DRAINAGE PATTERNS

Drainage pattern refers to the physical lay out of a river and its tributaries on the earth's surface.

The main types of drainage patterns in East Africa are controlled by;-

- ✓ Slope of the land scape.
- ✓ Differences in rock hardness over which the river may be flowing.
- ✓ Structure of the rock as it may be determined by different geomorphic processes.
- ✓ Climatic factors and earth movements.

There are **two** bread groups of drainage patterns namely; ***accordant and discordant drainage patterns.***

Accordant drainage patterns is the one where the drainage is related to the structure of the rock eg dendritic, trellis, annular etc

While discordant is the drainage pattern which does not show any relationship between the river system and the structure of the rock and relief eg super-imposed drainage pattern.

The distractive drainage patterns in East Africa include;

(a) ACCORDAND DRAINAGE PATTERNS

- ✓ **Dendritic drainage pattern**

  Is the one whose structure is shaped like a tree trunk and the branches of the tree or the structure of a leaf and its veins.

  The tributaries converge on the main stream from many directions at a cute angles eg rivers Panagani, Rufigi, Ruizi, Tana, Congo, Wankaw on the cape coast of Ghana, Victoria Nile, Malagalasi, Ruvuma, Nyando, Nzoia etc.

CONDITIONS FOR THE DEVELOPMENT OF DENDRITIC DRAINAGE PATTERN

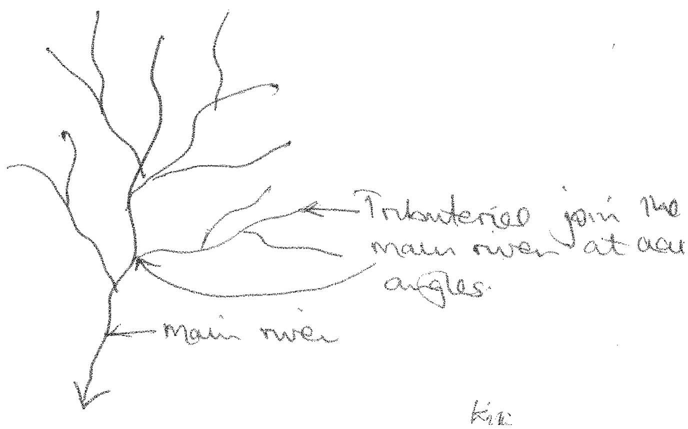
- ✓ It develops in a region which is made of homogeneous crystalline (igneous) rocks which offer the same resistance to erosion and which have a uniform structure.
- ✓ It develops on gently dipping / sloping land scape and this determines the direction of the river and its tributaries.

- ✓ Each tributary flows in a valley proportional to its size or volume of water and maintains its flow.

- ✓ It develops in regions which receive heavy rainfall which is reliable. That is why it is most prominent in the equatorial / tropical regions where there is heavy and reliable rain fall to support the multiple tributaries.

- ✓ It develops in a common large catchment area. The multiple tributaries cover at a large catchment area.

Diagram



- ✓ **Radial drainage pattern**
  This one develops on a dome on volcanic cone. The rivers flow outwards forming a pattern like the spokes of a wheel eg Mt. Elgon with rivers like Siroko, Siti, Koitobosi, Mara, Manafa, Nzoia and Mountains Meru and Kilimanjaro areas where the tributaries of R. Tsavo and Ruvu form a radial pattern and on Mt. Rwenzori where rivers Mobuku, Nyamugasani, Nyamwamba, Mugusu, Lume, Ruanoli etc originate.

CONDITIONS WHICH FAVOUR DEVELOPMENT OF RADIAL DRAINAGE PATTERN

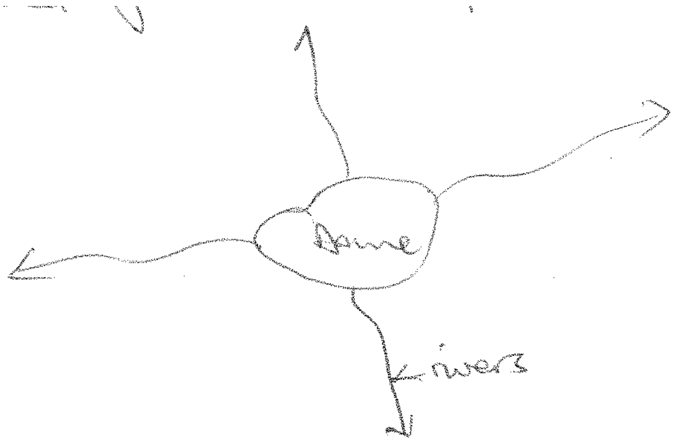
- ✓ Presence of a dome or cone shaped highlands such as a volcanic cone / mountain or highlands which provide the source of the rivers.

- ✓ Presence of steep slopes which accelerates down ward movement and erosion of the rocks to create channels along which rivers flow.

- ✓ It develops in areas of homogeneous and crystalline (igneous) rocks which offer the same resistance to erosion. This enables the rivers to erode on any side of the mountain. Thus the development of a radial pattern.

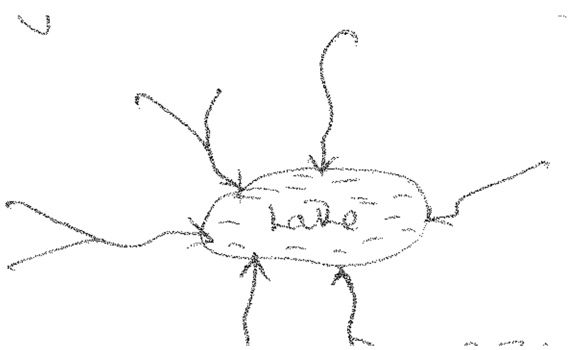
- ✓ High precipitation in the catchment area inform of rain fall, snow or the melting of glaciers which provide a continuous supply of water needed for the development of rivers.

Diagram



CENTRIPETAL DRAINAGE PATTERN

This is a pattern characterized by a large number of rivers from different directions converging onto a common point. It is commonly formed in areas of in land drainage eg around L.Victoria where rivers Katonga, Kagera, Nzoia and Sio flow and L.Baringo where rivers like Loboit, Ol mukutani, Ol Arabel and Malo converage.



CONDITIONS FOR ITS DEVELOPMENT

- ✓ Basin landscape on valley which could be formed by warping like the case of L.Victoria or faulting line in the case of L. Baringo. Such basins accelerate or steepen the gradient of the adjacent rivers which then undertake head-ward erosion towards common point.
- ✓ Heavy rain falls to support the multiple rivers flowing towards the common point.
- ✓ Develops in regions which offer equal resistance to erosion. Generally soft rocks favour the development of the river through head ward erosion.

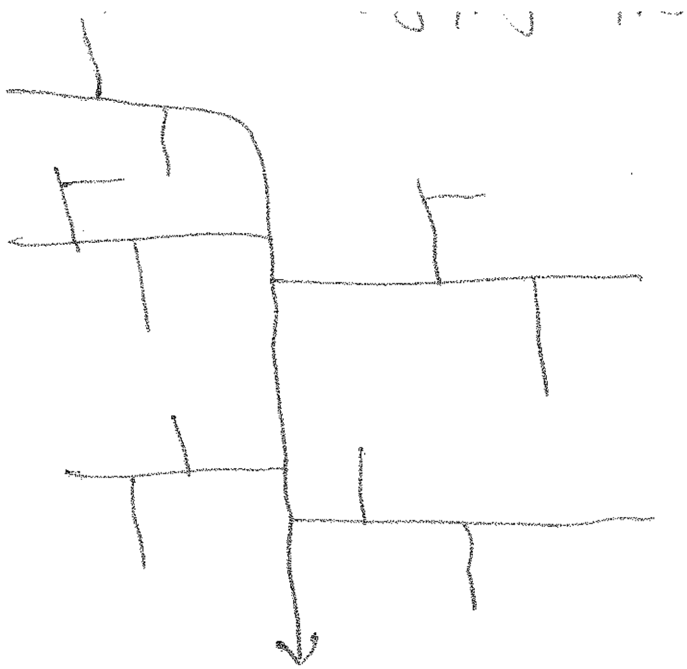
TRELLIS DRAINAGE PATTERN

It develops in areas made up alternating belts of hard and soft lakes where all dip in the same direction and which lie at right angles to the general slope down which the principal (consequent) river flows.

The tributaries (subsequent) extend their valleys by head ward erosion into the weak rocks which are turned into wide valleys called **vales** and the hard rocks stand up as escarpments.

Trellis pattern also occurs in areas that have been affected by faulting eg R. Kerio in Kenya and R. Mayanja with tributaries Kato, Wasswa, R. Aworanga, Pager, Aswa, Tiva and Galano.

Diagram



CONDITIONS FOR THE FORMATION OF TRELLIS DRAINAGE PATTERN

- ✓ Develops in areas of heterogeneous rocks ie areas with both soft and hard rocks.
- ✓ It develops also in areas of jointed rocks due to faulting.
- ✓ Heavy and reliable rainfall to support development of consequent and subsequent rivers which constitute to the drainage pattern.
- ✓ Cover a large catchment area with reliable rainfall since the streams are widely spaced.
- ✓ May also develop due to river capture eg along river Tiva, Galana, Aswa, Tochi, pager etc.

RECTANGULAR DRAINAGE PATTERN

This is a pattern which displays a rectangular shape with tributaries joining the main stream at approximately right angles (90^0) eg R. Mayanja- Kato, Wasswa.

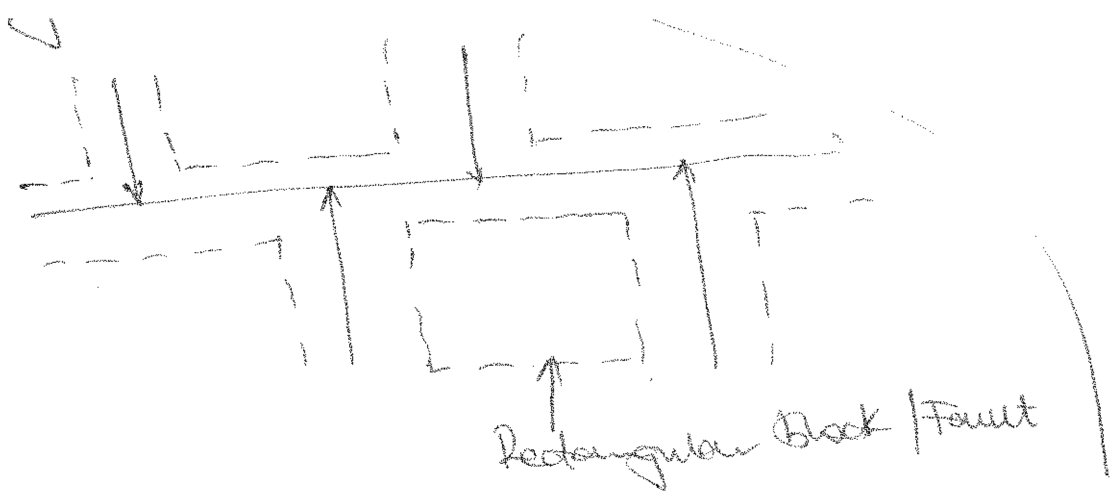
It develops in areas which have been affected by earth movements and where the faults intersects each other almost at right angles.
Streams may develop along such faults and such streams will therefore be fault guided and all will acquire a rectangular pattern eg R.Aswa, Tochi, Awovanga and pager.

CONDITIONS FOR ITS DEVELOPMENT

- ✓ Areas must be receiving ample reliable rainfall to maintain the flow of streams to complete the patterns.

- ✓ Structural control with streams following joints or fault lines in the rocks ie faulting influences rectangular drainage pattern development.

Diagram

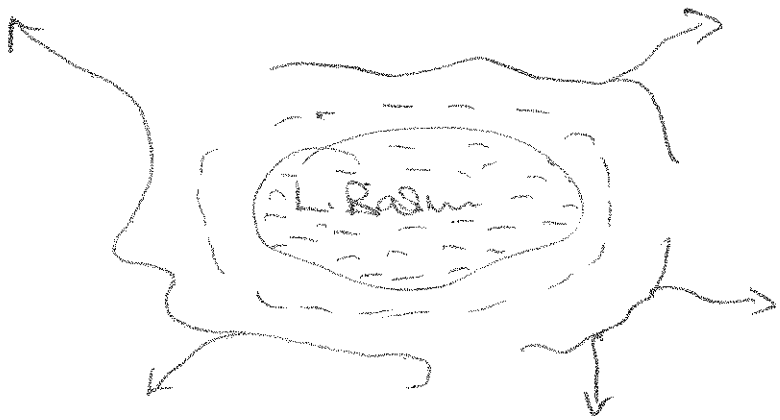


ANNULAR DRAINAGE PATTERN

Is a pattern where tributaries join the main stream at sharp angles but in a series of curves.

It develops in volcanic regions where rivers flow sharply in a series of curves around craters or calderas eg around Ngorongoro caldera.

Diagram



CONDITIONS FOR ITS DEVELOPMENT

- ✓ It develops on a dissected dome / upland with alternating hard and soft rock which favours its development where streams erode valleys in less resistant strait.
- ✓ Presence of heavy rainfall to supply water to the flowing streams.
- ✓ Rivers must flow in concentric curves conforming to the weaker rock out crops and flow outwards eg around L. Bosumutwi in Ghana where rivers Banko and Buonim flow in concentric curves.

PARALLEL DRAINAGE PATTERN

This is a pattern where streams and their tributaries flow parallel to one another on side by side down slopes eg rivers on Mt. Rwenzori, R. Nkusi and R. Hoima flow parallel to each other on Butiaba escarpment before joining L. Albert, and west of Mau ranges, where tributaries of river Athi such as R. Nairobi, Thirika, Komu and Ruiru flow parallel to each other and rivers flowing from Mt. Muhawula.

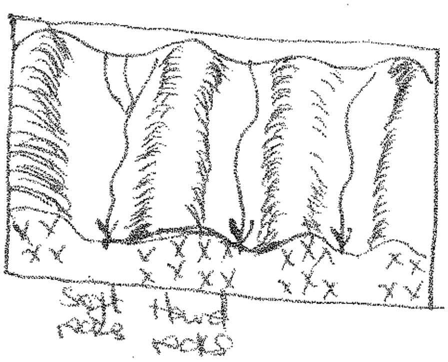
CONDITIONS FOR ITS DEVELOPMENT

- ✓ Develops in areas of alternating bands of soft and hard rocks. Soft rocks are eroded to form the river channel while the hard rocks resist erosion to form a divide which limit chances of adjacent rivers joining each other.
- ✓ Rivers flow in the same direction each forming its channel through hardward erosion of the soft rocks.
- ✓ Pronounced divides made up hard resistant rocks between the rivers limits the chances that the rivers could join each other.

- ✓ It also develops in faulted regions in that rivers tend to flow by eroding through the lines of weakness (fault lines) created by earth movements.

- ✓ Reliable rainfall and a large catchment basin important to sustain the existence of the river.

Diagram

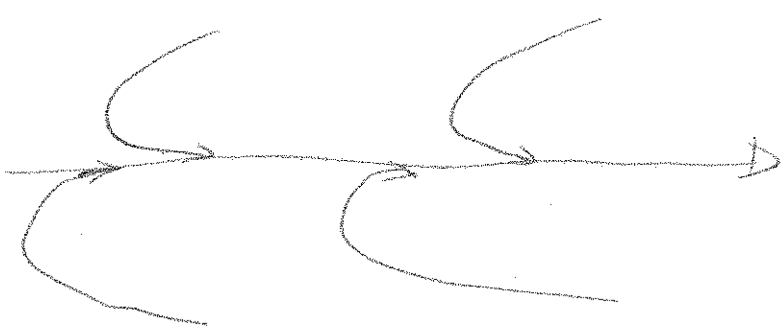


BARBED OR HOOKED DRAINAGE PATTERN

Is the one where tributaries of a river join the main stream at angles contrary to the original flow of tributaries ie at acute angles.

It develops on rivers whose direction of flow has been reversed due to warping on one side and uplifting on the other eg R.Ruizi, Kagera, Kafu, Katonga all of which are reversed rivers.

Diagram



CONDITIONS FOR ITS DEVELOPMENT

- ✓ Existence of alternating dips of slope. The rivers joining the main rivers originated from a higher point opposite to the source of the main river. After the change in gradient as a result of the uplift in the direction of the main river, the joining rivers reverse to join the main river because they fail to climb or erode through the steep gradient created a head of them.

- ✓ River capture where a strong river diverts the waters of a weaker stream into its system.

- ✓ A big catchment area and reliable rainfall.

BRAIDED DRAINAGE PATTERN

This is found or formed in flood plains of a river where the energy of the river to transport sediments is considerably reduced and the river is forced to drop some of its lead along its channel / course dividing it into several channels eg the lower parts of the Nile, Kilombero, Rufigi, Mkomanzi.

CONDITIONS FOR ITS DEVELOPMENT

- ✓ Reduced energy of the river to transport sediments.
- ✓ Reduced gradient.
- ✓ High competence of the river to erode in the upper and muddle course of the river. Hence carrying a large load.

Discordant /obsequent drainage pattern

Super imposed drainage pattern
Is the one where rocks on which the river was initially flowing has been worn away and the river is now flowing over older and different land scapes to which the river is not adjusted or related.

If the drainage pattern from above is maintained and is not affected by the structures of the current exposed older rocks, then, it is super imposed eg R. Zambezi was super imposed on the Karro rock sediments R. Nile at Sabaloko in Sudan.

Conditions for its development

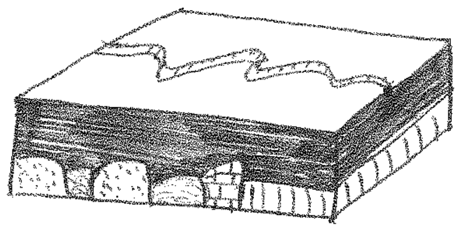
- ✓ It develops where there is no direct relationship between the river and the rocks upon which the pattern is flowing.

- ✓ When the drainage pattern / river is energetic enough to erode or under cut far deeper and reach new rock structures.

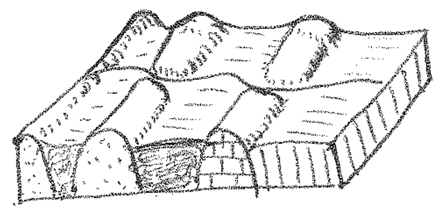
- ✓ When the river is able to maintain its drainage pattern, original course and direction on the new rock structure.

- ✓ When the original rock onto which the river originally developed were soft and therefore, highly eroded through down cutting / incision to reach the new set of rocks down wards.

Diagrams



Bef the removal of the cover rocks.



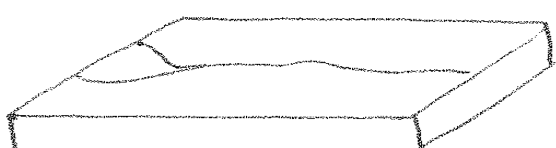
After the removal of the cover rocks

1. **Antecedent drainage pattern**.
   Is another type of discordant type /pattern. They are common in areas where uplifting took place slowly enough for the river to maintain its down cutting and where there has been insufficient time for the drainage to become completely adjusted to the structure.

   Their formation involves an uplift of land within the river course. As the uplift occurs, the river maintains its course by down cutting at a rate balanced by the rate of uplift.

   Therefore, the rate of uplift should be slow enough to allow a river to maintain its course through vertical erosion.
   Thus creating a deep gorge within the uplifted region eg along R. Ruaha in the irringa highlands of Tanzania and the Lukuga river which flows into the Zaire basin.

