

DRAINAGE SYSTEM IN EAST AFRICA

Drainage system is a network well-defined channels through which water flows. The drainage system of an area is the outcome of the geological time period, nature and structure of rocks, slope, topography, amount of water flowing and the periodicity of flow.

RIVERS AND RIVER SYSTEMS.

River is a mass of water flowing over land through a defined and specific direction

A river is a body/Mass of water flowing on the earth's surface in a defined channel in a specific direction from the source to the mouth. Rivers normally flow from highland areas to low land areas.

River source. This is a place where a river originates from and it can be a mountain, a lake or swamp.

River mouth. This is a place where a river pours its water. It can be an ocean, a sea, lake or swamp.

River load. This is the material carried by a river from its source to mouth. It can be boulders, gravel, sand, silt etc.

River regime. This is the seasonal variation in the volume/level of water in a river.

River volume. This is the amount of water carried by the river.

Tributary. A smaller river that joins the main river at a given point.

Distributary. A small river that leaves/branches off the main river.

River confluence. This is the point at which two rivers meet/divide.

River catchment area. This is the area that supports/provides a river with water.

River basin. An area drained by a river and its tributaries.

Divide/watershed. This is an area of high ground separating two or more river basins.

River competence. This is the ability of the river to carry its load.

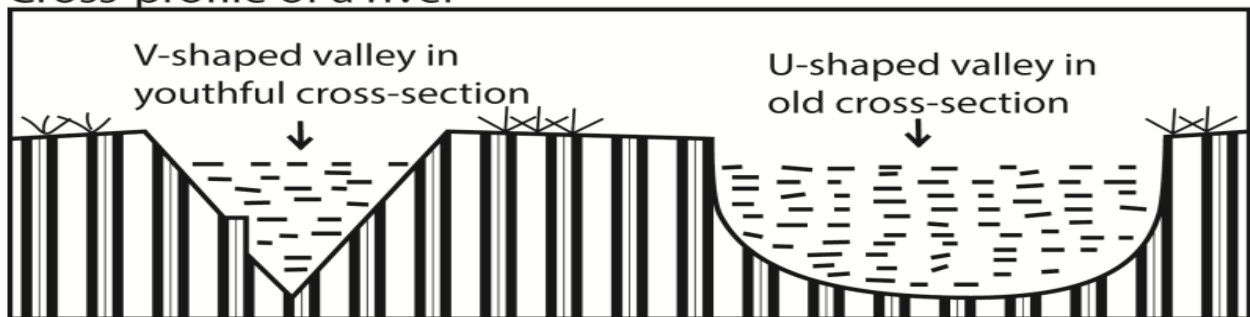
Cross profile of a river

It is a section showing the vertical shape of a river from one bank to another. It defines in terms of width of a river valley.

It is characterized by the following:

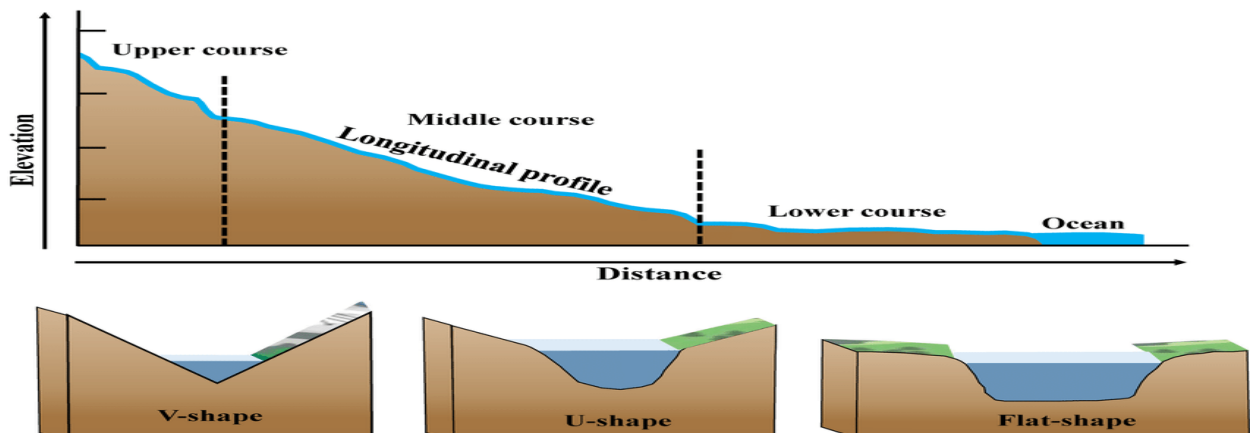
- it's narrows in the youthful stage and wide in the old stage. This is because in the youthful stage there is more vertical erosion than lateral.
- While in the old stage there more lateral erosion than vertical hence the valley is widened.
- It's V-shaped in the youthful stage and U-shaped in the old stage.
- The youthful stage is deep while the old stage is shallow

