsing of young trees by domestic animals
- Leads to competition for soil nutrients between trees and crops.
- Encourages planting of illegal crops e.g. bhang.

Forest management measures

1. Public awareness/campaign on the importance of forest through mass media, spear headed by Green Belt Movement, NGOs, UNEP, UN- Habitat etc.

2. Forest research stations have been established to intensify research on soil requirements for different species of trees as well as ways of controlling pests and diseases e.g. ICRAF - International Centre for Research in Agro forestry.

3. Establishment of forest training school at Londiani and Department of Forestry at Moi University to oversee forest management and conservation.

4. Introduction of faster maturing trees of high commercial value e.g. Eucalyptus, Pines, and Cypress.

5. Reduction of wastage of forest resources by encouraging recycling of forest products.

6. Forest protection by employment of forest guards who patrol the forests to keep off illegal loggers.

7. The government has slapped a total ban on logging in indigenous forests.

8. Kenyans are being encouraged to use alternative sources of energy e.g. solar, biogas and energy saving jikos to ease pressure on forests for wood fuel. Zero rating tax on cooking gas is a step in the right direction.

9. Attempts to improve tree-cutting practices through selective harvesting and rotational felling of trees followed by replanting National tree planting day.

What is Agro Forestry?

- ✓ This refers to a tropical land use system involving the mixture of tree planting, crop growing and livestock rearing on the same piece of land simultaneously.
- ✓ Benefits of Agro-forestry. The practice of Agro-forestry was started in the 1970's due to the following benefits.
 - i. It maximizes the use of land.
 - ii. It is a sustainable source of biomass (charcoal and firewood).
 - iii. Trees create a micro-climate within the farm.
 - iv. Some agro-forestry trees are of medicinal value.
 - v. Tree products such as fruits, poles, timber etc. are used or can be sold to earn income to the farmer.
 - vi. Livestock dung increases soil fertility.
 - vii. The leaves and pods of some trees are used as animal fodder as they are rich in fat, protein etc.
 - viii. Leaf litter adds organic material and minerals to the soil.
 - ix. The trees increase soil water retention thus reduce soil erosion.

Characteristics of trees for Agro forestry

- The tree should be fast growing/maturing.
- Tree should yield good quality timber
- Tree leaves and pods should be palatable and nutritious so as to provide fodder.
- It should be fruit bearing.
- Tree should have nitrogen fixing abilities
- Tree should be deep rooted to allow weeding of the food crops and limit competition for soil nutrients
- It should be thorn less.

- ✓ Examples of trees are- calliandra colothyrsus, acacia mellifera, sesbania sesba, terminalia brownii, adansonia digitata

Factors that have favored the establishment of softwood forests in Kenya Highlands.

- (i) The Kenya highlands experience a cool climate which enables conifers to flourish. Absence of severe winters ensures tree growth all year round.
- (ii) The highlands receive heavy rainfall of over 1000mm.
- (iii) Some parts of Kenya highlands are rugged and steep. Such areas discourage settlement and agriculture leaving the forest to flourish.
- (iv) High demand for timber and wood products in the country encourages tree farming.
- (v) Kenya highlands have fertile acidic volcanic soils.
- (vi) Availability of cheap and ample labor.
- (vii) Hydroelectric power is readily available to the few sawmills and paper factory in Webuye.
- (viii) The government's efforts to create forests through implementation of afforestation and re-afforestation programmes.

Major lumbering areas in Canada

- Newfoundland
- Nova Scotia
- Quebec
- New Brunswick
- Prince Edward Island
- Ontario
- British Columbia

Explain five factors favouring forestry in Canada

- (i) The low temperature experienced discouraged settlement and other forms of land use, leaving forestry as the alternative economic land use. Conifers thrive in the long severe winters (-25°C).
- (ii) The ruggedness of the landscape and thin soil discourage agricultural leaving forest to thrive.
- (iii) Availability of large expanses of land owing to the low population density.
- (iv) Heavy rainfall on the windward slopes of the mountain ranges encourages growth of conifers.
- (v) The valley bottoms along the coast provide good sites for paper mills and clay used in smoothening the paper surface.
- (vi) There are many waterfalls used to generate hydro-electric power for use in the paper mills.
- (vii) Coastal location favors exportation of timber products (sawn timber, veneers, pulp, newsprint). Major timber exporting ports are Vancouver, Halifax, Quebec and Prince Rupert.
- (viii) The numerous rivers provide cheap transport system, and water for timber processing.
- (ix) There's ready market in Canada and abroad for forest products especially pulp and newsprint.