   Diagrams



Before uplift

After uplift by faulting

SOILS

Soil is a natural body made up of weathered rock particles and decayed plants and animals tissues existing as a thin layer covering the earth's surface.

It is composed of mineral particles, air, water, living organisms and weathered rock particles. Soils are formed by the process known as weathering.

There are various soil types e.g. loam soils, sand soils, clay and pod soils.

FACTORS THAT INFLUENCE SOIL FORMATION

(1) CLIMATE

It influences soil formation through its elements of temperature and rainfall. Its importance lies in its control of the rate and nature of weathering.

Equatorial climatic conditions. The hot temperatures and heavy rainfall, accelerates chemical weathering resulting into the formation of mature deep and fertile soil. The presence of water also leads to leaching and evluviation leading to the development of mature fertile soils in well-developed soil profiles e.g. along shores of L. Victoria.

Tropical climatic conditions of alternate wet and dry conditions accompanied by warm temperatures lead to the formation of lateritic soils through the process of leaching leading to undeveloped soil profiles. During the dry season, physical weathering operates leading to the formation of regolith with undeveloped soil profile.

In wet seasons, chemical weathering occurs leading to developed soil profile.

Temperate and polar climatic conditions. The cold temperatures and less rainfall have resulted into less intensity of weathering and soil formation processes are very low in such areas. They have thin stony soils, in undeveloped soil profile.

Arid and semi-arid areas. The very hot temperatures of above 30^{o}C and absence of rainfall in semi-arid areas like Karamoja and Northern Kenya lead to slow process of soil formation e.g. red desert soils are thin, sandy and have a high salty content due to increased evaporation, limited leaching resulting in undeveloped soil profile.

The hotter and dry conditions result into high evaporation rates high capillary attraction, leading to the formation of alkaline soils which are shallow, poor with undeveloped soil profile.

Climate influences soil formation in the following ways:-

It influences the rate of gradual breakdown into increasingly small particles until soil is formed by dissolving salt.

In areas where rainfalls with great intensity. It results into a beating action on the rocks especially where the ground is bare. It erodes the surface and removes the particles from one locality to another and depth through erosion and leaching by rain. This lead to the formation of different soil types.

The hot temperatures and heavy rainfall increases the rate of decay and decomposition of plant and animal materials which provide humus to the broken down rocks to form mature fertile soils in well-developed soil profiles.

Temperatures also influence the growth of bacteria which decomposes the dead matter into humus which makes the soils fertile when added to the broken down particles thus formation of well-developed soil profiles.

Climate also influences vegetation cover growth indirectly as an important element in soil formation which decomposes into humus forming mature well developed soils.

(2) PARENT ROCK

This refers to the material that breaks down to form soil particles by mechanical and chemical means. Rocks differ in many ways and influence soil formation in different ways:

(i) Rock resistance

Soft rocks containing mica minerals e.g. limestone are weathered easily and this accelerates the rate of soil formation, forming deep fertile soils in a well-developed soil profile. Hard and resistant rocks limit the rate of weathering resulting into the formation of thin skeletal soils in undeveloped immature soil profile.

(ii) Mineralogical compositions. This is where the mineral matter of the soil is derived from. This determines;

- The nature and fertility of soils e.g. rocks of volcanic origin weather into fertile soils which are deep and well-developed.
- Quartz forms grains which are resistant to chemical weathering, forming sandy soils in undeveloped soil profiles. Ferricate, rich in iron tend to be dark coloured and therefore weather to produce soils which are well-developed in well-developed soil profiles.

(iii) Age of the rock

Rocks of recent formation don’t weather into well-developed soils. They form thin stony soils with underdeveloped soil profiles. Whereas old rocks weather into well-developed soils because of being exposed to soil formation process for a long period of time. Thus development of mature soil profiles.

(iv) Rock jointing

Well jointed rocks allow easy penetration of water and gases thus accelerating the rate of chemical weathering, forming deep mature soils in well-developed soil profiles.

Unjointed rocks are not easily broken down so they produce thin immature soils in undeveloped soil profiles.

(v) Rock colour

Dark coloured rocks absorb a lot of heat hence easily weathered forming deep well-developed soils in well-developed mature soil profile. Brightly coloured rocks like limestone reflect heat and don't absorb it hence making it difficult for them to be broken, leading to the formation of thin immature soils in undeveloped immature profiles.

(vi) Basic igneous rocks and sedimentary rocks are hard to break down they produce shallow immature soils in immature undeveloped soil profiles.

(vii) Rock permeability

Permeable rocks allow water to percolate, leading to deed chemical weathering, thus forming deep mature soils and form a well-developed soil profile. Impermeable rocks don't allow water to enter them, thus reducing the rate of their breakdown thus forming immature soils in undeveloped soil profile.

(3) VEGETATION

The nature of vegetation influences soil formation in the following ways:-

(i) It produces hums compounds which make up soil. Tropical forests therefore produce a lot of humus derived from the decay of leaves.

(ii) It also determines the amount of water which is retained which in turn determines the rate of weathering. Tropical rainforests retain more moisture.

(iii) The vegetation helps to maintain the soils from soil erosion and deep soils form because the weathered materials are not washed away.

(v) Where vegetation is scanty, soils are eroded resulting into the formation of thin soils in undeveloped immature soil profile.

(vi) Vegetation roots also lead to the disintegration and formation of deep mature soils. Forested areas therefore tend to have deeper soils in well-developed soil profiles while areas with thin vegetation have thin skeletal soils and poorly developed profiles.

(4) LIVING ORGANISMS

The influence of living organisms is largely mechanical. Earth worms, termites e.t.c contribute to soil formation through changing the texture as they make passages through the rocks leading to formation of deep soils with developed soil profile.

(i) Burrowing animals like wild pigs, chum up rock fragments thus improving aeration and drainage which promotes weathering and soil formation, thus forming deep mature soils in a well-developed soil profile.

(ii) Man's influence on soil formation through practices like agricultural road construction, quarrying e.t.c. all these lead to breakdown of rocks and formation of deep fertile soils thus forming deep mature soils in well-developed soil profile.

(5) TOPOGRAPHY / RELIEF

The nature of slope influences soil formation from deep to thin soils.

On steep slopes, erosion is more rapid than on gentle slopes. This facilitates the washing away of weathered materials and consequently steep slopes develop thin skeletal soils.

On gentle slopes erosion is slow and there is a lot of deposition which leads to the formation of mature soils in developed soil by the formation of immature soils in undeveloped soil profiles.

(6) TIME

Soil formation process is very long and slow. Ample time is therefore needed for the formation of mature fertile deep soils in well-developed soil profile.

If the time is short, immature or azonal soils are formed with poorly developed profile e.g. the soils of Nyamulagira are still skeletal because they have not been exposed to the weathering process for long.

SOIL FORMING PROCESSES

Processes refer to activities which operate materials and dead materials or matter to produce soils. They include:-

(1) Weathering

This involves the physical breakdown of big rocks into small particles forming skeletal stony immature soils. There is also chemical weathering which involves decomposition of rocks into small pieces in situ forming deep soils with developed soil profiles.

(2) Leaching

This is the process which involves the washing down of soluble mineral nutrients in a solution or suspension from horizon A to horizon B of the soil profile. This empoverishes horizon A and enriches horizon B of the soil profile.

(3) Eluviation

This involves the movement of mineral nutrients in a solution or suspension from one place to another either horizontally or vertically. This process enriches horizon B and empoverishes horizon A of the soil profile.

(4) Illuviation

This process involves the accumulation and precipitation of the leached and eluviated soil nutrients from horizon A into horizon B. this process enriches horizon B with mineral nutrients.

(5) Humifiation

This is a process which involves the decomposition of dead organic matter forming humus which is added to the broken down rock materials to form deep fertile mature soils with well-developed soil profile. Consequently areas with thick vegetation like L. Victoria basin where there are tropical rainforests develop fertile deep mature soils.

(6) Mineralization

This is a process of soil formation which takes place under extreme conditions of heavy rainfall and hot temperatures in which decomposition of organic matter exceeds humification i.e. humus is broken into other inorganic substances e.g. carbondioxide, water and silica. This mainly occurs in horizon A of the soil profile hence enriching it.

(7) Podsolization

This process prevails in cool temperate regions especially in Boreal and coniferous forest regions. This process which leads to formation of podzols includes leaching, eluviation and humification.

Humification is very important here because it results into acidic conditions which intensifies other processes of soil formation in such areas. These acids result from decomposition of organic matter.

Podzolisation results into the formation of the best developed soil profile with different horizons and sub-horizons clearly developed.

(8) Salinization

This process involves the formation of a thin layer of salt on the surface of the earth through capillary action. Capillary action involves a wide range of soluble mineral salts as a result of excessive evaporation, accumulating on the earth's surface. It enriches horizon A of the soil profile with salts.

(9) Gleization

This process leads to the formation of frozen soils in the temperate regions while in the tropical regions; it leads to the formation of peat soil which are pre-mature due to low temperatures and poor drainage. These two factors don't allow complete decomposition of organic matter because soil bacteria are not serviving.

This process mostly occurs in frozen areas especially in glaciated regions where permanent frost provides an impervious horizon / layers usually at shallow depths.

(10) Laterisation

This is a process which involves the formation of laterites and lateritic soils. The process require the following conditions in order to occur:-

- Deep and intense weathering under humid tropical conditions or sub-tropical conditions.
- Availability of abundant supply and rapid decay of organic matter.
- Mildly acid to mildly alkaline pH (5-8) which results from the rapid process of mineralization.
- Decomposition of clay to kaolinite. The laterisation results into formation of various soil types that differ from each other e.g. Ferruginous, latosols and oxisols. The laterisation process also takes place in humid regions.

Qn. Account for the formation of lateritic soils in East Africa.

Approach:

- Identify and describe lateritic soils.
- Locate them in East Africa.
- Give the factors responsible for the formation of lateritic soils.
- Explain the formation process of lateritic soils.

Answers:

Lateritic soils are red / black residue soils created from weathering of rocks under humid and hot tropical conditions.

Lateritic soils consists of either iron or Aluminium oxides and they are formed either as hard pans, soft clays or as horizontal granules in East Africa.

In East Africa lateritic soils are found in various areas of savannah and equatorial forests, Buganda hills due to the following factors:-

- **Relief or nature of slope**. Lateritic soils form under conditions of low relief. This allows percolation of water and leaching of horizon A and deposition in horizon B.
- **Geological time**. Lateritic soils require long geological period to allow formation and accumulation of oxides e.g. many laterites in East Africa are relics of tertiary weathering process.
- **Chemical weathering.** By oxidation, solution changes the colour and transports the cementing silicates, by oxidation respectively.
- **High temperatures**. This is required during the rates of chemical reactions.
- **Vegetation cover**. This helps to hold the soils to be leached and to allow weathering in situ to provide organic matter.

- **Human activities**. The formation of laterities is interrupted by human activities like mining.
- **Drainage**. Poorly drained soils do not allow formation of lateritic soils. They form in well drained areas.
- **Nature of the parent rocks**. Rocks shouldn't be extremely hard and should contain iron and aluminium for oxidation to take place.
- **Deep and intense weathering** under humid tropical and sub-tropical regions.
- Decomposition of clay into kaolinite.

- Mildly alkaline and mildly acid pH about 5 – 8 which results from rapid process of mineralization.

PROCESS OF FORMATION OF LATERITES

Laterites formation is due to excessive rainfall and hot temperatures which bring about decay and intense weathering of rocks.

Silica from rocks is removed by water and transported from horizon A to horizon B of the soil profile through a process of eluviation and leaching.

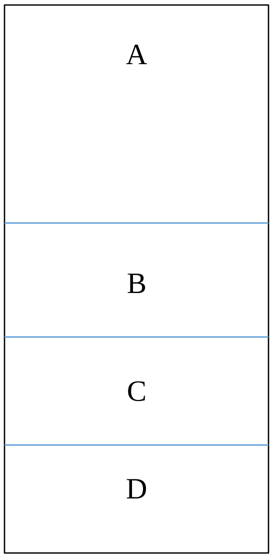
The iron and aluminium compounds are also moved to horizon B through eluviation and leaching.

When temperatures rise, the iron and aluminium are carried to the soil surface through capillary action which fuses together with soil particles and harden to form a layer known as "duricrust" or may remain in presence of surface moisture to form soft clays called kaolinite.

SOIL PROFILE

This refers to the vertical arrangement or section through the soil from the surface upto the parent rocks. It's composed of soil layers called horizons which are differentiated in terms of colar, texture and mineralogy.

Soil profiles differ from place to place however an ideal profile is composed to four horizons as shown below.



A_{oo} Undecomposed organic matter
A_o Decomposing organic matter
A_1 High humus content
A_2 Maximum leaching
A_3 Transitional zone
B_1 Transitional zone
B_2 Maximum deposition
B_3 Transitional zone

Partially weathered rocks

Unweathered rock / solid parent rock

The soil profile is made up of four horizons i.e. horizon A which is comprising of the top soil. This is sub-divided into sub horizons.

- Aoo : Un Decomposed organic matter
- A_0 : Decomposing organic matter
- A_1 : High humus content
- A_2 : Maximum leaching
- A_3 : Transitional zone

Examine the processes responsible for the development of soil profile.
- Define soil profile.
- Draw.
- Describe it.
- Identify and explain the processes indicating their effects on soil profile development.

HORIZON B
This is comprising of the sub-soil. It is also called the illuviation zone. It's sub-divided into;
B_1 – Transitional zone
B_2 – Maximum deposition
B_3 – Transitional zone

Horizon **C** which is made up of partially weathered rock materials.

Horizon D which is made up of unweathered parent rock.

- **Factors responsible for the development of soil profile.**
  Refer to the factors for soil formation.

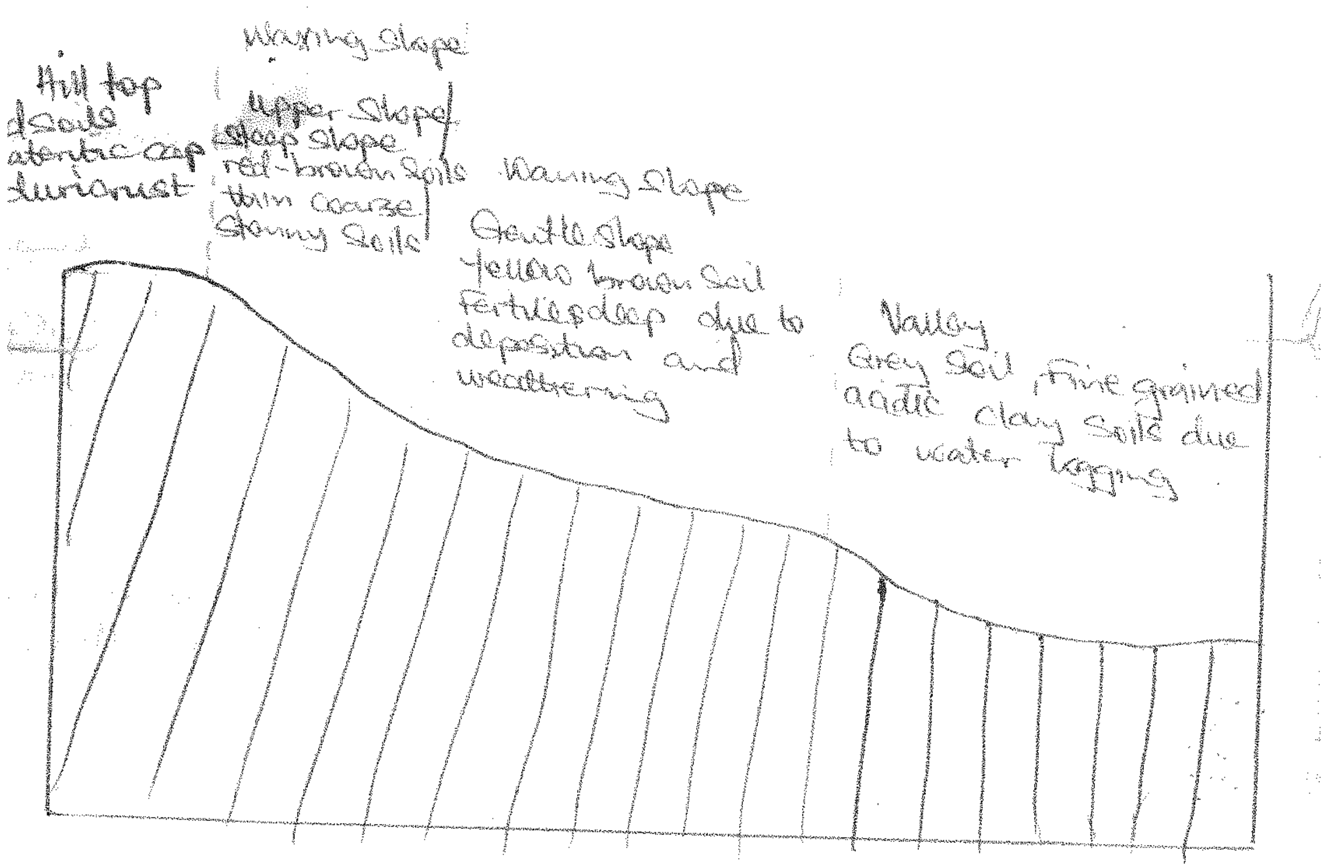
- **Process responsible for soil profile development**
  Refer to the processes for soil formation

SOIL CATENA

This is the horizontal / sequential arrangement of soils along a slope from the hill top to the valley bottoms formed under similar climatic conditions.

Soil catena thus shows different characteristics in terms of colour, depth, texture and water content as one progresses from the hill top to valley bottoms as shown below.

Diagram



FACTORS THAT INFLUENCE SOIL CATENA

(1) Relief

Flat hill top develops lateritic reddish brown soils due to high rates of leaching.

Steep slopes / waxing slope develop reddish brown thin stony skeletal soils due to high rates of soil erosion.

Gentle slopes / waning slopes develop,
Brown soils which are deep fertile and well developed soils due to deep chemical weathering and high rates of deposition.

(2) Drainage

The poor drainage / water logging conditions in the valleys / lowlands limit activities of living organisms and lead to low temperatures thus facilitating the formation of grey acidic water logged clay soils.

The good drainage on gentle slopes and the high water holding capacity result into the formation of yellow brown soils which are deep fertile and well developed.

The high rate of surface run off and limited water pacoration on the steep slopes limit chemical weathering and therefore result into the formation of reddish brown thin stony skeletal soils.

The high rate of water pacoration and good drainage on the flat hill top lead to high rates of leaching and therefore formation of lateritic soils or a duricrust.

(3) Climate

Heavy rainfall and hot temperatures lead to high rates of leaching and oxidation on the flat hill top, thus forming lateritic soils.

Heavy rainfall leads to high rates of soil erosion on the steep slopes thus forming reddish brown stony thin skeletal soils.

Heavy rains lead to high rates of water pacoration and the hot temperatures on gentle slopes lead to deep chemical weathering thus forming yellow brown deep fertile well-developed soils.

Heavy rains in valleys / lowlands lead to water logging conditions which facilitate the formation of grey acidic water logged clay soils.

(4) Living organisms

The limited activities of living organisms in low lands due to water logging conditions leads to the development of grey acidic water logged soils.

Living organisms like worms, bacteria help in churning the soils as they make passages through the soils, facilitating water pacoration on gentle slopes thus facilitating deep chemical weathering. Thus forming yellow brown, well-developed deep fertile soils.

Human activities of quarrying, agriculture on steep slopes encourage removal of soils and erosion thus facilitating the formation of reddish brown stony thin skeletal soils.

(5) Time

Ample time is required for the development of an ideal soil catena.