Cross-profile of a river



Long profile of a river

It is a section showing the slope of a river from its source to its mouth. It's is defined in terms of distance covered by a river. It has three stages: youthful, mature and old stage.



The youthful stage is characterized by:

- a very fast speed of river flow,
- high volume of water,
- the river has a steep gradient.
- The rivers' cross-profile consists of a deep narrow V-shaped valley.
- The river tends to wind within interlocking spurs.
- Vertical erosion is dominant over lateral erosion
- Numerous rapids, waterfalls, gorge, potholes, interlocking spurs and plunge pools

The mature stage characterized by

- Moderately steep slope
- The river channel is U-shaped
- moderate speed of river flow
- Lateral erosion removes interlocking spur.
- Meanders and river bends begin to develop

The old stage characterized by

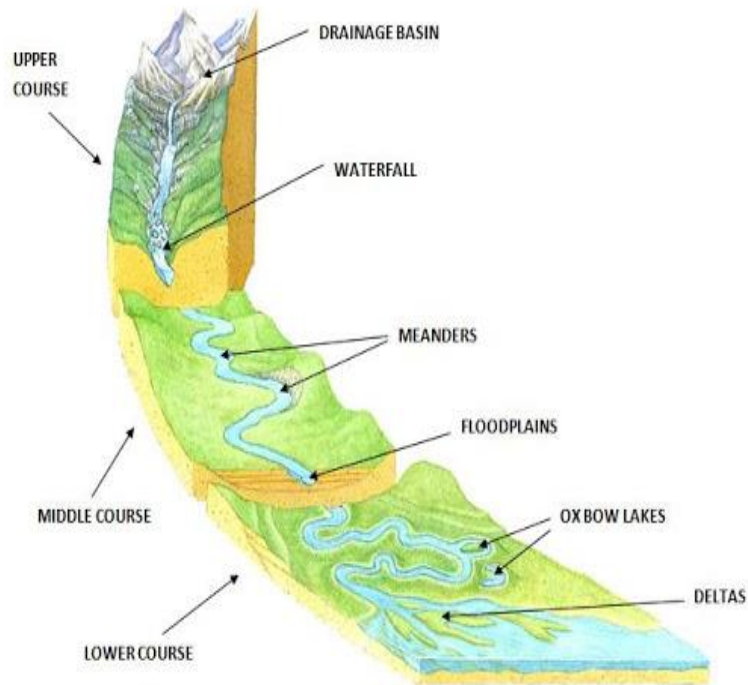
- Very gentle slope
- Deposition occurs
- Very slow speed
- Wide valley
- Meanders, bluffs, slip-off slopes, ox-bow lakes and alluvia's fans formed

Long profile

The long profile refers to the section/shape of the river valley showing the slope of a river from its source to the mouth hence it is the distance covered by the river.

The river's long profile is divided into three stages or courses. Namely;

- i. Youthful/torrent/ upper stage/ young and juvenile stage.
- ii. mature /middle stage.
- iii. old/senile stage/lower stage.



STAGES OF RIVER DEVELOPMENT

Rivers usually go through three stages from the source to its mouth and these include Youthful/torrent/ upper stage, mature /middle stage and old/senile stage/lower stage.