Highlight four problems facing forestry in Canada

- (i) Periodic forest fires destroy large areas of forests.
- (ii) Pests and diseases attack (Aphids) also destroy forests
- (iii) The forests in northern parts are not accessible in winter because of snow.
- (iv) The harsh, cold conditions do not allow trees to mature quickly. This slow growth had led to overexploitation.

(v) The north has a rugged terrain which hinders its accessibility.

Importance of Lumbering in Canada

- i. Lumbering provides employment opportunities e.g. tree farmers, lumber jerks as well as worker in related industries.
- ii. Exports of forest products earn foreign exchange.
- iii. It has stimulated the improvement of infrastructure to open up the country.
- iv. It has led to the establishment of many pulp and paper factories.

Characteristics of soft wood forests in Canada

- Evergreen trees characterized by narrow, needle-like leaves.
- There's little undergrowth in these forests
- Trees have conical shape
- Trees have shallow roots
- Trees species occur in pure stands
- Trees have straight trunks
- Trees have thick barks with a lot of resin.
- Trees take a long time to mature (50-70 years)
- Trees are tall and close to each other.

Major tree species

Pines, Larch, Red Spruce, Balsam Fir, Hem lock, Parana, Douglas fir.

Uses of conifers

Pulp and paper making, Furniture, synthetic e.g. rayon, acetate

Economic uses of the bark of trees

- i. Source of latex
- ii. Source of Tannin used in leather processing
- iii. Gums used in making chewing gums
- iv. Cork used to close bottles
- v. Resins
- vi. Have medicinal value

Compare forestry in Kenya and
Canada

Canada

Kenya

There are both exotic and indigenous
softwoods

Main trees are indigenous

Little undergrowth

Forests have dense underground

Forests are mainly planted

Mainly natural

Forest are in the highland only do not
grow in areas beyond 3000m a.s.l

Forests extend from the foot of the
mountain to their summits

Trees grow faster due to high
temperatures

Slow growth due to low

Another way of comparing Softwood Forests in Kenya and Canada Under sub topics

i. Growth

- Several unites in Canada show down growth of trees hence take long to mature

while in Kenya trees mature faster due to cool climates in the highlands.

ii. Harvesting

- In Canada harvesting is done through clear cutting while in Kenya selective cutting is used.
- In Canada harvesting is done in summer while in Kenya it takes place throughout
- In both cases machines are used for logging. 2mks

iii. Marketing

- Most of Canada's wood products are exported to USA/ Britain/ Europe while wood products in Kenya are sold locally with few being exported to USA and Europe.

iv. Transportation

- Transportation of logs in Kenya is done using tractors, lorries, trucks and trains while in Canada, it is done using mobile cable steel bars, skiing on ice-covered ground and also floating down rivers.

v. Distribution

- In Kenya, softwood forests are found mainly in the highlands while in Canada they are found both in highland and lowland areas. In Kenya softwood forests cover a small percentage of the total land area while in Canada they cover large tracts of land.

vi. Climate:

- In Canada, due to low temperatures, softwood tree species take many years to mature while in Kenya, moderate to high temperature encourages faster growth and maturity to take short time/few years.

End of topic

Did you understand everything?

If not ask a teacher, friends or anybody and make sure you understand before going to sleep!

Past KCSE Questions on the topic

1. a) i) What is forestry? (2mks)
ii) Explain three factors that favour the growth of natural forests on the slopes of Mt. Kenya. (6mks)
iii) State five factors that have led to the reduction of the area under forest on the slopes of Mt Kenya. (5mks)
b) Explain four measures that the government of Kenya is taking to conserve forests in the country. (8mks)
c) Give the differences in the exploitation of softwood forests in Kenya and Canada under the following sub-headings;
i) Period of harvesting; (2mks)
ii) Transportation (2mks)
2. Explain factors favouring forestry in Canada
3. List two species of indigenous hardwood forest trees in Kenya. (2mks)
4. Name two industries associated with forestry. (2mks)
5. Explain three measures being undertaken to conserve forests in Kenya. (6mks)
6. Explain four problems that are being experienced in exploitation of hardwood forests in Kenya. (8mks)
7. Explain three reasons why only a small part of Kenya is forested. (6mks)
8. Outline three consequences of forest depletion in Kenya. (3mks)
9. State the factors favouring forestry in Kenya. (8mks)
10. Name four secondary products of forests. (4mks)
11. List eight major indigenous tree species in West Africa. (8mks)

12. (a) Define agro-forestry. (1mk)
- (b) Outline four benefits of agro-forestry (4mks)

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