TYPES OF SOILS

There are 3 broad categories of soils:

- Zonal soils
- Intra-zonal soils.
- Azonal soils

ZONAL SOIL

These are mature soils with a well-developed soil profile due to the prolonged action of climate and vegetation. These soil types are largely as a result of climatic factors which contribute to their forming processes. They develop under conditions of good drainage. They develop on gentle slopes and flat landscape.

Zonal soils are mainly divided into two namely;

- **Pedacals.** These have high calcium carbonate content under conditions of low rainfall.
- **Pedalfers.** These are rich in aluminium and iron.

The resultant soil type is closely related to the nature of weathering that takes place under specific type of climate. These include:-

- In the low latitude areas, the hot humid conditions give rise to latosols and tropical black soils (basisols).
- In mid-latitudes, climate of humid conditions are associated with the development of podisols and brown soils.
- In areas receiving seasonal rainfall in the mid-latitudes, chernozems soils develop e.g. on the Canadian Prairies.
- High latitude climate lead to the development of Tundra and acidic brown soils.
- Semi-arid conditions yield chestnut coloured soils.

INTRA-ZONAL SOILS

These are mature soils classified according to the great influence of relief and the parent rock during their formation. They include:-

- **Peat**. These are soils formed in low lying areas and poorly drained areas.
- **Calcerous soils**. These are derived from limestone rocks. They are of two types namely;
- **Terrarossa**. These are red soils which form in limestone regions under semi-arid areas e.g. Northern France and parts of Yugoslavia.

- **Rendizina**. These are soils of limestone origin formed in areas with heavy rainfall. They are best developed in parts of England and are well known for the growing of cereals like wheat and barley.

AZONAL SOILS

These are immature soils with undeveloped soil profiles. They can't be distinguished from one another because of their recent formation. So their development is incomplete and therefore no marked horizons.

The soil forming process is incomplete either because the period of formation is either short that the horizons have not been formed or because of the steep slopes where surface run off is greatest.

The soils are skeletal with shallow profiles and show characteristics of their original parent rock material which weather into situ and resist change. They are derived from unconsolidated rock materials e.g. alluvium, sandy and volcanic ash.

Azonal soils include;

- **Volcanic soils**. These are young deposits of lava and ash which are weathered rapidly to form soils eg in kenyan highlands and south western Uganda.
- **Alluvial soils**. These are soils got from sandy, silt and clay deposits along water courses. They are very fertile and where they occur are areas of dense population e.g. Nile delta in the Sudan and Egypt.
- **Glacial soils**. These are soils of glacial origin and consist of out washed moraines of sand and gravel and clay deposits laid down in glacial lakes.
- **Wind deposits**. They include sand sheets, loess and sand dunes.
- **Screes**. Formed by weathering.

FACTORS THAT INFLUENCE THE FORMATION OF AZONAL SOILS.

- **Weathering.** Weathering of the parent rock leads to the formation of screes on the slope. These soils usually show the characteristics of their original material and resist change.
- Tectonic deposit of lava via volcanic action which leads to the formation of lava ash, cinder and pumice**.**
- Materials may be transported by high rate of erosion and get deposited in low lands e.g:-
  - Wave action which leads to formation of marine deposits forming soils like mud flats, marine clay soils.
  - Wind action which leads to the formation of loess soils, sand sheets and sand dunes.
- Glacial action which forms fluvio glacial soils e.g. out washedsands and gravel and resorted clays deposited in glacial lakes.

- River action leads to the formation of alluvial soils in lowlands and valleys.

- **Climate.** High amounts of rainfall cause river floods that lead to deposition of alluvial soils in the lower course.
  - Temperature changes on mountain slopes influence physical weathering, consequently forming screes.
  - Human activities like quarrying leads to the breaking of rocks, forming screes.
  - Deforestation, bush burning and overgrazing exposes the parent rock which leads to formation of young soils.

- **Relief**
  Steep slopes influence soil erosion of screes on mountain slopes and their subsequent deposition hence forming new soils called screes.

- **Time**
  Azonal soils are immature soils and this mainly depends on a short period of time entailed in their course of formation.

SOIL EROSION

Qn. To what extent is soil erosion in East Africa a result of physical factors?

Approach:
- Definition of soil erosion.
- Areas affected by soil erosion.
- Description of soil erosion processes in details.
- Evaluation / stand point.
- Physical factors with processes intergrated.
- Other factors / Human factors.
- Conclusion.

Soil erosion is the washing away of soil materials from one place to another by agents like running water, wind e.t.c.

Soil erosion is most dominant in highland areas of East Africa like Kigezi, southern Tanzania highlands, Rwenzori and dry flat areas of East Africa like Kondoa of central Tanzania, Karamoja, Turkana, Ankole, Masaka dry corridor.

TYPES OF SOIL EROSION

(1) Splash erosion

This is a type of soil erosion is caused by the impact of rain droplets which dislodge loose soil particles and these join running water to move in any direction.

(2) Sheet erosion

Removal of a uniform thin layer of the top soil by running water and wind. It involves a slow movement which covers a wide area. It's common on gentle slopes and flat areas e.g. Nakasongola and Nyika plateau.

(3) Rill erosion

Is a process of soil erosion which occurs where water runs in small channels which guide soil movement on the surface of the earth.

It takes place over gentle and steep slopes. In most cases the small channels widen to form wide gullies/grooves.

(4) Gulley erosion

This is a form of erosion where there are deep wide channels/grooves in which soil is washed down slope by running waters. It occurs in areas of heavy rainfall. It occurs in areas of heavy rainfall. It occurs on gentle and steep slopes.

It results into formation of waste lands / Bad Lands.

(5) Wind erosion

A form of erosion by the deflation process of wind. Deflation is the removal of loose soil particles from one part of the earth's surface to another. Deflation is very active in dry flat areas like northern Kenya, Central Tanzania.

CAUSES OF SOIL EROSION

(1) Climate

Heavy torrential rainfall received in highland areas of East Africa like southern Tanzanian highlands Kabale largely accelerate gulley, sheet erosion.

Unreliable / unpredictable rainfall in dry areas like Turkana, Karamoja have led to gulley, sheet erosion.

Strong winds in dry flat areas like Kondoa also lead to deflation which leads to soil removal hence soil erosion.

(2) Relief

Steep and gentle slopes of Bundibugyo, Kabale encourage rill splash erosion.
Flat areas like Turkana, Kondoa encourage wind erosion.

(3) **Lack of vegetation cover** e.g. in Turkana, Kondoa facilitate gulley, sheet, wind erosion because the soils are directly exposed to erosion.

(4) **Crustal instabilities like earthquakes** that destabilize the rock particles making them vulnerable to gulley, sheet and rill erosion.

(5) Nature of soils
Unstable soils like sandy and volcanic soils are greatly affected by gulley, sheet erosion in Turkana, Kisoro.

(6) **Overgrazing by wild animals** e.g. in National Parks like Queen Elizabeth, Tsavo exposes the soils hence accelerating gulley, sheet.

(7) **Wild bush fires** exposes soils to gulley, sheet, rill erosion as it leaves the soils bear.

Human factors:

- Defforestation in Kigezi, Kabale which exposes the soils to sheet and gulley erosion.
- Overstocking or over grazing in Karamoja, Ankole, Masaka, dry corridor, Kondoa hence leading to gulley and sheet erosion.
- Monoculture which results into soil infertility and this makes the soils exposed to gulley and sheet erosion e.g. in Mbale where bananas are grown, Mukono with tea plantations.
- Up and down cultivation which encourages runoff through rill and gulley erosion e.g. in Bundibugyo.
- Planting poor cover crops like sorghum, maize which leads to the soils being exposed to erosion hence facilitating sheet and gulley erosion.
- Mining and quarrying in hilly areas e.g. Kireka, Kilombe, Mbuya hills which involves clearing of vegetation first exposes the soils to soil erosion agents thus facilitating sheet and gulley erosion.
- Construction of roads, settlement e.t.c. which involves removal of vegetation first, exposing the slopes e.g. along the northern by-pass in Kiwatule, Bwaise, Bundibugyo, Entebbe Express Highway.

EFFECTS OF SOIL EROSION

Positives:

- Leads to soil formation in the lower areas where the eroded soils are deposited e.g. on the foothills of mountain Elgon in Mbale.
- Exposes several volcanic features like Inselbergs which attract tourists.
- Exposes hard rocks that are used for installation of TVs, Telephone masts e.t.c.

- Removal of top soil exposes fresh rocks to weathering thus formation of new soils.

Negatives:

- Created Bad Lands in Machakos, Kondoa and Nyanza which discourages agricultural mechanization.
- It's one of the causes of drought in northern Kenya, Ankole Masaka corridor, Kotido.
- It involves washing of top fertile soils which reduce agriculture productivity. Hence food shortage, leading to famine e.g. in Northern Kenya.
- Leads to siltation of lakes and rivers where eroded soils are deposited e.g. Manafa and Kibimba are highly silted by erosion from the Elgon.
- Leads to flooding of rivers like Manafa due to silting up in kampala, floods are also due to Nakivubo channel.
- It has led to scarcety of pastures in pastoral areas like Turkana, Karamoja which has led to death of animals.
- Lowers the water table whereby eroded materials are deposited in lowlands.
- Soil erosion especially wind erosion leads to poor visibility due to the dust in the atmosphere e.g. in Moroto and Turkana.
- Forced migration of people from areas seriously affected by soil erosion to other unaffected areas e.g. Bakiga from Kabale to Kibale.

MEASURES:

- Terracing has been adopted in mountainous areas like Kigezi.
- Strip cropping.
- Sacks and gabions are filled with soil and stones and placed in gullies along steep slopes to provide protection against surface run off e.g. in Bundibugyo.
- Crop rotation has been adopted to control monoculture effects e.g. in Kabale, Masaka and Mbale.
- Artificial and natural fertilizers are being applied to replace the lost fertility e.g. cow dung in Mbarara and Mbale.
- Cover crops like beans, sweet potatoes are widely grown to control rain infiltration and reduction of splash of rain drops on soils e.g. in Kabale, Kericho and Arusha.
- Contour ploughing in highlands like Kigezi; this involves digging of land and planting crops across the slope.

  This reduces the movement of soils down slope.
- .afforestation and re-afforestation measures in Kabale.
- Public awareness through mass media, magazines, seminars to teach people in those areas the soil conservation measures.
- Controlled grazing and introduction of ranching in areas of soil erosion.
- Mulching in Mukono, Bushenyi e.t.c.

- Controlled bush burning.
- Setting up of organisations like NEMA, NFA to address the dangers of environmental degradation, thus control soil erosion.

<u>Qn</u>. Account for the soil degradation in East Africa.

<u>Approach:</u>

Define soil degradation
It's the reduction in the productive value of soil which results into low crop yields.

Identify where it occurs.
- Turkana
- Nakasongola
- Kisoro

Identify and describe the forms of soil degradation and their causes which include:-
- Loss of soil nutrients through leaching, eluviation, crop removal.
- Soil erosion

VEGETATION IN EAST AFRICA
- Account for the growth of equatorial vegetation in East Africa.
- Location
- Characteristics which must be accounted for.
- Factors for the distribution with characteristics integrated.

NATURAL VEGETATION IN EAST AFRICA

This refers to the green plant cover onto the earth's surface which regenerates automatically without man's influence.

Although East Africa lies astride the Equator, its vegetation is not purely equatorial forests. She has a variety of vegetation types namely tropical vegetation, Arid and semi-arid, montane, and swampy vegetation and equatorial vegetation.

EQUATORIAL / TROPICAL RAINFOREST VEGETATION

This covers a small percentage of the total land area limited to L. Victoria shores e.g. L. Victoria island e.g. Bugala, Kalangala, Kome in Bunyoro, e.g. Budongo, Bugoma, Kibale, Karinzu, Bwindi Impenetrable Immaramagambo, Marabigambo in Rakai and along the East African coast.

CHARACTERISTICS

- Characterized by a close cover of tall trees with a strong stem ranging from 8 – 50m because they are looking for sunlight.

- Form dense ever green canopies of 3 – 4 layers because they are searching for light.
- They don't occur in pure stands because they are natural and not planted by man on a planned basis.
- They often look thick under growth because sunrays never penetrate these canopies to facilitate the growth of grasses and other undergrowth.
- Large ever green trees which develop due to excessive water intake.
- Trees have buttress roots to support the great height and size of trees.
- Trees are broad leaved to facilitate evapo-transpiration.
- Trees are ever green because they shed off leaves at different intervals throughout the year.
- They develop into thickets at their margins due to man's encroachment.
- They have creepers like lianas and epiphytes because they are looking for light and support.
- Contain tropical hard wood tree species such as Mvule, Mahogany, Okoume, Ebony, Rose wood, Teak; this is due to the constant hot temperatures that accelerate the loss of water from leaves.
- Trees have a long gestation period of over 50 years because they are indigenous which take long to mature.
- They are umbrella shaped to preserve water around the plant.
- Have shallow roots due to heavy rainfall and abundant water in the soil.

CONDITIONS FOR THE GROWTH OF EQUATORIAL FORESTS

- Favourable climate, characterized by;
- Heavy well distributed reliable rainfall of 1500-2000 mm annually which favours the growth of tall ever green trees.
- High humidity of over 80% which favours the growth of hard wood ever green trees.
- Uniformly hot temperatures between 20 – 30^{o}C which favours the growth of ever tall green trees.
- Abundant sunshine which favours the growth of broad hardwood tree species.
- Deep fertile soils which favours the growth of ever green tall tree species.
- Well drained soils which favour the growth of a variety of tall ever green tree species.

- Latitudinal location between 0 and 5° north and south of the Equator which areas are characterized with uniform hot temperature, heavy rainfall due to high evaporation and evapo-transpiration and over heading sun which favour the growth of hard wood tree.
- Altitude between 1800 – 2500mm which altitude is characterized by hot temperatures which encourage the growth of tall broad hard wood tree species.
- Relief characterized by gentle slopes, well drained lowland areas which favour growth of evergreen trees.
- Favourable government policy for gazetting forests e.g. Mabira, Kibale has led to their continued existence.
- Limited human encroachment for agriculture, lumbering e.t.c. which has led to the continued growth of forest.

PROBLEMS OF LAND USE IN EQUATORIAL FORESTS

- High temperatures and heavy rainfall encourage multiplication of dangerous pests in these forests.
- Heavy rainfall makes the soils boggy which makes transport difficult which hinders economic activities.
- Sparse population of these areas hinders their exploitation.
- Trees of great economic value are widely scattered which makes their exploitation difficult.
- They habit dangerous wild animals which are a threat to human beings.
- Very big logs of the trees make transport difficult.
- Closeness of the trees makes their felling difficult.

TROPICAL / SAVANNAH VEGETATION

Account for the distribution of tropical vegetation in East Africa.

Approach:

- Identify types of tropical vegetation.
- Locate each type.
- Describe the characteristics of each type.
- Then explain the factors, integrating the types of savannah.

Tropical / Savannah vegetation covers half of East Africa's total land area. It's divided into 3 broad categories i.e. Savannah grasslands, Woodlands and Dry Savannah.

SAVANNAH GRASSLANDS

This is a form of savannah dominated by a continuous cover of tall grasses dotted by trees.

Most of Uganda is covered by Savannah grassland and is more pronounced in Luweero, Bunyoro, Arua parts of northern Uganda, Nyika plateau in Kenya, Queen Elizabeth National park in Kasese.

CHARACTERISTICS

- Tall grasses of 5 – 8m tall.
- Elephant and spear grass dominate.
- Grasses turn yellow – brown colour during dry seasons.
- Grasses grow in turfts with sharp edges.
- Grass has fibrous roots.
- Grasses dry up during the dry season.
- Scattered trees are dotted within grasses.
- Trees are deciduous in nature.
- Trees are umbrella shaped.
- Trees are hardwood species.
- Deep rooted trees.
- Drought resistant trees.
- Baobabs and acacia dominate.

CONDITIONS FOR THE GROWTH OF GRASSLANDS

- Favourable climate characterized by;
- Moderate rainfall of 760 - 1000 mm which favours the growth of tall grasses with scattered trees.
- Seasonally distributed rainfall and wet seasons which favours the growth of trees and dry seasons that favour yellowing and browning and drying up of the grasses.

- Low humidity of about 30% which favours the growth of tall grasses.
- Hot temperatures of 20 - 30^oC which favour the growth of a continuous cover of tall grasses with scattered trees.
- Good / fair drainage which favours the growth of tall grasses with scattered trees.
- Relief of lowlands and plateau which favour the growth of tall grasses.
- Latitudinal location of 5 – 15^o north and south of the Equator which areas are characterized by hot temperature and moderate rainfall which favour the growth of a close cover of tall grasses with fewer contours.
- Altitude below 1800 m above sea level favouring the growth of tall grasses because of their hot temperatures.
- Man's encroachment on woodlands for charcoal burning, lumbering which degenerates them to grasslands.
- Government policy of conserving grassland areas into national parks and game reserves e.g. Queen Elizabeth, Tsavo which has led to the continued existence of the grassland.

SAVANNAH WOODLANDS / MIOMBO WOODLAND

This is the type of savannah vegetation with more or less continuous cover of trees and shrubs intertwined.

It's dominate in western and south west Tanzania where it's called Miombo, parts of western rift valley region, south western and Eastern Kenya, southern Arua, parts of northern Uganda and Nakasongola.

CHARACTERISTICS

- Moderate height of trees of 8 – 16 m high.
- Umbrella shaped trees.
- Continuous cover of trees because of moderate water supply.
- Predominance of Acacia and Cacti tree species.
- Deciduous trees.
- Dense undergrowth.
- Trees are intermingled with xerophytic thorny lianas, cactie and ferry hardy shrubs.
- Trees have gnarled / twisted stems.

- Trees have thick barks.
- Trees have small leaves to reduce transpiration.
- Drought resistant trees due to swollen trunks and long tap roots.
- Fire resistant trees.
- Most trees develop branches close to the ground.
- Hard wood trees species.

CONDITIONS

- Moderate rainfall of 760 – 1500 mm per annum which favours the growth of continuous cover of trees.
- Seasonal rainfall, concentrated in one peak which favours the growth of shrubs.
- Dry conditions which favour shading off leaves.
- Hot temperatures of about 20 – 30^{o} which lead to dominance of drought resistant trees.
- Moderate humidity of 50%. Favour the growth of a continuous cover of medium sized trees.
- Fairly fertile soils with a water holding capacity to encourage the growth of continuous cover of trees.
- Relief of low lying and gentle slopes. Favour growth of a continuous cover of trees.
- Latitudinal location of 5 – 15^{o} north and south.
- Good drainage / lack of / limited drainage encourage the growth of medium sized trees.

Biotic factors e.g.:

- Minimal human activities due to presence of tsetse flies and bees.
- Man’s activities in tropical rainforest e.g. deforestation, lumbering degenerate the tropical rainforests to woodlands.

DRY SAVANNAH VEGETATION

This is a type of savannah characterized by scrubs, bush and thickets with stunted trees found in the drier margins.

It’s found in the fringes of northeastern Uganda, Ankole-Masaka dry corridor, central Tanzania, Turkana.

CHARACTERISTICS:

- It’s characterized by scrubs and thicket.
- There are scattered trees.
- Trees are stunted.
- Trees have thick barks.
- Trees are deep rooted to suck underground water.
- Trees are drought resistant due to swollen trunks and deep roots.
- Trees have small leaves to minimize water loss.
- Trees have no or very few leaves.
- Trees produce very many seeds which remain dormant during dry season as a form of insurance.
- The leaves of the trees have a waxy / oily coating to reflect sun’s insolation to minimize water loss.
- Trees are thorny for defense purposes.
- Trees are small to avoid being broken by strong winds.
- Drought resistant trees.
- Fire resistant trees.