YOUTHFUL/TORRENT/JUVENILE/ UPPER STAGE OF THE RIVER

This is the stage of the rivers long profile from the source and a few km away. It includes the area where the river originates from.

CHARACTERISTICS

- Deep and narrow valley with a V-shaped cross profile.
- The river flows at a very fast speed due to steep gradient.
- The river tends to wind within interlocking spurs as it avoids obstacles.
- The major function of a river at this stage is vertical erosion.
- The river has very short tributaries.
- The stage is characterized by mainly erosional landforms notably v-shaped valley, potholes, rapids, interlocking spurs, gorges, waterfalls and plunge pools.

RIVER EROSION AND ASSOCIATED LAND FORMS

River erosion refers to the detachment of rocks from the rivers bed and banks by the action of the rivers load and water.

River erosion is a common phenomenon in the youthful stage of the river and there are two types of erosion.

Types of River erosion

Vertical erosion. This is the deepening of the river channel by gradual down cutting. It is when the river digs into its bed through abrasion leading to the deepening of the river's bed common in the upper course of the river.

Lateral erosion. It is the wearing away of the river banks/ sides that leads to the widening of the river channel.

Head ward erosion. This is when the river cuts back at its source which gradually increases its length.

PROCESSES OF RIVER EROSION

Abrasion/corrasion. This is the process through which the river uses the material it is transporting to erode both the river bed and the sides. Some of the material transported includes; boulders, pebbles and small stones. The grinding action of the walls and bed of the river channels, Abrasion mainly leads to vertical erosion.

Hydraulic action. This is caused by the force of moving water which sweeps out loose materials especially where the rocks are jointed or weak where the force compresses air in the cracks leading to expansion therefore loosening and breaking the rocks.

Attrition. This is the process involving the breakdown of materials as they bump/collide with each other. The fragments or particles carried by a river like pebbles and boulders are in constant collision with each other hence reduce in size during attrition and becomes easier to transport.

Solution/corrosion. This is the solvent action which involves soluble rocks like limestone and chalk dissolving in water and washed away in solution form.

LAND FORMS FORMED IN THE YOUTHFUL STAGE OF THE RIVER

RIVER EROSIONAL LANDFORMS

The erosional features formed in the youthful stage include gorge, waterfall, plunge pool, pot holes and interlocking spurs

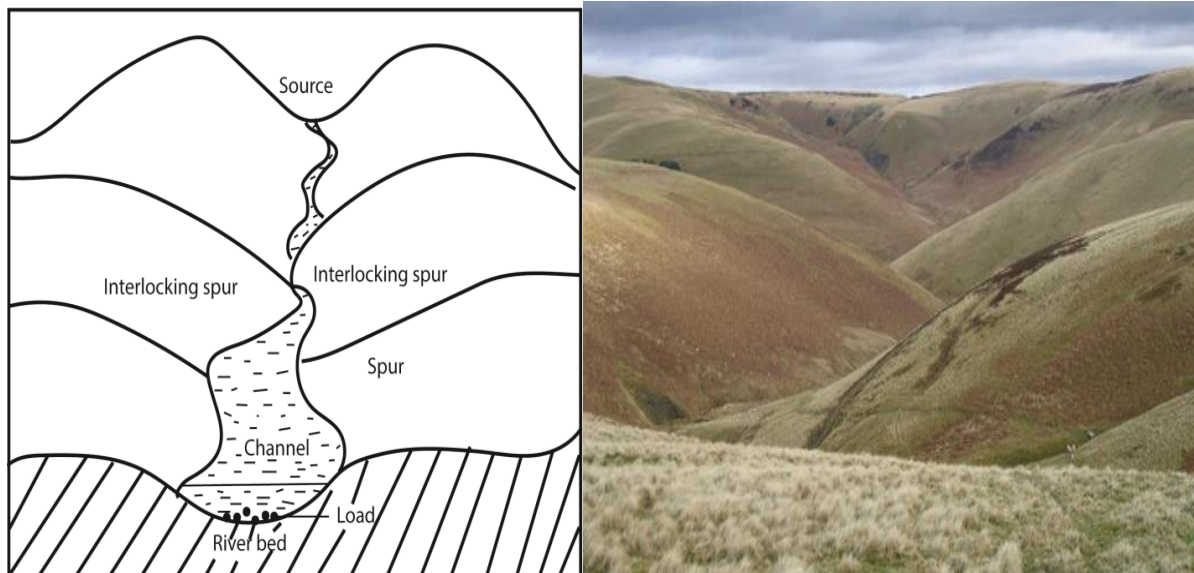
Interlocking spurs are characteristic features of river flowing in a highland area. When a river flows through a series of highlands it tends to twist and turn around in the bid to avoid resistant obstacles.