CONDITIONS:

- Low rainfall below 250 mm which is highly unreliable and unevenly distributed which have enabled the growth of scrubs.
- Very hot temperatures above 30^{o}C which have favoured the growth of drought resistant trees.
- Very low humidity below 20% which has enabled the growth of thicket.
- Fair drainage encouraging the growth of scrubs and thickets.
- Poor infertile sandy soils favoure the growth of scrubs.
- Low flat lands which are fairly drained encourage the growth of scrubs and thicket.
- Altitude of below 1000m above sea level encourage the growth of thicket.
- Latitudinal location between 5 and 15^{o} north and south of the equator characterized by hot to very hot temperatures encourage the growth of thicket.
- Human activities of deteriorating, overgrazing, bush burning of grasslands which degenerates the grasslands into dry savannah.

Qn. Account for the existence of dry Savannah in East Africa.

ARID AND SEMI-ARID VEGETATION

Note: - Refer to dry savannah for areas of occurrence.
- Characteristics and conditions.

FACTORS FOR THE DEGENERATION / MODIFICATION CHANGE / DETERIORATION / TRANSFORMATION OF SAVANNAH VEGETATION

Qn. To what extent have physical factors modified Savannah vegetation?

Approach:
- Describe Savannah, types and location.
- Briefly outline some of the characteristics.
- Make a stand point / evaluation.
- Show the role of physical factors.
- Show the role of other factors.
- Conclusion.

PHYSICAL FACTORS:-

- Pests e.g. termites in Nakasongola which have degenerated savannah grassland to dry savannah through eating them.
- Locusts in Turkana have degenerated dry savannah to Arid and semi-arid.
- Prolonged drought / desertification which leads to the drying up of grasslands degenerating them to dry savannah and woodlands are degenerated to grassland savannah and dry savannah to arid vegetation.
- Wild bush fires during dry seasons which destroy savannah grasslands degenerating them to dry savannah and dry savannah degenerated to arid and semi-arid or these are burnt and replaced by bare ground.
- Flooding during heavy rainfall in areas of Kumi-Soroti which leads to the decaying of grasslands replacing them with swampy vegetation.
- Overgrazing by wild animals on the grasslands e.g. along Kazinga channel which have degenerated grassland savannah to dry savannah or bare ground.
- Human factors:
- Defforestation of woodlands reducing them to grasslands for charcoal burning.

- Crop cultivation which lead to disappearance of woodlands replacing them with planted crops.
- Animal grazing e.g. in Mbarara degenerates grasslands to dry savannah.
- Clearing grasslands, woodlands for settlement leading to their disappearance completely.
- Bush burning by cattle keepers and hunters which changes grasslands into scrubs.
- Road construction leading to the disappearance of woodlands replacing them with tarmac.

SWAMPY VEGETATION

This is a type of vegetation which grows in poorly drained lowland areas. They include papyrus which are mainly found in central Uganda along the shores of Lake Victoria and mangrove forests along the coast.

MANGROOVE SWAMPS

These are found growing along the East African coast mainly at Mombasa, Dar-es-Salaam, Tanga, Lamu and Malindi.

They grow best in salty waters at high tides.

CHARACTERISTICS

- Trees are ever green throughout the year due to constant high rainfall and adequate water supply by wave action.
- Trees shed off their leaves at different intervals as they fully mature.
- Trees have broad leaves in order to trap sunlight for photosynthesis and aid evapotranspiration in case of excess water in trees.
- Trees are short approximately 10m.
- Trees have short stumpy roots supported by aerial roots that bend at right angle to support the stout trunks.
- Trees are umbrella shaped and develop branches close to the ground.
- Trees form a close cover with bushy stands.
- Hard wood tree species due to constant high temperatures that accelerate water loss from trees.
- Trees develop grey foliage on their stems and the shrubs in the neighbourhood also have grey and silver foliage.
- Trees have a long gestation period of 40 years.

- Trees and thick shrubs grow parallel to the coast due to constant alluvial deposits by waves.
- Trees have limited undergrowth.

CONDITIONS:

- Hot temperatures of over 20^{o}C which influence high rates of evapotranspiration.
- Heavy rainfall above 1000 mm favouring the growth of broad ever green leaves.
- High humidity of 70% favouring the growth of broad and ever green trees.
- Low altitude of 500m above sea level which are associated with hot temperatures.
- Deep leached alluvial soils ideal for the growth of forests.
- Shallow marine salty soils which at certain points allows the growth of shrubs.
- Poorly drained and heavily logged soils to allow forest growth.
- Government policy of conservation and preservation of forest.

ECONOMIC IMPORTANCE OF MANGROOVE FORESTS

- Mangroove forests act as a link between terrestrial and marine systems i.e. marine organisms depend on mangrove forests for part of their life cycle.
- Mangrove forests export organic matter to the sea for marine survival.
- They contribute to man's food web through their production of organic matter.
- Mangrove forests provide food for the animals at the coast.
- They promote timber production and thatching materials.
- Trees are traditionally known for the extraction of sugar and alcohol (Nipa palm).
- Contribute to honey and bees wax production since they provide spaces for bee hives.
- Mangrove swamps are sources of medicine e.g. Chincona tree which is highly processed to provide malaria drugs.
- Trees and shrubs are used to promote the art and craft industries.
- They act as homes for many birds and animals hence promoting tourism.
- Promote research and study for both marine and parastoral environment.
- Promote fishing activities e.g. lung fish and mud fish which are caught in the muddy environment.
- Provide timber for the construction of boats and floats for fishing.

Negative importance:

- They have poor soils due to leaching and salinity hence limiting agriculture.
- They are remote due to inaccessibility.
- Habour dangerous wild animals like crocodiles.
- Marshy areas act as habitats for disease vectors like snail and mosquitoes which transmit bilharzia and malaria.
- Hinder port construction.

MONTANE VEGETATION

This is the type of vegetation mainly found in cool mountainous areas of East Africa. It consists of vegetation zones on mountains. They vary due to varying altitude. They include the following:

Diagram:

Probable swampy vegetation and Mangroove forest below 500m above sea level.

Note: For characteristics and conditions, refer to the above notes.

This is followed by Savannah vegetation in areas below 1800m above sea level. This is categorized into;

- Dry savannah between 500 and 800m above sea level.
- Grassland savannah between 800 – 1500m above sea level.
- Woodland savannah between 1000 – 1800m above sea level.
- This is followed by Equatorial vegetation between 1800 and 2000m above sea level.

Note: For characteristics and conditions for the above vegetation refer to the above notes.

This is followed by temperate forests between 2500 and 3000m above sea level.

CHARACTERISTICS

- Coniferous soft wood trees like cedar, cypress, podar cap, camphor, e.t.c.

- Evergreen trees.
- Thick barks.
- Shorter trees particularly as rainfall decreases.
- Needle shaped leaves.
- No under growth.
- Trees have straight trunks and small branches.
- Trees are cone shaped.
- Trees are cone shaped.
- Trees appear in pure stands.
- Trees have a shorter gestation period.

CONDITIONS

- High altitude of 2500m – 3000m above sea level which favours the growth of coniferous trees.
- Cool temperatures of about 10ºC favouring the growth of coniferous trees.
- Low levels of humidity of less than 20%.
- Shallow infertile soils.
- Fairly drained soils.
- Steep slopes.
- Favourable government policy of conserving forest.
- Limited man's interference due to high altitude and steep slopes.

BAMBOO FOREST 3000 – 3500m above sea level

Characteristics:

- Bamboo plants have segmented stems and are hollow inside.
- Have small tough pointed leaves.
- Greenish when young but yellowish when mature.
- Have prop roots.
- Are single in layer.
- Trees are light.
- Trees have small and bent branches.

Conditions:

- High altitude of 3000 – 3500m above sea level.
- Cool temperatures of about 10oC.
- Low levels of humidity of less than 20%.
- Fairly drained soils.
- Thin skeletal infertile soils.
- Favourable government policy of conservation.
- Limited man's interference due to steep slopes.

MORE LAND AND HEATH (3500 – 4000m above sea level)

It consists of grass, shrubs and flowers. Plants include lobelia and giant ground sel, ferns and lichen.

- Plants appear very short.
- Flowers are turfted.

Conditions:

- High altitude of 3500 – 4000m above sea level.
- Thin skeletal infertile soils.
- Steep slopes.
- Cool temperatures of below 10^{o}C.
- Low levels of humidity of less than 20%.
- Low rainfall of below 700mm.
- Fairly drained soils.

Qn1. With reference to any mountainous in East Africa, account for the vegetation distribution.

- ***Approach:***
- Identify the mountain.
- Describe the vegetation zonations.
- Describe the characteristics of each vegetation cone and the conditions for each zone.

Qn2. To what extent have natural factors degraded / modified natural vegetation in

East Africa?

Qn3. Examine the factors that influence the distribution of natural vegetation in East Africa.

- ***Approach:***
- Define natural vegetation.
- Identify, locate and describe all the characteristics of the various natural vegetation types in East Africa.
- Identify and explain the factors which affect the distribution of all the vegetation types, integrating the types.

CLIMATOLOGY

This is the study that involves analysis of specific distribution of the atmospheric conditions / phenomena out of which climate is composed.

CLIMATE

Average atmospheric conditions of a large area/place studied and recorded for a long period of time e.g. equatorial, tropical, arid and semi-arid climate.

WEATHER

Refers to the day-to-day atmospheric conditions of a small area studied and recorded for a short period of time e.g. rainfall, temperature, sunshine e.t.c.

Note: The above elements of weather are studied and recorded at a weather station where there is a Stevenson's screen.

STEVENSON'S SCREEN

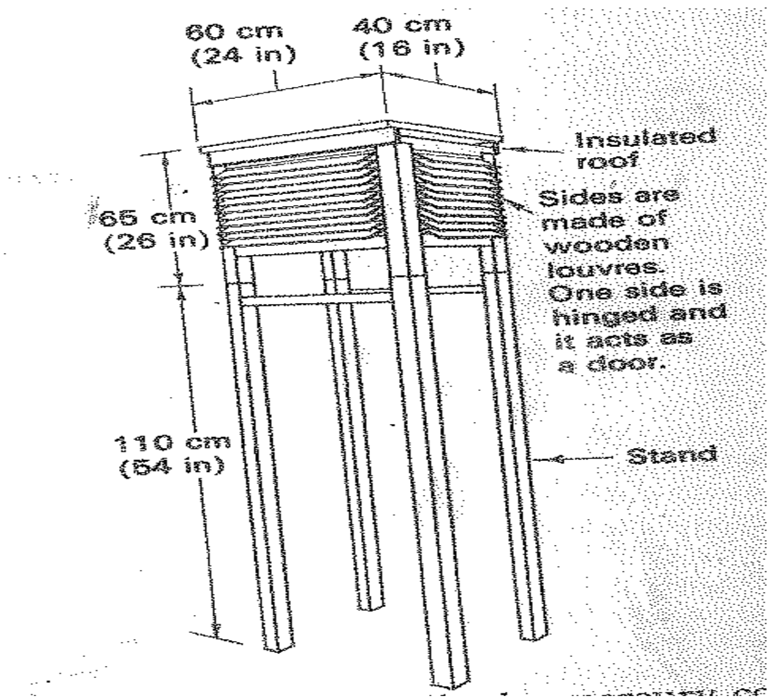
It's a special box designed to keep thermometers used to measure weather elements at weather station e.g. wet and dry bulb thermometer e.t.c.

Designing of a Stevenson's screen

- It's designed in such a way that;
- It's about 1.2m in height above the ground to ensure that air temperature is measured.
- It's set up in an open space without surrounding houses and trees so as to measure only air temperature and to avoid exaggerated air temperatures from buildings and trees.
- It has louvers which protect the thermometers from direct sun rays and also to allow free circulation of air whose temperature is to be measured by the thermometers inside.
- The screen is painted white in order to reflect sun rays and heat to avoid exaggerated results.

- It’s made of wood which is a poor conductor of heat to limit direct insolation.
- It must stand on a grass covered ground to minimize heat from the ground.
- The roof must be double boarded to prevent heat from reaching inside.

A Stevenson’s screen
Diagram:



MEASURING OF THE ELEMENTS OF WEATHER

(1) Temperature

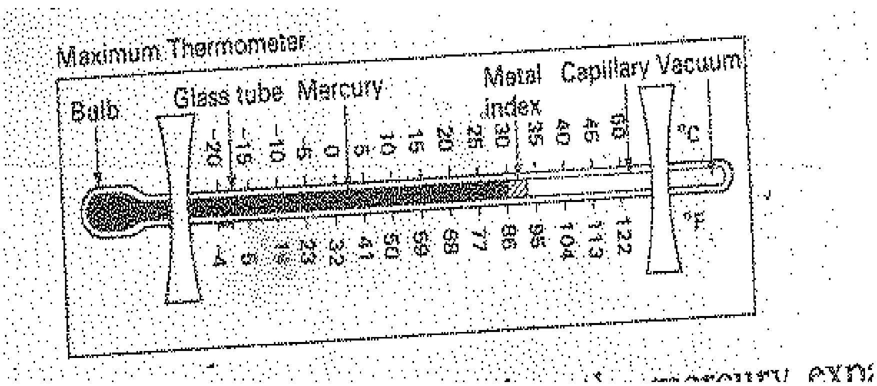
Is the balance of heat received from the sun’s insolation and the heat lost by the earth through radiation i.e. it’s the degree of hotness or coldness of atmospheric air expressed in degrees centigrade or fareignheight. The instrument used to measure temperature is called a thermometer.

There are 3 main types of thermometers i.e. maximum, minimum and six’s thermometers.

(2) Maximum thermometer

It's designed to measure the maximum temperature of the day. It contains mercury. On top of the thread, there is a metal index which is pushed up by the expanding mercury to record the highest temperature of the day. If temperature falls, the mercury contracts but the metal index remains behind. The maximum temperature is then obtained by reading the scale at the end of the index which was behind the mercury. The index is pulled back by a magnet.

Diagram:



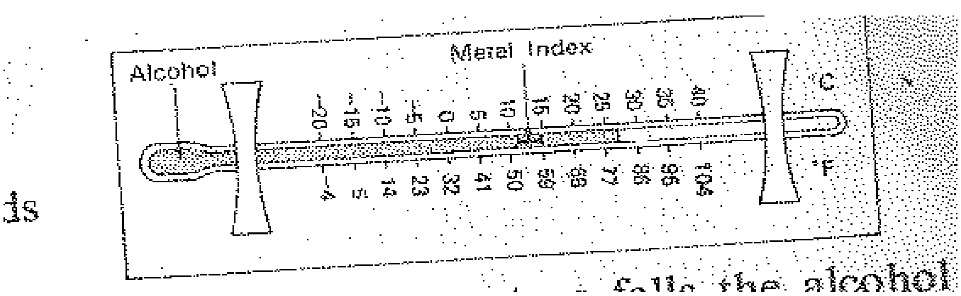
(3) Minimum thermometer

It's designed to measure the minimum temperature of the day. It contains alcohol within which a metal index is suspended.

When the temperatures falls, the alcohol contracts and its meniscus pulls the index along the tube.

The minimum temperature is then obtained by reading the scale along the tube. The index is then returned to its normal position by tilting the thermometer.

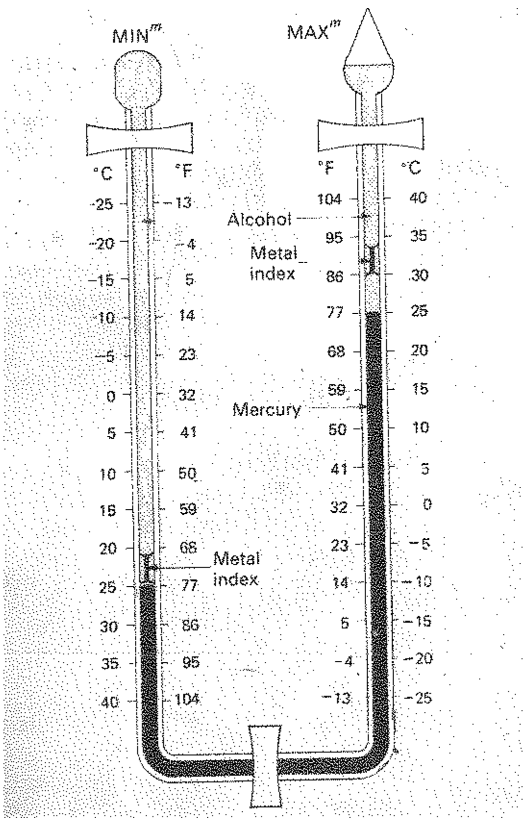
Diagram:



(4) Six's thermometer

It's designed to measure both the minimum and maximum temperatures of a day concurrently. It's a two limbed thermometer which contains mercury and alcohol. When atmospheric temperatures rise, alcohol of the left limb expands and pushes mercury down the limb forcing mercury in the right limb to rise and record the highest temperature of the day. The alcohol will have vapourised and occupied the space in the bulb. When temperature falls, the alcohol in the left limb contracts and in the process, the mercury in the left limb pushes the metal index upwards to measure the lowest temperature of the day.

Diagram:



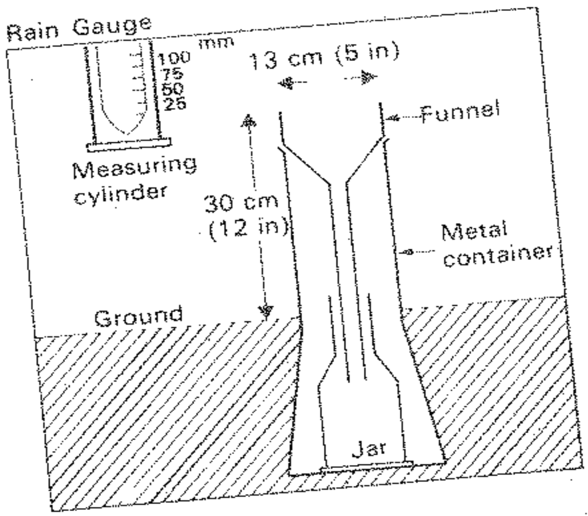
MEASURING OF RAINFALL

Rainfall is a type of precipitation in form of water droplets.

The instrument used to measure it is a rain gauge. It consists of an outer cylinder/metal container inside which is funnel which fits in the neck of a collecting bottle. It’s sunk into the ground and only part of it (top half) is visible.

The rain falls into the open top of a funnel and the funnel directs the water into a collecting bottle. Each day the bottle is removed from the container and its water is emptied into the measuring cylinder to measure the rainfall received in mm or inches.

Diagram:



Positioning of a rain gauge at a weather station.

- It must be placed in an open place so that no water enters it from buildings, trees or any shelter.
- It must be sunk a few centimeters into the ground to avoid evaporation of the collected water.
- About 30cm (12 inches) of the rain gauge must be stuck above the ground to prevent water from splashing into the jar and prevent surface run off from entering the jar.

HUMIDITY

Refers to the amount of water vapour in the atmosphere.

Absolute humidity

This is the actual amount of water vapour present in the given quantity of air at a given time. It's expressed in g/cm^3.

It depends on temperature and pressure.

Relative humidity

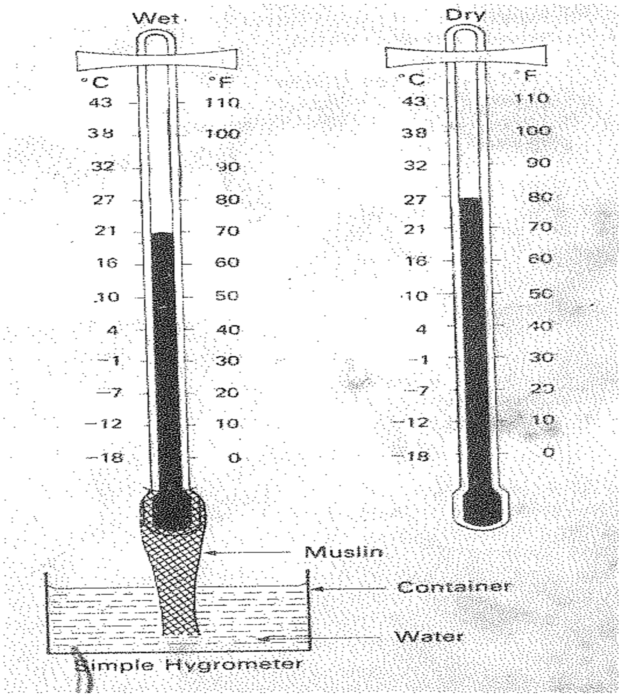
Refers to the actual amount of water vapour present in a given volume of air expressed as a percentage or ratio the maximum it can hold when saturated.

It also depends on temperature and pressure.

Measuring of Humidity

The instrument used in a simple hygrometer. It consists of two ordinary thermometer one tied in muslin which dips into a container of water. This is called the wet bulb thermometer and the other is the dry bulb thermometer which is left free in the atmosphere. When the air is not saturated, water evaporates from the muslin and cools the wet bulb thermometer, causing the contraction of mercury.

Diagram:



The two thermometers show different readings i.e. same reading means that there was no evaporation and the atmosphere was saturated.

A small difference in the readings means that humidity is high in atmospheric air.

A large difference means that the humidity is low in the atmospheric air.

ATMOSPHERIC PRESSURE

Is the force exerted onto the earth's surface by the atmospheric weight. It keeps on changing depending on latitude, altitude, temperature differences and rotation of the earth.

It is highest at sea level where it measures upto 1.034kg force per cm.

The instrument used to measure pressure is called a mercury barometer. It consists of a mercury container with a long glass tube inverted onto the mercury in the container. The weight of atmospheric air above the surface of mercury will force the mercury to enter the tube hence determining atmospheric pressure of the environment.

If atmospheric pressure decreases, the mercury column falls and if it increases, the mercury column rises.

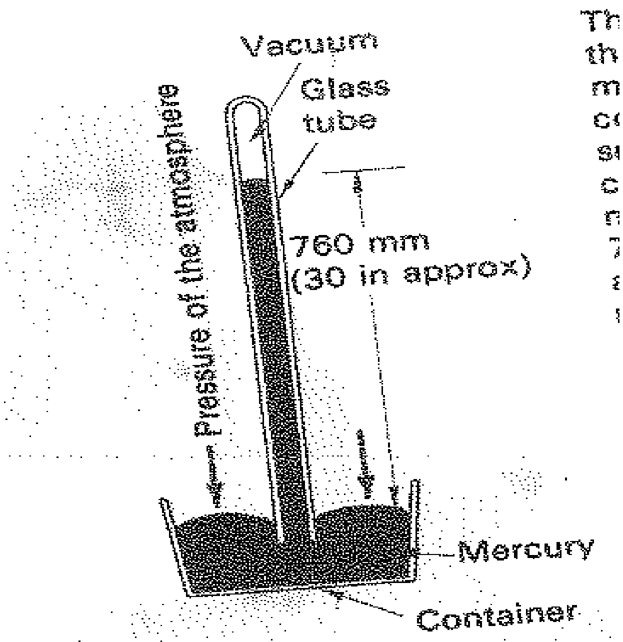
At sea level the mercury column is normally between 735 – 745mm.

Such a reading in mm is converted into millbars by using a special log book were 1000milbs = 760mm. the glass tube of 760mm supports an atmospheric pressure of about 18kg altitude.

At different places of the world, the atmospheric pressure is not the same. This difference leads to the development of winds where air masses blow from high pressure zones to low pressure zones.

A MERCURY BAROMETER

Diagram:

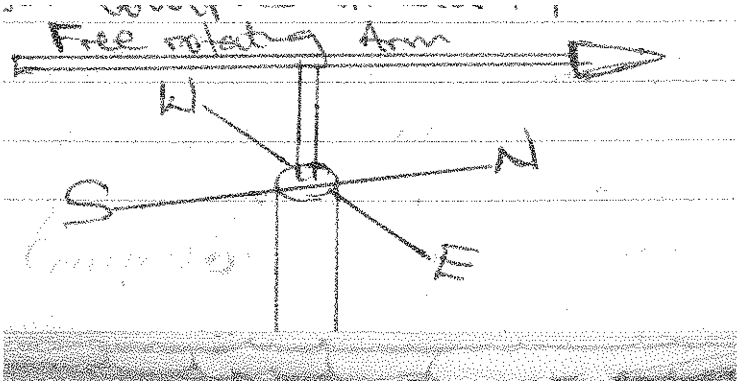


WIND DIRECTION

Wind is determined by the wind vane. It contains a free rotating arm pivoted on a vertical shaft and the arrow of the wind vane will always point in the direction from which the wind blows and wind will be named after that direction.

A WIND VANE / COMPASS DIRECTION

Diagram:

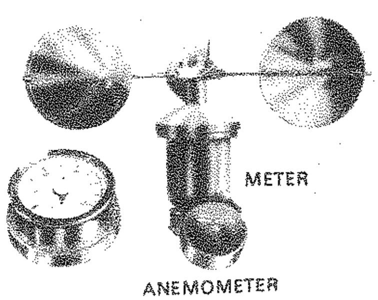


WIND SPEED

It's measured by an instrument called the anemometer. It has got 3 or 4 horizontal arms pivoted on a vertical shaft metal caps are fixed at the end of the arms. When there is wind, the wind hits the caps which forces the arms to begin rotating. The rotation of these arms operate a meter which records the speed of wind in km per hour.

The higher the speed of wind the more the meter moves and vice versa.

Diagram:



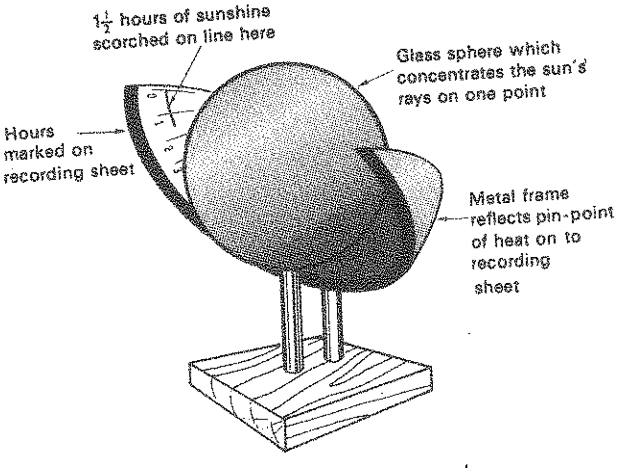
SUNSHINE

To measure the duration of sunshine for a day, meteorologists use a sunshine recorder or compabells stoke apparatus. It determines the hour of the day when it's brightest outside.

The instrument consists of a glassphere, recording sheet of paper and metal frame. The sphere focuses the sunrays on the sensitive recording card gradiated in hours. When the sunshine burns, it / scotches a line on the sensitive card in the hour when it was brightest. Faint sun rays even at down or when the sun is obscured, are not recorded.

A CAMPABELL STOKE APPARATUS / SUNSHINE RECORDER

Diagram:



VISIBILITY

This refers to the extent to which light or weather enables one to see things at a distance. Visibility varies due to constituents in the atmosphere. These include:-

- **Haze**

  This is a mass of smoke particles in the low atmosphere where humidity is relatively low.

  It reduces visibility to below 2km.

- **Mist**

  Water droplets formed as a result of condensation of water vapour floating at ground level. It reduces visibility to about 1000m.

FOG

Is a dense mass of water droplets containing smoke and water particles. Reduces visibility to less than 1000m.

TYPES OF FOG

(1) Smog

This is a type of fog which occurs in industrial areas where fog and smoke combine. It reduces visibility to less than 200m.

(2) **Advection fog** is a type of fog formed when warm air blows over a cold surface which cools it instantly forming fog.

(3) **Radiation fog** occurs as a result of the rapid cooling of the land surface which cools the air near the surface to saturation level, forming fog. It occurs in temperate regions during winter and in swampy areas in the tropics during early morning and night.

(4) **Sea fog** occurs when cooling takes place over water bodies where warm and cold ocean currents meet and the warm air above the warm ocean current rises above the cold ocean current which cools it instantly, forming fog.

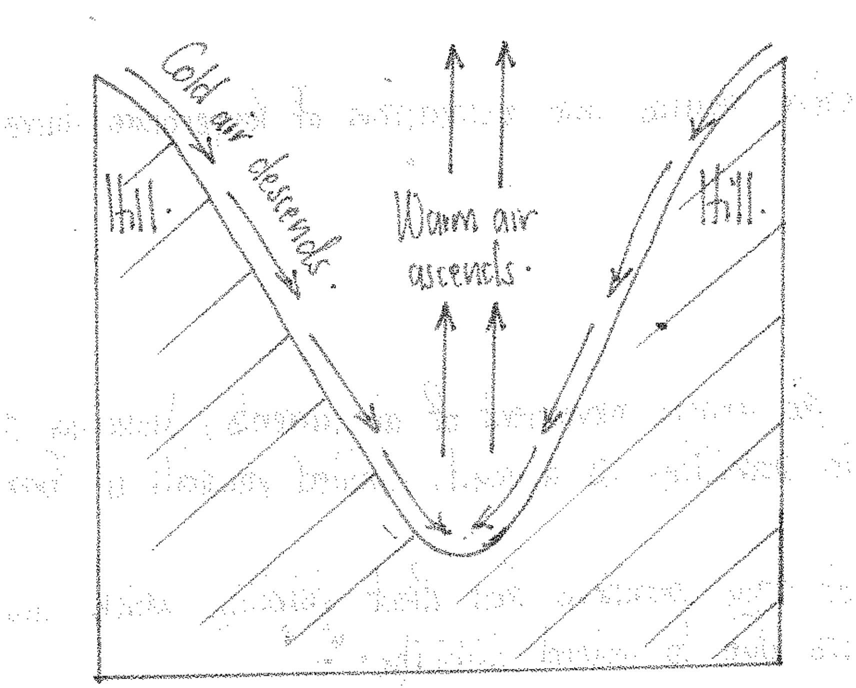
(5) **Frontal fog** formed when a warm air mass falls under a cold underlying air at a front forcing it to cool and condense to form frontal fog.

(6) **Hill fog** which occurs in hilly areas in the early morning. It occurs during dry and calm weather. During the day, much insolation is received, leading to intense heating of mountain slopes.

Radiation and rapid cooling occurs at night on the hill slope. Heavy cool dense/air descends into the valley and collects into the hollow displacing the warm air to higher levels. At the edges of cool and warm air, mixing occurs resulting into condensation at lower levels, forming hill fog.

GENERAL CAUSES OF FOG

Diagram:



- Meeting of cold and warm ocean currents.
- Rapid radiation (radiational form)
- Warm air blowing over a cool land / water surface (advection fog)
- Falling of warm air into a cold underlying air nearer the earth's surface at a front (frontal fog).
- Industrial emission of gases which combine with fog to form smog.

EFFECTS OF FOG

- It leads to poor visibility which leads to accidents.
- Leads to coldness related diseases e.g. pneumonia, Asthma.
- Frost conditions in valleys discourage the growth of some crops as it limits flowering and fruiting of crops.
- Cool conditions limit working hours.
- Unfavourable cold temperatures discourage settlement in valleys e.g. Kigezi highlands.
- In East Africa occurrence of fog in the morning is followed by clear skies and hot temperatures in the afternoon.
- Fog leads to temperature inversions.
- Fog may favour the growth of some crops such as pyrethrum, tea, sorghum and temperate crops e.g. apples, vines e.t.c.
- Fog results into easy spread of industrial pollutants at a high level i.e. industrial fumes being warm, rise first through fog and then spread fast on reaching the level of warm air.

TEMPERATURE INVERSIONS

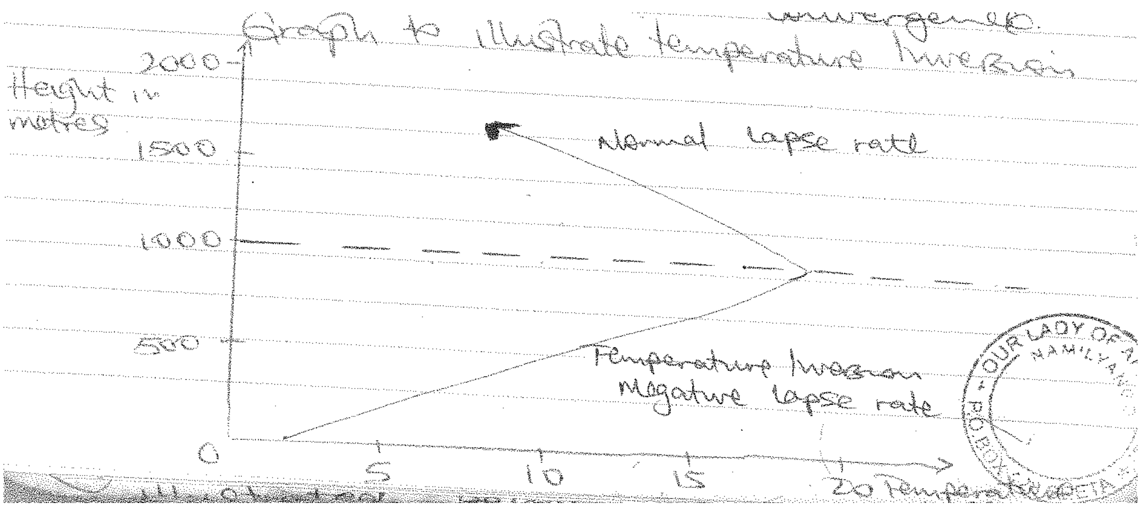
- Temperature inversion refers to an atmospheric condition in which air temperature increases with height into the atmosphere.

Note: It's the reverse of normal / environmental lapse rate where temperatures decrease with altitude.

- With temperature inversion, the higher you go, the warmer it becomes.

- However in the troposphere, the increase in temperature with altitude is up to a certain level referred to as the temperature inversion point level. Beyond this point, the normal lapse rate applies.
- In the troposphere, temperature inversion is a temporary phenomenon. It's experienced in the morning hours.
- As the temperatures rises/as the sun warms up the air, the condition later disappears.
- There are basically two forms of temperature inversions i.e. low ground level, temperature inversion especially in the hilly areas due to rapid outward radiation / when warm air is advocated over a cold surface.
- There is also the high level inversion that occurs due to frontal convergence.

Diagram:



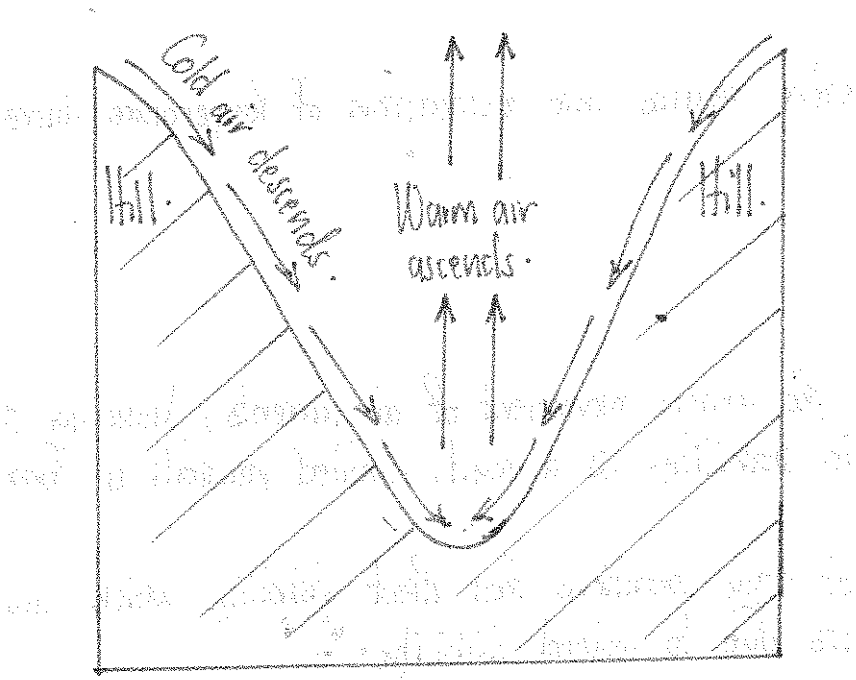
In East Africa, temperature inversions are common in hilly / mountainous areas and areas of limited cloud cover marked by air stability/calm weath.

CAUSES / CONDITIONS FOR TEMPERATURE INVERSIONS

- **Hilly and valley nature of relief.** Out radiation and rapid cooling at night on mountain / hill slopes, results into cold dense air. This dense cold air then descends down into the valleys under the influence of gravity and collects in the valley / hollow, displacing warm light air upwards to the higher levels. This results into formation of fog, mist and is normally experienced in the early morning.

- The subsidence of cold dense air results into temperature inversion referred to as Katabatic effect.
- It's common in Kigezi highlands, Ankole hills and central Buganda hills e.t.c.

Diagram:



- Radiation cooling due to rapid outward radiation by the surface at night due to limited or lack of cloud cover. This excessive loss of heat, results into a cold surface that cools the air immediately above it.
- Meanwhile the air layers further above are warmer since some of the heat is retained by the greenhouse gasses, humidity and dust particles. This may also be referred to as nocturnal radiation temperature inversion.
- Frontal convergence of two air masses of different characteristics i.e. the meeting of a warm light air mass and a dense air mass at a frontal zone. The warm air being lighter is lifted above the cold dense air mass or the cold air mass under cuts, the warm air leading to temperature increase with altitude.
- This is referred to as frontal/cyclonic temperature inversion and occurs within the ITCZ zone in East Africa.

- Advection also results into temperature inversion. This is when a mass of warm air current horizontally blows over a cold surface. The lower layers of the air mass will be cooled by the cold surface while the overlying layers remain warmer.
- The layer in contact with the cold surface may be cooled to form advection fog.
- This is referred to as advective temperature inversion.
- Trade winds blowing at a higher altitude tend to be warmer than the air close to the surface. This therefore results into a situation of temperature increase with altitude.

EFFECTS OF TEMPERATURE INVERSIONS

- Temperature inversions retard the vertical movement of air currents, inducing a state of atmospheric stability. As a result, limited rainfall is formed.
- Low rainfall may also be due to premature / surface condensation.
- Formation of fogy conditions that affect visibility / transportation which poses a risk of accident due to reduced visibility.
- Frosty conditions are created which discourage the growth of some crops.
- Frost tends to destroy the flowers of crops e.g. bananas and fruits.
- Cold / frosty conditions reduce morning working hours.
- Cold / frosty conditions discourage settlement in the valley bottoms.
- It leads to occurrence of coldness related diseases e.g. cold, Asthma e.t.c.
- It results into easy spread of industrial pollutants at high levels i.e. industrial fumes being warm, rise fast through the cold air and then spread horizontally on reaching the level of warm air.

HAIL / HAIL STORMS

Form of precipitation falling in form of small pellets of ice / hail stones. It’s made up of frozen rain droplets which range between 5 – 50mm in diameter.

It’s associated with extreme instability in the atmosphere resulting from uplift of air by convective currents.

It usually occurs, in unstable cumulo nimbus clouds where vertical uplift / rise of air are strong enough and carry condensed droplets above to great heights of the freezing level i.e. where they are turned into ice crystals at very high altitude.

The initial droplets freeze above the freezing point hence condensation nucleus ice. After being carried upwards to great height by upward currents, an additional layer of ice is formed on the original ice nucleus by collision and coalescence with super cooled water vapour / droplets around.

The pellets fall and rise many times until the weight of the enlarged ice crystals is sufficiently great to overcome any uprising current, then the crystals fall as hailstones due to gravity.

TEMPERATURE

Is the balance of heat released by the sun onto the surface and the heat lost by the earth to the atmosphere through radiation.

The world's atmosphere exists at varying temperatures and the main source of heat energy for the earth is the sun that measures upto 51800°C. The sun constantly emits solar energy which influences temperature on the earth. This solar radiation is what is known as the sun's insolation.

SOLAR RADIATIONS / SUN'S INSOLATION / HEAT RECEIVED

This refers to the total energy / heat released by the sun through the atmosphere onto the earth's surface where it's converted into heat energy which is eventually distributed onto the earth's surface and into the atmosphere to raise environmental temperatures. It passes into the atmosphere as a beam of short waves. It occurs during day time.

Note: The water, land surfaces and atmosphere all attract the emitted heat from sun's insolation.

TERRESTRIAL RADIATION

Refers to the heat energy transferred from the earth's surface to the atmosphere after receiving solar radiation which is converted into heat energy. Its transferred in form of long waves and occurs all the time i.e. both day and night.

The amount of terrestrial radiation varies with the nature of the earth's surface, area and size e.g. water surfaces emit less radiation than land surfaces. Mountain tops emit less radiation than lowlands.

Terrestrial radiation gives arise in atmospheric temperatures.

FACTORS INFLUENCING TEMPERATURE DISTRIBUTION

(1) Latitudinal location

The overhead sun in the tropics leads to hot temperatures because sun's insolation is distributed over a narrow area.

Whereas outside the tropics the sun appears to be at a distance and temperatures are correspondingly lower because sun rays are spread over a wider area and travel for longer distances.

(2) Movement of the overhead sun north and south of the equator.

An overhead sun in the northern hemisphere causes high mean annual temperatures in July while at the same time causing low mean annual temperatures over the Capricorn.

On the centrally an overhead sun in the January causes higher mean annual temperatures over the Capricorn in the southern hemisphere but at the same time causes low annual means of temperature over the cancer. (Northern hemisphere) at the same time.

(3) Altudinal location

High altitude areas have low temperatures throughout the year. Temperatures decrease with an increase in altitude this is because of the rare fied atmosphere. This makes higher altitudes unable to trap sun's isolation / heat and the heat escapes rapidly.

Whereas at low altitudes, the atmosphere is full of impurities which trap / preserve a lot of heat at the lower altitude. Hence raising environmental temperatures and it reduces as one gains height.

Infact environmental temperatures change at a rate of 1^oF for every 300ft rise and this is called environmental lapse rate.

(4) Prevailing winds

These influence environmental temperatures by transferring heat from one place to another e.g. the north east trade winds originate from the Arabian Desert and are hot winds. They raise the temperatures of Turkana and Karamoja.

In temperate latitudes ($45 – 65^o$), prevailing winds from the land to the sea lower winter temperatures but may raise the summer temperatures.

The prevailing winds from the sea to land, lower summer temperatures and raise winter temperatures.

In tropical latitudes, on shore winds modify temperature of coastal areas because they will have blown over cool ocean surfaces.

The local winds in different environments often produce rapid upward and downward changes in temperatures and the inland lakes and slopes of mountains.

(5) Ocean currents

These transfer temperatures from one place to another e.g. warm ocean currents like Mozambique, Guinea and Agulhas, have a warming effect which raises temperatures of the adjacent land masses.

On the centrally cold ocean currents such as Benguela and Canary currents, tend to lead to low temperatures on coastal lands adjacent to them.

(6) Cloud cover

Clouds reduce the amount of solar radiation reaching the earth's surface and amount of the earth's radiation leaving the earth's surface. This explains why day temperatures in tropics rarely exceed 30^{o}C and why night temperatures never fall below 21^{o}C.

Whereas the absence of clouds in desert and semi-desert environments explains why temperatures may rise above 38^{o}C and fall below 21^{o}C during the night.

(7) Large water bodies

Such as oceans, lakes, rivers, wetlands e.t.c. also have a cooling effect / moderating effect on mean annual temperatures through a combined effect of breezes and on shore winds on the adjacent land masses.

(8) Surface cover

These influence temperature due to the ability of such surfaces to absorb insolation.

Ice surfaces such as on mountain Rwenzori reflect heat hence low temperatures.

Whereas dark colored land surfaces absorb much insolation leading to high mean temperature ranges.

(9) Aspect

It influences temperature distribution in that slopes facing the direction of the sun are often warmer than the slopes on the other side of the sun's insolation e.g. in the tropics, the East facing slopes of mountain are warmer in the morning and cooler in the evening.

Whereas the west facing slopes are warmer in the evening and cooler in the mornings.

In the northern hemisphere, the south facing slopes are warmer than the north facing slopes whereas in the southern hemisphere the north facing slopes are warmer than the south facing slopes.

FACTORS FOR THE VARIATIONS IN HEAT RECEIVED / SOLAR RADIATION

(1) **The amount of heat received varies** due to obstacles between the sun (source of radiation) and the earth's surface.

(2) **Influence of cloud cover**. Cloud cover reflects, absorbs isolation and this reduces the amount of heat reacting the earth's surface.

(3) **Distance between the sun and the earth's surface**. This varies with altitude. The overhead sun gives higher isolation at the equator than at the southern and northern hemisphere during summer.

At the poles, the amount of the sun's isolation is low. This is also true of the northern and southern hemisphere during winter seasons. When the sun is far from the earth's surface. These are largely the effects of the earth's rotation.

(4) **Length of the day and night**. The day light hours of summer are longer than nights. This leads to more isolation / heat than during winter where the nights are longer and days are shorter in temperate regions, leading to less heat received.

(5) **Existence of increased greenhouse gases** and the depletion of the ozone layer. This makes ultra-sun's isolation reach the earth's surface, leading to more heat being received.

(6) **Influence of aspect**. Slopes facing away from the sun receive minimum heat well as slopes facing the sun receive maximum heat (more).

(7) **Latitudinal location influences the amount of heat received**. Tropical regions being astride the equator, receive maximum heat whereas those far away areas in temperate regions, receive less heat.

TEMPERATURE READING

(1) Diurnal range of temperature

= Difference between daily maximum and daily minimum temperature.

(2) Mean daily temperature

$$= \frac{Daily\ maximum + daily\ minimum\ temperature}{2}$$

(3) Mean monthly temperature

$$= \frac{Average\ daily\ temperature\ of\ the\ month}{Number\ of\ days\ in\ the\ month}$$

(4) Mean annual temperature

$$= \frac{Sum\ of\ mean\ monthly\ temperature\ of\ year}{12\ months\ of\ the\ year}$$

(5) Annual range of temperature

= Difference between maximum monthly temperature and minimum monthly temperature of the month i.e. the difference between hottest and coolest month of the year.

HUMIDITY

It refers to the amount of water vapour in the atmosphere.

FACTORS INFLUENCING HUMIDITY VARIATIONS IN EAST AFRICA

(1) Temperature

High temperatures encourage high rates of evaporation leading to high humidity while low temperatures lead to low rates of evaporation leading to low humidity.

Consequently areas with high temperatures e.g. around the equator like L. Victoria basin have high humidity while areas with low temperatures like the highland areas have low humidity.

(2) Water bodies

These are sources of water vapour consequently areas with large water bodies have high humidity while areas with limited water bodies e.g. North eastern Uganda, Northern Kenya have low humidity.

(3) Altitude

There is high humidity at low altitudes due to hot temperatures and being near water vapour sources and also because water vapour molecules are pulled downwards by gravity from high altitude well as areas at high altitudes e.g. mountains have low humidity.

(4) Vegetation cover

Areas with thick vegetation cover lead to high humidity. This is because the thick vegetation there is high evaporation leading to a lot of water vapour in the atmosphere whereas areas with scanty vegetation e.g. semi and vegetation in Karamoja, Turkana have low humidity because of limited evaporation.

(5) Air masses / winds

Winds have the ability to transport water vapour from one place to another, thus influencing the amount of water vapour in a given place e.g. the south east trade winds pick a lot of moisture from the Indian Ocean leading to high humidity at the East African coast.
The westerly winds from the Congo pick a lot of moisture from the Congo forest leading a lot of humidity in some parts of western Uganda.

The north east trade winds originate from dry areas leading to low humidity in northern Kenya and Karamoja.

(6) Ocean currents

Areas near Warm Ocean currents like of East African coast are affected by the warm Mozambique ocean currents have high humidity because of high evaporation.

Well as areas boardering Cold Ocean current like canary and Banguela currents have low humidity because the cold ocean currents don't experience evaporation because of the low temperatures.

(7) Human activities

Human activities like deforestation, swamp reclamation, bush burning e.t.c. reduce evaporation and evapotranspiration leading to low humidity in an area.

Man's activities like afforestation and reafforestation and cloud seeding increase humidity in an area.

(8) Continentality / distance from the sea

Areas near the sea tend to have high humidity because the sea is a source of water vapour while areas far away from the sea have low humidity because of being far away from water vapour sources.

(9) Seasonal, weather changes / ITCZ

When the sun is over head a certain area, there are hot temperatures resulting into high evaporation and high humidity. The hot temperature leads to low pressure resulting into being a zone of convergence (ITCZ) and winds that converge to such areas bring humidity from their sources, leading to high humidity in July in northern Uganda and in January in southern Tanzania.

(10) Influence of relief

The wind ward sides of mountains act as barriers to the moisture bearing winds hence loading to the high humidity on the wind ward sides of mountains.

Generally flat land areas e.g. northern Uganda, north eastern Uganda, central Tanzania and northern Kenya have less humidity because the moisture bearing winds just blow over such areas. Uninterruptedly without rising or being trapped / to a rise humidity of such areas.

Questions:

(a) Distinguish between absolute humidity and relative humidity.

(b) Account for the variation in humidity in East Africa (UNEB 2007)

WINDS

Wind is moving air blowing from one environment to another.

The development of wind is as due to many factors e.g. difference of wind in pressure and rotation of the earth.

FACTORS THAT INFLUENCE THE DEVELOPMENT OF WINDS

- Influence of the earth's rotation. Stationary air can be forced to move by the rotation of the earth i.e. as the earth rotates it forces stationary air to begin moving as wind.
- The rotation of the earth also deflects wind to the right in the northern hemisphere and to the left in the southern hemisphere.
- In the diagram below, the dotted lines represent the path that the wind would take if the earth was stationary.
- But winds don't follow the straight line, for they get deflected as shown by the continuous lines below (Pic.9)

DIFFERENCES IN PRESSURE AND TEMPERATURE

These influence wind in that air blows from high pressure zones where temperature is generally low to low pressure zones where temperature is high. This can be illustrated by land and sea breezes.

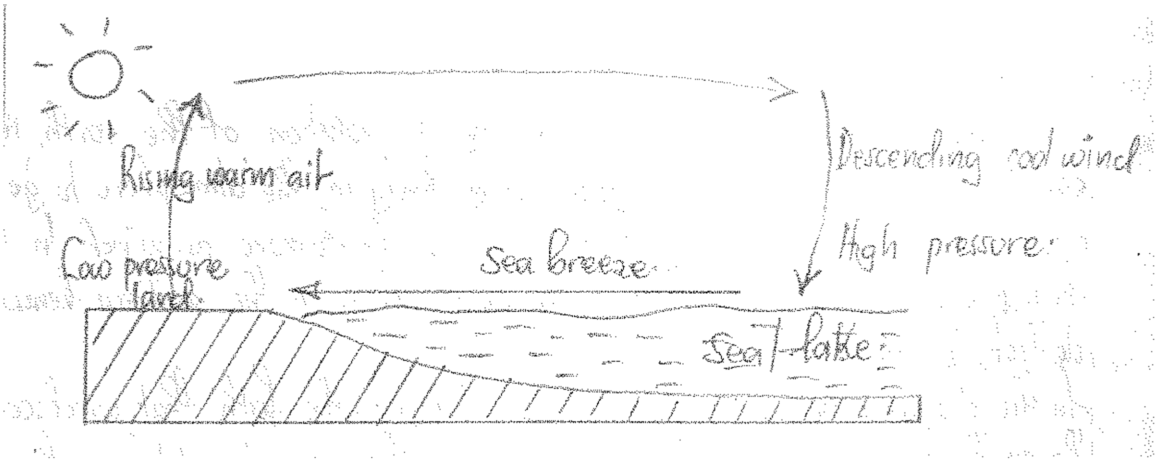
SEA BREEZE

A sea breeze is a local wind which occurs in areas where land is lying in close proximity to a water body e.g. shores of Lake Victoria and coastal areas of East Africa during the day.

During day time, land adjacent to the sea heats up much quicker than the sea / water.
Air above land becomes warmer, expands and begins to rise.

A cooler air from the sea then flows towards the land to occupy space of the rising warm air. The rising warm air eventually cools, condenses to form cumulo nimbus clouds and later results into heavy showers usually in afternoon.

Diagram:



EFFECTS OF SEA BREEZES ON CLIMATE OF ADJACENT LAND MASSES

- Lowering of temperature of land in the afternoon.
- It leads to formation of foggy / misty conditions on land and leads to poor visibility.
- On shore rainfall is formed which is usually received in the afternoons.
- It results into high thunder and lightning.
- It results into high humidity on land.
- It leads to formation of cumulo nimbus clouds after the warm air has been displaced upwards and has condensed.

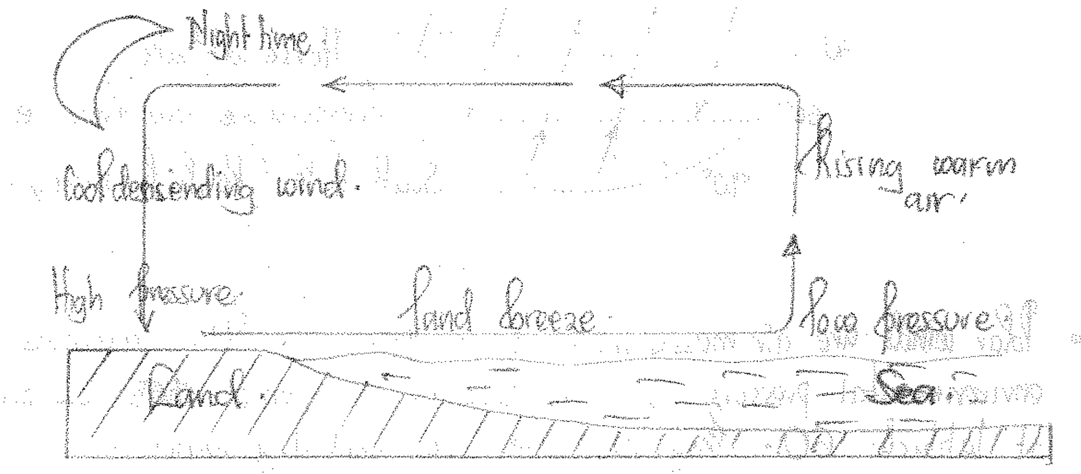
LAND BREEZE

Is a local which occurs in an area lying in close proximity to water body e.g. shores of L. Victoria, coastal areas of East Africa during the night.

During the night, the land experiences rapid loss of terrestrial radiation at coastal lands / shores. Cools much faster than the sea / water which retain much of its heat. Water loses heat much slowly such that air above it also warms up; low pressure is created over the warm sea and high pressure over a cold land.

Cold air from land where there is high pressure, blows towards the sea to replace the rising air hence a land breeze.

Diagram:



EFFECTS OF LAND BREEZE ON CLIMATE

- It decreases temperature of the sea.
- It leads to the formation of foggy conditions over the sea which results into poor visibility.
- Offshore rainfall is formed over the sea.
- Dry conditions on land because little or no rainfall is received.
- It results into violent thunderstorms and lightening.
- It results into high humidity over the sea or lake.
- It results into the formation of a thick cloud.

PREVAILING WINDS

Are winds / type of air masses which blows more frequently over a particular region.

Prevailing winds in different regions depends on environmental temperature-pressure systems and rotation of the earth.

The overhead movement of the sun determines the latitude within which the prevailing winds exist.

Prevailing winds are often named according to the direction from which they blow. The air includes polar winds, westerlies and trade winds.

Note: If the earth was stationary, winds would blow in the straight line but they are deflected to right in the northern hemisphere to the left in the southern hemisphere by the rotation of the earth.

CHARACTERISTICS OF POLAR WINDS

- Polar winds are air masses which blow from the poles where environment pressure is high towards the temperate low pressure zones at latitude 60. They are often cool and dry winds.
- They are more pronounced in the southern hemisphere. They are deflected to the right to become the north east polar winds and to the left in the southern hemisphere to become the south east polar winds.
- They are irregular in the northern hemisphere.

CHARACTERISTICS OF WESTERIES

- They blow from the horse latitude to the temperate low pressure latitude 60^o.
- They are deflected to the right to become the south westerlies in the northern hemisphere and to the left in the southern hemisphere to become the north westerlies.
- They are variable in both direction and strength.
- They contain depression.

CHARACTERISTICS OF TRADE WINDS

- They follow regular path / route.
- They blow from horse latitudes to doldrums.
- They are deflected to the right in the northern hemisphere to become north east trade and to the left in the southern hemisphere to become the south east trades.
- They are very constant in strength and direction.
- They sometimes contain intense depression.

Qn. (a) What is an air mass?
(c) Explain the influence of air masses on the climate of East Africa.

AIR MASSES

An air mass is a larger body of air with uniform horizontal temperatures and humidity conditions.

An air mass forms when stationary air settles over a larger area for long enabling it to acquire uniform conditions of humidity and temperature.

Air masses have got certain characteristics

- They have definite source origin / latitudes e.g. polar winds from the poles.
- Trade winds from the tropics
- Uniform humidity and temperature conditions.
- Air masses blow from areas of high pressure to areas of low pressure.
- They blow either overland (tropical continental) or over the sea (tropical maritime)
- Air masses converge at a front.
- They may modify completely/partially conditions of areas – they blow over.

Air masses which affect the climate of East Africa include:-

- Tropical maritime or south east trade winds. These originate from the Indian Ocean and blow on shore of the adjacent land masses.
- They lead to high humidity modified (cool temperature) cloudy conditions and heavy rainfall along the east African coast.
- They transverse mainland of Tanzania when they are hot and dry causing very hot temperatures less humidity, clear skies and dry conditions there.
- Over Lake Victoria they are recharged with moisture and deflected to the right at the equator thereby bringing conditions of high humidity, cloudy and wet conditions over the northern shores and north eastern shores of L. Victoria.
- However because of this deflection they blow off Ankole-Masaka dry conditions leading to low humidity, unreliable rainfall and clear skies.

NORTH EAST TRADE WINDS

These originate from the Arabian desert drop all their moisture on the leeward side of Ethiopian highland and on descending into northern Kenya, north western Kenya and north eastern in

Uganda they are dry and hot, causing conditions of very low humidity, clear skies and low / unreliable rainfall.

Often times, tropical marime and the north east trade winds meet at the I.T.C.Z and in the process, the warm moist tropical air masses are forced to rise, thereby giving rise to cumulo nimbus clouds, light variable winds, frequent thunderstorms and cyclonic rainfall.

Westerlies

These blow from Congo basin and they are warm and moist. During their east ward journey, they blow over western Uganda highlands bringing heavy rainfall, thick cloud cover, high humidity, modified temperatures.

On descending the leeward side of, the western Uganda highlands the western are hot and dry which cause conditions of no clouds, no rainfall, very hot temperatures e.t.c. in eastern Kasese and Ankole - Masaka dry corridor.

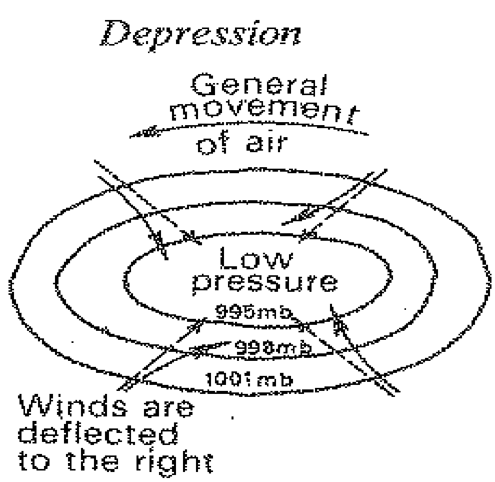
DEPRESSIONS / CYCLONES. "AKAZIMU"

A cyclone is a low pressure cell or it's a mass of air whose isobars form an oval shape with low pressure at the centre but increases towards the outside.

Cyclones develop when two air masses meet and as a result they start swirling either anti clockwise in the northern hemisphere or clockwise in the southern hemisphere.

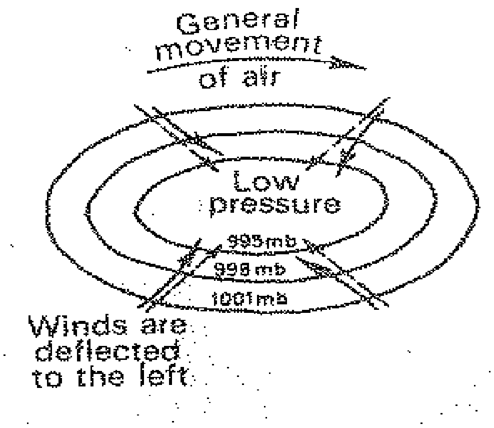
(a) Northern hemisphere

<u>Diagram</u>



(b) Southern hemisphere

<u>Diagram</u>



Depression are well developed in the westerlies along latitude 60 and they sometimes develop in the tropics especially in the doldrums / in the tropics.

MAIN CHARACTERISTICS OF CYCLONES / DEPRESSIONS

Depressions in the Northern hemisphere have their air circulating in anticlockwise direction and in the southern hemisphere; they swirl in a clockwise direction. This is mainly because of air deflection resulting from the rotation of the earth.

Depression often have very low pressure at the centre. This is often as a result of the warm environmental conditions.

Temperate cyclones develop cyclonic rainfall which is in form of drizzles and last for longer periods. Whereas cyclonic rains in the tropical cyclones are often in form of heavy showers and last for shorter periods.

Cyclones develop converging winds due to low pressure at the centre. The converging winds are often misty and cause rainfall which cools the area to create a high pressure zone. Cyclones are often cloudy and have a lot of moisture due to the converging moist winds.

TYPES OF CYCLONES

(1) Temperate (Mid-latitudes) cyclones

These are low pressure cells which develop in the temperate regions as a result of polar winds from the Polar Regions meeting with the westerlies from the tropical high pressure latitude

30ºN and S of the equator at the temperate low pressure latitude 60 which begin to swirl to create low pressure at the centre.

(2) Tropical cyclones / low latitude cyclones

These are low pressure cells which form as a result of trade winds meeting at the doldrums or within the tropics swirling and creating low pressure at the centre.

EFFECTS OF CYCLONES OR DEPRESSION ON CLIMATE

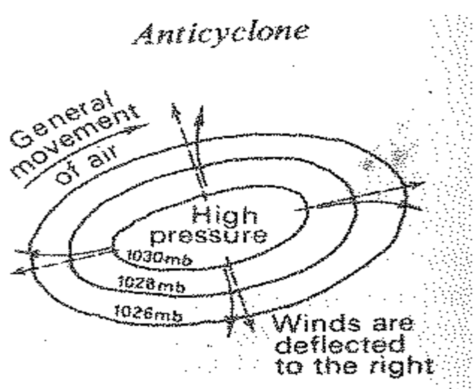
- Lead to the development of strong converging winds due to low pressure at the centre.
- Associated with low pressure at the centre due to the warm environmental conditions.
- Associated with high temperature at the centre due to the warm conditions.
  Leads to thick cloud cover due to moist
- Lead to foggy conditions.

ANTICYCLONES

These are high pressure cells. They develop when two air masses of great density meet at a front, causing a high pressure at the centre which later sets off diverging winds.

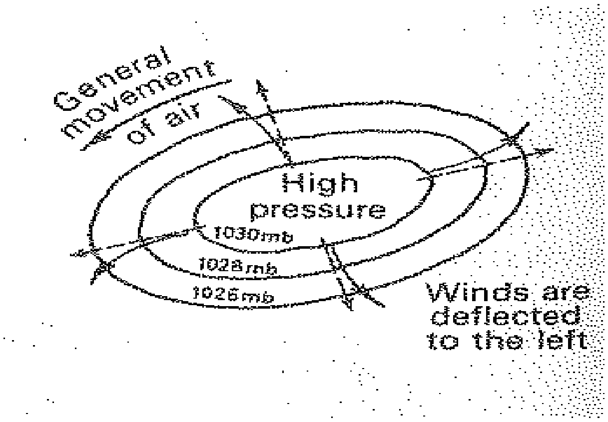
(a) Northern hemisphere

Diagram



(b) Southern hemisphere

Diagram



CHARACTERISTICS OF ANTICYCLONES

- They swirl clockwise in the northern hemisphere and anti-clock wise in the southern hemisphere due to rotation of the earth.
- Develop high pressure at the centre due to cool environmental conditions. They are associated with diverging winds due to high pressure at the centre.
- They are associated with clear skies due to the diverging cool dry winds.
- They lead to dry conditions due to the divergence of winds.
- Lead to no humidity due to dry cool diverging winds.

LOCAL WINDS

A local wind are winds which develop as a result of local environmental conditions and cover a small geographical area.

Local winds may develop around pressure cells /cyclones water bodies and mountains, they include:

(1) Depressional winds

Those are converging winds which develop in depressions / cyclones due to low pressure.

(2) Land and sea breezes

Note: Refer to previous notes.

(3) Ascending (Anabatic) and Kabatic winds / descending winds

These are local winds which develop as a result of the existence of a hill / mountain in the environment

ASCENDING (ANABATIC) WINDS

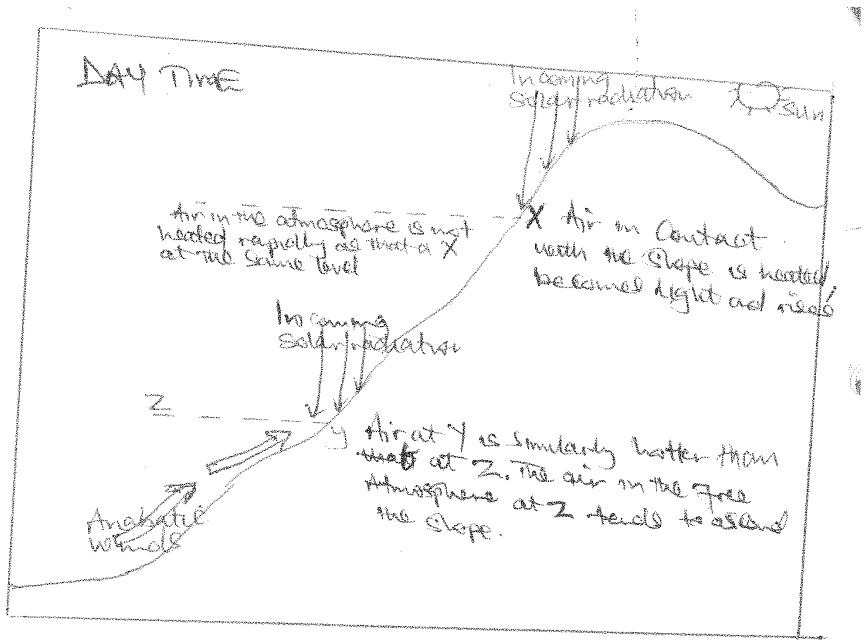
These are local winds which blow from the valley up the mountain slopes during day. They are as a result of differential heating of the slopes both at lower or upper slopes.
Thus during the day, the sun heats up the slope more than the valleys because they are exposed.

The air in contact with slopes is heated, expands, becomes light and begins to rise thus convectional rising of air on the upper slopes. This creates a low pressure area on the slopes.

The cool and dense air in the valleys where there is high pressure rises up the slopes to displace or replace the light warm air up slope. These winds from the valley flowing upslope are called Anabatic / Ascending winds.

Ascending winds cool at a rate of 4.5^0C for every 1000m ascent.

Diagram



WEATHER CONDITIONS ASSOCIATED WITH ANABATIC WINDS

- ✓ It leads to formation of mist and fog in the upper slopes of mountains.

- ✓ It triggers off convectional currents which leads to formation of orographic rainfall in mountainous areas.

- ✓ It leads to formation of low clouds in the highland areas due to its cooling of air to and beyond its dew point / condensation level.

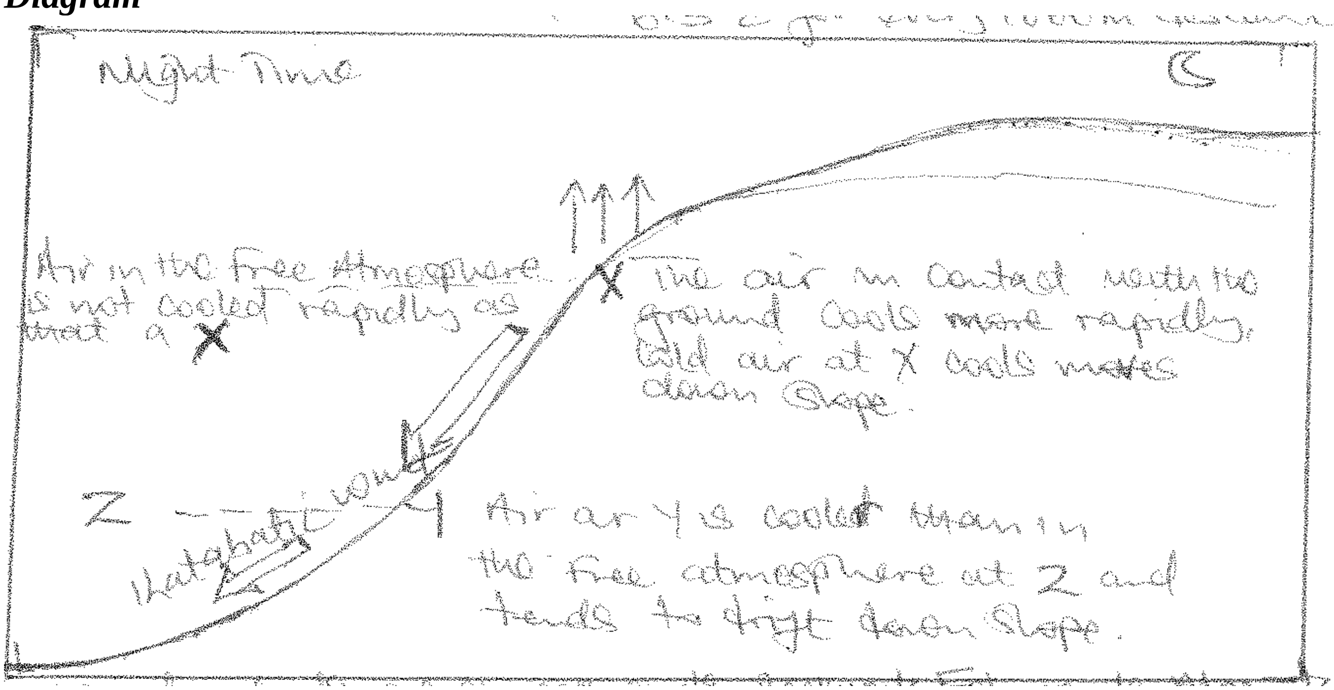
- ✓ Anabatic winds transport cold temperatures to the upper slopes.

KATABATIC WINDS / DESCENDING WINDS
There are winds which flow down slope under the influence of gravity during the night.

Because the slopes are more exposed than the valleys, they lose a lot of heat through radiation, then cool down much faster than the valleys. Hence becomes areas of high pressure. So the air becomes denser than the air in the valley which is warm and light creating a low pressure area.

So wind from upper slopes descends down in the valley. This wind is called the katabatic wind. Katabatic winds warm at a rate of 6.5^{0}C for every 1000m descent.

Diagram



WEATHER CONDITIONS ASSOCIATED WITH KATABATIC WINDS

- ✓ They cause frost due to rapid cooling in valley areas.

- ✓ Temperature inversions take place. This is where cold air in the valley is colder than air above it.

- ✓ Leads to formation of fog and mist due to radiation cooling.

1. LAND AND SEA BREEZES
These are local winds which develops as a result of the existence of a river or lake in an environment.

The lake and rivers lead to environmental temperature differences and pressure distribution such that air will be set in motion to create sea and land breeze.

Note; refer to the previous work

Note:Both local and prevailing winds influence the environmental climate by bringing about changes in the environmental temperature, Rain fall, cloud cover, atmospheric moisture, pressure systems and other elements of wather.

PRECIPITATION AND RAINFALL

It is the condensation of water moisture which may be in form of a gas into small water droplets as a result of very low temperatures.

Precipitation results into the rainy clouds, mist, fog or dew. It is this precipitation which may lead to the development of rainfall in various regions.

RAINFALL

Rainfall is a type of precipitation in form of rain droplets.

TYPES OF RAINFALL

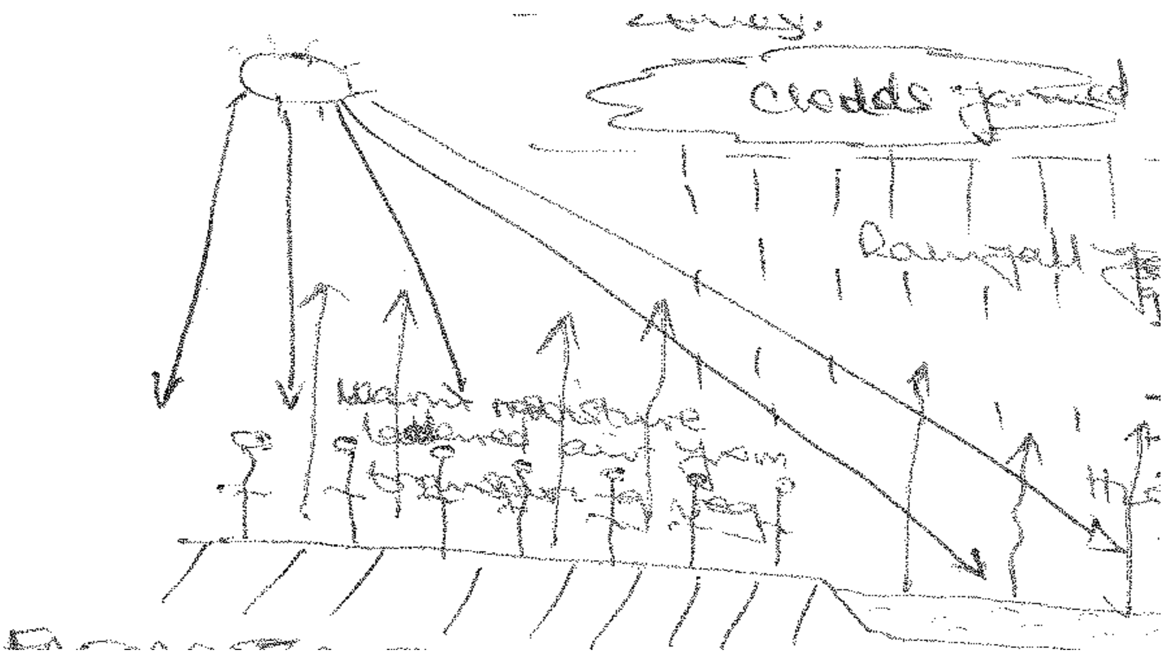
(1) Convectional rainfall.

This is the type of rainfall received around water bodies and forests.

It's received during the day when there is maximum heating by the sun's insolation. The heating of the earth's surface by the sun which causes evaporation of the water bodies and release a lot water vapour which rises and condenses on reaching the condensation level causing thick clouds which consequently result into heavy rainfall which is normally received during the day when there is maximum heating and in the early hours on the morning due to land breeze.

It is received in Lake Victoria basin around Budongo forest, Bwindi e.t.c.

<u>Diagram:</u>



Conditions / factors for development of convectional rainfall

- Presence of large water bodies and forest which supply a lot of water vapour through evaporation and evapo-transpiration.
- Hot temperatures resulting from maximum heating by the sun's insolation which result into high evaporation and evapo-transpiration rates.

Land and sea breezes

Latitudinal location astride the equator where the sun is overhead which causes maximum heating and evaporation and evapotranspiration rates.

Position of the sun

Where the sun is overhead, there is maximum heating which results into high evapotranspiration and evaporation rates thus facilitating convectional rainfall.

- Human activities – Afforestation
- Altitude ie low altitude characterized by hot temperatures
- Trade winds ie South East trade winds along the East African Coast.

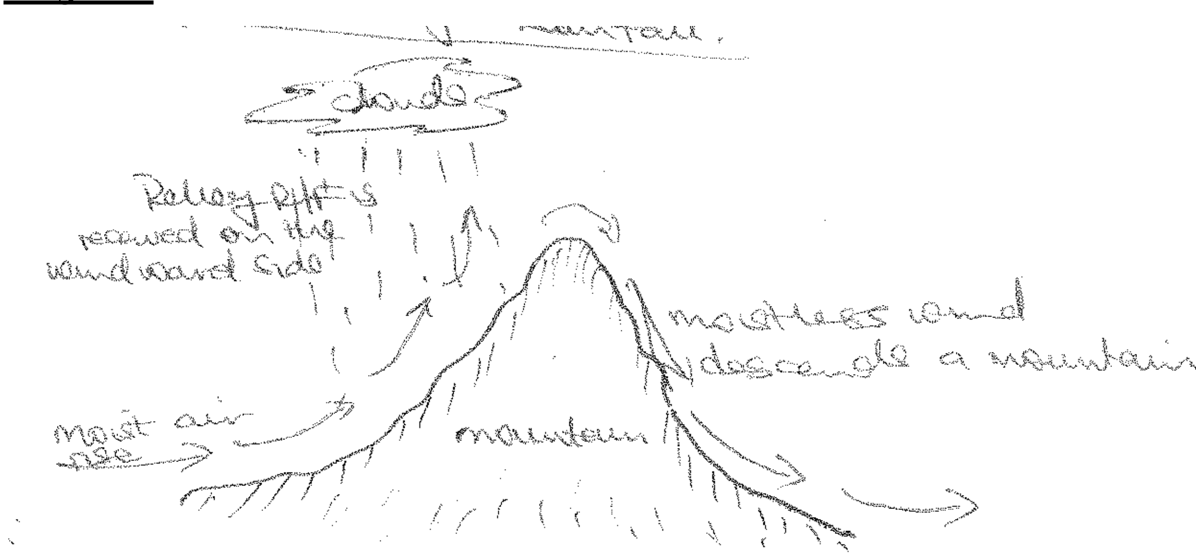
(2) RELIEF / OROGRAPHIC RAINFALL

It is a type of rainfall received in highland areas like Rwenzori, Kilimanjaro, Kenya and Elgon.

It is formed when warm moist air is forced to rise by a mountain acting as a barrier against free flow of wind on the earth's surface.

On rising, the moisture in the wind is condensed at a high altitude and later develops into clouds which consequently result into heavy relief rainfall on the windward side of the mountain side as the leeward side / slope remains dry and rainless because of the hot dry descending winds.

Diagram:

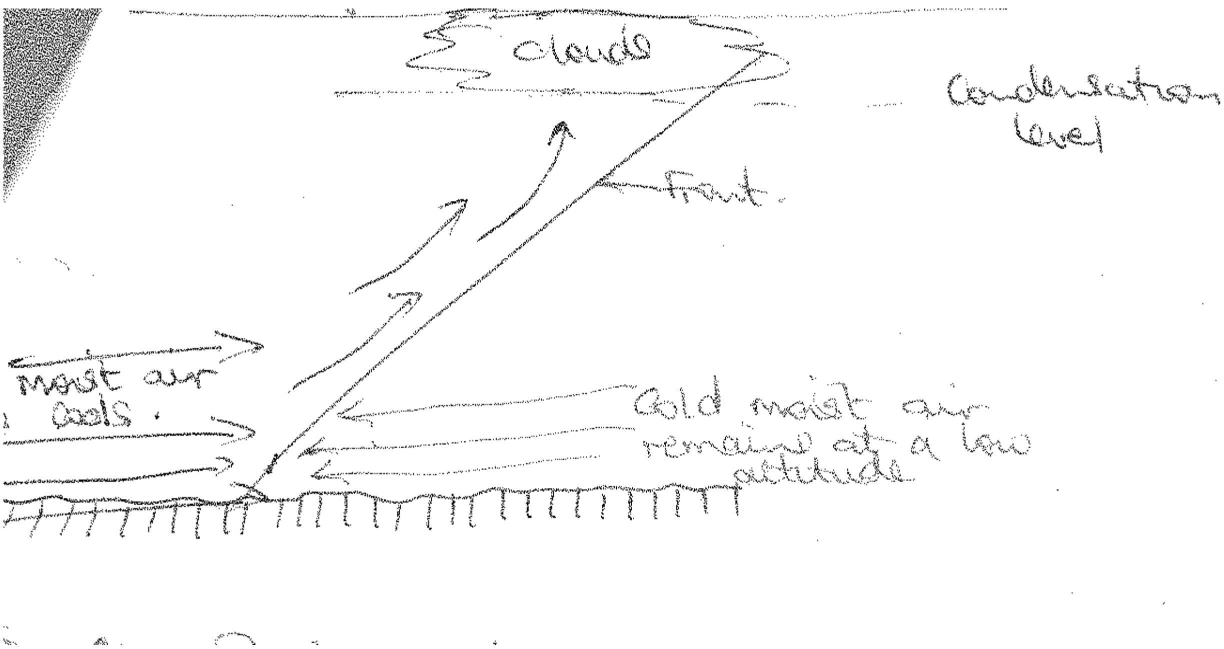


(3) FRONTAL RAINFALL

It is a type of rainfall which is received in depressions / cyclones. It develops when two air masses of different characteristics meet at a front; the warm air is forced to rise over the cool air and on reaching its dew point. It condenses to form clouds which consequently result into formation of cyclonic, frontal, depressional rainfall.

Frontal rainfall in temperate regions in form of drizzles which last for longer periods where as in the tropics, it is in form of heavy showers which last for shorter periods.

Diagram:



OCEAN CURRENTS

Ocean currents are general movements or drift of the surface waters of the ocean in a defined direction.

They are generated / caused by;

(1) **Differences in salinity or density of ocean waters**. Water with a high salinity thus flows to areas of less salinity and vice versa e.g. the surface current which flows from the Mediterranean Sea to the Atlantic Ocean is due to high salinity of the Mediterranean Sea due to the limited rainfall and limited number of inflowing rivers plus a high evaporation rate.

(2) **Effects of winds.** Prevailing winds tend to drift water / of oceans from one place to another creating different currents, the north east and south east trade winds e.g. generate oceanic currents that move from mid-latitudes towards the equator.

(3) **Earth's rotation.** It inflicts a deflective force over the oceans called cariolis force. This causes the currents to flow clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere.

(4) **Shape of the adjacent landscape / Nature of coast / Coastal configuration.**

The coastal configuration and the presence of sub-marine ridges can also cause currents. Both the north equatorial and south equatorial currents are deflected north and south respectively due to the shape of the coast.

(5) **Tides**. The sun and the moon exert a gravitation pull onto the earth's surface. This results into rising and falling motions to develop on water of large oceans. These risings and fallings, produce tides which result into movement of ocean water in form of currents.

WARM OCEAN CURRENTS

This refers to the drift / movement of surface ocean waters which have relatively high temperatures than the surrounding areas e.g. the Guinea current on the coast of Guinea, Brazilian current on Brazilian coast, North Atlantic drift on the coast of UK, Norway, Kurosiwa current along the coast of Japan, Mozambique current on Mozambique coasts.

CHARACTERISTICS

Characterized by hot temperatures e.g. Brazilian current.

- They flow from low latitudes to high latitudes i.e. they flow pole wards from the equator.
- Generally flow on the eastern sides of continents in low latitudes e.g. Brazilian, East Australia currents except for Guinea currents.
- In the mid-latitudes and high latitudes, they generally flow on the western side of continents e.g. Pacific currents and North Atlantic drift.
- Characterized by low density / high salinity.
- Flow on the surface but lose temperatures as they flow towards the poles.
- Move clockwise in the northern hemisphere e.g. gulf stream and anticlockwise direction in the southern hemisphere e.g. East Australian and Mozambique currents.

INFLUENCE OF WARM OCEAN CURRENTS ON THE CLIMATE OF ADJACENT LAND MASSES
(Effects of warm ocean currents)

- They tend to raise the temperature of the adjacent land masses due to the warm on shore winds blowing over it e.g. the North Atlantic drift raises temperatures of coasts of Portugal, Britain, Norway and ocean ports remain ice free in winter.

- Durban on the eastern coast of South Africa is affected by the warm Mozambique Ocean current and has temperatures of 24.4°C compared to Port-Nolthi of the west coast on the same latitude which has 15.5°C because of the cold Benguela current.
- They increased the humidity of adjacent land masses because of moist on shore winds which blow over them and due to high temperatures which enhance evaporation e.g. areas like Natal which are affected by the warm Mozambique current and Western Europe washed by the North Atlantic drift.

- They enhance the formation of cyclonic rainfall when warm moisture laden air rises over cold dry air. Also much rainfall is received in Natal because of the warm Mozambique current this is because of the warm Mozambique currents.

- They increase the cloud cover of adjacent land masses. This is because as winds blow over the warm ocean currents they absorb the moisture over that current and became moisture laden. As winds meet the current the vapour is cooled down to condensation level leading to formation of thick moist Cumulo Nimbus clouds e.g. the West Europe coast washed by the warm North Atlantic drift.

Other effects:

- As warm ocean currents induce heavy rainfall this has favoured plantation farming e.g. Natal sugarcane plantations, Cocoa and Palm oil plantations along the West African coasts, boarder warm currents.

- The heavy rainfall received has promoted the growth of thick tropical rainforests e.g. along the West African coast boardering warm Guinea currents. This has promoted lumbering.

- The warm ocean currents passing along the East African coast has favoured coral reefs which have boosted the cement and tourism industry.

- Favoured the growth of planktons which have favoured the growth of fish hence boosting the development of the fishing industry.

COLD OCEAN CURRENTS

These refer to drifts or general movement of the surface water of the ocean in defined direction characterized by lower temperatures than the surrounding areas e.g. Canary current along Morrocan coast, Benguela current along the Namibian coast, Peruvian currents along the coast of Peru, Californian current along the coast of California, Oyashio current along the coast of Japan.

CHARACTERISTICS:

- They are characterized by low temperatures e.g. the canary current along the Moroccan coast.
- They flow from high latitudes to low latitudes i.e. they flow equator wards from the poles.
- Generally flow on the western sides of continents e.g. Benguela currents, Peruvian (humboldt current) and in the mid-latitudes, they flow on the eastern sides of continents e.g. Labrador and Oyoshio.
- Characterized by high density / less salinity.
- Characterized by upwelling along the coast.

EFFECTS (on climate of adjacent land masses)

- Tend to lower the temperatures of the surrounding areas / land masses due to the influence of land and sea breezes e.g. Benguela current lowers the temperature of the adjacent Namib coast e.g. Walvis bays average temperature is 16^{o}C compared to Durban's 25^{o}C at the same latitude.

- They are associated with offshore winds and cause low levels of condensation leading to the development of desert conditions e.g. Sahara, Kalahari and California which are adjacent to canary, Benguela and Californian currents respectively.

- Cause the formation of offshore fog when there is rapid radiation cooling e.g. there are frequent fogs at Sanfranscisco and also North east Canada because of the Labrador current.

- They are associated with a low humidity and low cloud cover.

- Coasts of higher latitudes which are boardered by the cold ocean currents in contrast their slopes are characterized by cold winters and cool summers.

Other effects:

- Cold ocean currents favour fishing. This is because they favour the growth of planktons which attract fish in an area that's why major fishing grounds boarder cold ocean currents e.g. Cape Agulhas and Moroccan fishing grounds boarder cold currents.

- Aridity along the cold ocean currents has encouraged pastoralism e.g. pastoral group of Fulani of Sahel and Hottentos of Namibia.

Qn1. Examine the effects of ocean currents on the climate of adjacent land masses.

- ***Approach:***
- Define ocean currents.
- Causes
- Types.
- Characteristics of each type.
- Effects of each type.

Qn2. Examine the effects of warm ocean currents on the climate of adjacent land masses.

- ***Approach:***
- Define warm ocean currents.
- Give examples.
- Explain the causes.
- Characteristics.
- Effects on climate.

CLIMATE OF EAST AFRICA

Although East Africa lies outside the equator, its climate is not purely equatorial. This is because of a number of factors.

CLIMATIC ZONES OF EAST AFRICA

(1) Equatorial climate

This is confined to limited areas of East Africa i.e. areas laying astride the equator between 0.-5^o North and south of the equator e.g. shores of Lake Victoria, coastal areas of East Africa, Kigezi highland, Kenya highlands, islands of Lake Victoria e.g. Ssese island.

Characteristics:

- Temperatures are generally hot. There is great uniformity of temperature throughout the year between 25 – 28^{o}C on average.
- It has a small diurnal range of temperature between 2 – 3^{o}C on average.
- Receives heavy rainfall of 1500mm – 2000m per annum.
- Convectional type of rainfall is received during afternoon, evenings and early morning accompanied by thunderstorms and lightning.
- Rainfall is well-distributed throughout the year.
- Double maxima rainfall with two peaks in March to May and September to November each year (Bi-modal pattern)
- Thick cloud cover.
- High humidity of over 80% due to high rate of evapotranspiration and evaporation.
- It is no clear/marked dry season.
- There is dominated by converging winds at the ITCZ hence region of calmness. Thus, the presence of low pressure.

(2) Tropical / Savannah climate

It is experienced in areas located between 5 – 15^{o}N of the equator e.g. in the Nyika plateau, Luwero, Bukoba, North of Tanzania, parts of Northern Uganda.

Characteristics:

- Alternate dry and wet seasons. Dry seasons between two – four months (2 - 4) months.
- Mean monthly temperature range between 25 – 38^{o}C.
- Great diurnal range of temperature during the dry season of about 10^{o}C.
- Moderate rainfall of between 760m – 1000mm and it increases towards the equator.
- Rainfall reliability is less.

- Rainfall is associated with thunderstorms.
- Convection rainfall is received.
- Moderate humidity of 50%.
- Fairly dense cloud cover dominated by cumulo nimbus clouds.

(3) Arid / Semi-Arid climate

It is experienced in North eastern Uganda, Ankole-Masaka corridor Rift valley floor in Kasese, L. Albert flats, North western Kenya (Turkana), north eastern Kenya, and Central Tanzania.

Characteristics:

- Low rainfall total of less than 500mm per annum.
- Unevenly distributed rainfall which is unreliable and seasonal is received.
- Very hot temperatures of over 30^oC.
- High diurnal range temperature of 10^oC.
- Less or no cloud covers especially during dry seasons.
- Has no definite wet season.
- Low relative humidity usually less than 20% because of intensive clear skies and low levels of evapotranspiration.
- Has a long dry season of over 9 months and a short wet season of only 3 months.
- The air / wind is dry due to constant desiccating / dry winds blowing across the area.

FACTORS INFLUENCING THE CLIMATE OF EAST AFRICA

(1) Altitude

It affects climate because climatic conditions change with increasing altitude. Areas of East Africa at high altitude e.g. mountain Rwenzori, Kenya, Elgon e.t.c. experience high levels of condensation which leads to the formation of thick clouds and consequently receive heavy rainfall. This is possible due to the very low temperature.

At the same time, areas at such high altitudes over 1000m above sea level experience very cold temperatures because of the rarefied atmosphere. Whereas areas at low altitudes like rift valley floor, experience limited condensation due to the hot temperature and therefore are characterized by very low humidity, limited cloud cover, very little and unreliable rainfall.

Altitude also affects atmospheric pressure. Places at low altitude experience high atmospheric pressure e.g. the East African coast whereas, areas at high altitude of highland areas of East Africa experience low pressure.

(2) Latitudinal location

It affects climate in that places which lie astride the equator e.g. Entebbe, Mukono, Wakiso and Jinja receive heavy reliable and evenly distributed rainfall because of excessive evapotranspiration due to overhead sun. East Africa also generally experiences hot temperatures most of the year due to the overhead sun which raises the environmental temperature.

Note: However the temperature and rainfall keep on changing with the movement of the overhead sun.

(3) Deforestation

This has involved clearing of large expenses of forest cover for charcoal burning, timber production e.g. Nakasongola, Northern Uganda.

This has deprived the atmosphere of sources of water vapour thus leading to reduced rainfall, reduced humidity, increased temperature and limited cloud cover.

(4) Industrialization

Massive industrial development especially in Kenya has led to a massive emission of thousands of tons of carbon monoxide in the atmosphere which has led to depletion of ozone layer thus leading to ultra-sun’s isolation reaching the earth’s surface thus leading to extremes of temperatures, reduced rainfall, reduced humidity, cloud cover e.t.c.

(5) Relief / Aspect

Mountainous areas of East Africa e.g. Kenya, Elgon, Rwenzori act as barriers to the blowing winds which forces them to rise and condense on the windward side of these mountains which raises humidity, cloud cover and the heavy rainfall received in these areas e.g. Kabale, Bundibugyo whereas the leeward sides of these mountains e.g. Ankole, Masaka dry corridor, Albert flats, North eastern Uganda experience hot dry descending winds which lead to arid conditions of very little and unreliable rainfall, low cloud cover, low humidity, very hot temperature.

Flat areas of East Africa e.g. central Tanzania, Northern Kenya, North eastern Uganda experience arid conditions of very hot temperatures, very low humidity, little and unreliable rainfall, limited clouds because winds just blow across such areas without rising to form rainfall.

Aspect influences climate of East Africa in such a way that the east facing slopes of mountains / hills experience warm temperatures in the morning because they are facing the direction of the rising sun and experience cool temperatures in the evening because they are facing away from the direction of the setting sun whereas west facing slopes are warmer in the evening because they are facing the direction of the setting sun.

The mountainous areas of East Africa experience temperature inversions at night due to the cold descending winds into the valleys which displace the warm air upwards leading to increase in temperature with altitude, a situation commonly known as temperature inversions.

(6) Influence of water bodies.

The availability of large water bodies in only a few regions of East Africa has also contributed to the climatic variations. Areas surrounding lakes e.g. Victoria shores receive heavy rainfall, high humidity, thick cloud cover due to the high evaporation rates of these water bodies which when heated lead to high water vapour in the atmosphere which condenses. Water bodies also moderate temperatures in East Africa through land and see breezes at different times of the day e.g. along the shores of L. Victoria and along the East African coast.

Whereas areas of East Africa without large water bodies e.g. central Tanzania, Northern Kenya, North eastern Uganda are devoid of sources of water vapour. Therefore this makes them have low humidity, limited cloud cover, very low and unreliable rainfall and therefore frequently suffer from prolonged droughts.

(7) Influence of vegetation cover.

Areas of East Africa with thick vegetation cover e.g. Mabira forest, Budongo, Bwindi impenetrable forest, Mangroove forest along the East African coast experience high rates of evapotranspiration leading high humidity, thick cloud cover, and heavy rainfall. These thick forests also have a modification effect of lowering environmental temperatures. Whereas areas of East Africa with scanty vegetation e.g. North Eastern Uganda, Northern Kenya, Central Tanzania, Albert flats, Ankole-Masaka corridor experience low evapo-transpiration rates, leading to arid conditions and very limited and unreliable rainfall, very low humidity and limited cloud cover.

(8) Influence of the position of the overhead sun.

The position of the overhead sun greatly affect the climate of East Africa. Particularly the location of the ITCZ zone which is a low pressure belt and a zone of convergence of winds.

The overhead sun twice a year in March and September leads to hot temperatures, heavy rainfall along the equator due to the high evaporation and evapo-transpiration rates hot temperature and therefore convergence of winds lead to high humidity; the thick cloud cover and consequently high rainfall while the rest of East Africa remains dry during the period.

In January the overhead sun in the southern hemisphere leads to hot temperature, low pressure, convergence of winds and therefore high humidity, thick cloud cover and consequently heavy rainfall in southern Tanzania. At the same time, Northern Uganda is dry.

In July, the overhead sun in the Northern hemisphere lead to hot temperatures, low pressure convergence of winds and therefore high humidity, thick cloud cover and consequently heavy rainfall in Northern Uganda. At the same time southern Tanzania is dry.

(9) Influence of the rotation of the earth.

When the earth rotates, it deflects winds to the right in the Northern hemisphere and to the left in the southern hemisphere.

The deflected winds cause variations in the local climate in various parts of East Africa e.g. the deflected North east trade winds are partly responsible for the aridity conditions in the North eastern parts of Kenya.

(10) Influence of air masses or trade winds

The North east trade winds which lose all their moisture on the Ethiopian highlands cause arid conditions of limited cloud cover, very low humidity and little or no rainfall in North eastern Uganda, North eastern Kenya and North western Kenya.

The south east trade winds from the Indian Ocean are moisture laden and therefore cause high humidity, thick cloud cover and heavy rainfall along the East African coast.

As they continue to cross central Tanzania, they are hot and dry and therefore cause conditions of low humidity, limited cloud cover and very little and unreliable rainfall.

As they continue blowing inland, they are deflected to the right and cross Lake Victoria which remoisturises them. This makes them to cause heavy rainfall, thick cloud cover and raise humidity in the northern shores of Lake Victoria.

The Westeries from the Congo, on ascending the western Uganda highland, cause heavy rainfall, thick cloud cover and raise humidity on the windward side e.g. Kabale, Kisoro and Kasese.

As the westeries descend the western Uganda highlands, they are hot and dry causing very low cloud cover, low humidity, very little and unreliable rainfall in Albert flats, Ankole-Masaka corridor and Kasese.

(11) Human activities

Human activities of afforestation and re-afforestation and forest conservation like Mabira, Bwindi, mountain Elgon and Rwenzori forests have helped in constantly supplying the atmosphere with water vapour hence leading to high humidity, thick cloud cover and heavy rainfall.

Whereas human activities of swamp reclamation, deforestation, bush burning, overgrazing deprive the atmosphere of water vapour sources hence leading to conditions of very hot temperatures, limited cloud cover and very little rainfall.

Qn1. Examine the factors that influence the climate of East Africa.

Qn2. Although East Africa lies astride the equator its climate is not purely equatorial. Discuss.

Qn3. To what extent do air masses influence the climate of East Africa?

Approach: to qn 1 and qn2

- Define climate.
- Describe the climatic types of East Africa i.e. identify them, locate them and describe all the characteristics of each.
- Explain the factors that influence the climate of East Africa.

Account for the formation of coral landforms.

Approach:

- Define coral landforms.
- Describe the conditions.
- Describe the formation process.
- Describe types.
- Describe the three theories.

Note: Don't give factors and conditions.