The river erodes the softer concave banks deposits on the relatively hard convex banks thus producing spurs on the either sides of the river.

The deeply eroded concave banks stand up as Cliffs while deposition on the convex bank produces gently sloping extensions called slip off slopes.

Examples of interlocking spurs are found on Mt. Rwenzori along R. Mubuku and river Nile between the source and Bujagali falls.

Interlocking spur

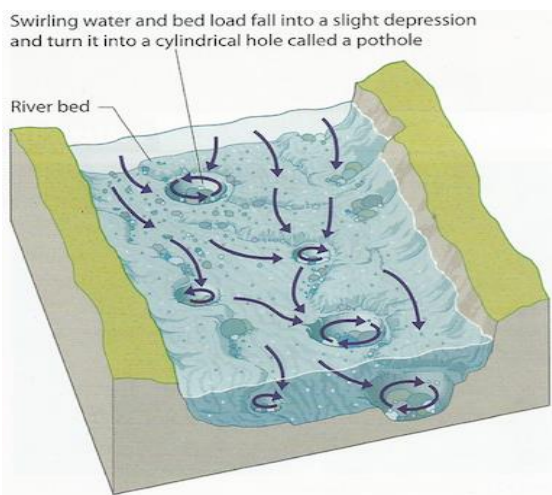


Potholes are circular depressions on the river bed. They are formed by swirling action of water along the river bed. The uneven bed of a fast-flowing river causes the water to swirl (forward circular rotation). The pebbles carried by the river will start cutting circular depression which are gradually enlarged and deepened to form potholes.

Potholes may also be circular depressions formed on the bed of the river. They are formed by abrasion due to the swirling action of water where water moves in a circular motion especially where the river bed is uneven hence boulders and pebbles in the water erode the river bed to form circular holes which are gradually enlarged to form pot holes.

Examples include

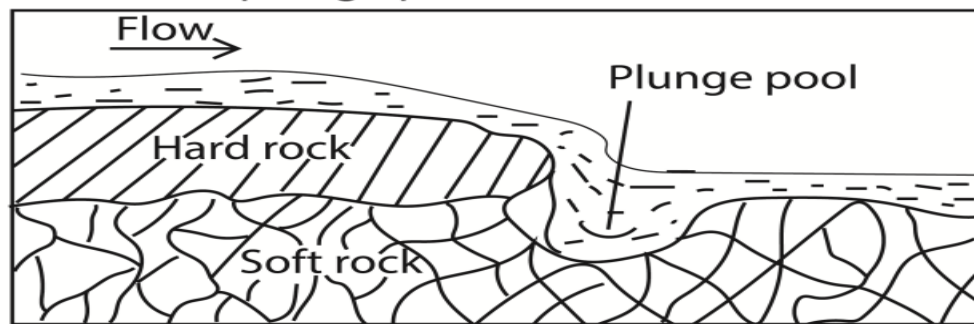
- River Ikiwe in Machakos.
- River Mubuku on Mount Rwenzori
- River Suam, Manafwa and R. Sironko on the slopes of Mount Elgon



Plunge pool

Plunge pool is a hollow or broad depression formed at the base of a waterfall. Or an enlarged pothole at the base of a waterfall due to the progressive drilling and grinding of the valley floor by the hydraulic erosion and abrasive action of water. It's found on rivers with waterfall in the youthful stage and along the rejuvenated section of a profile.

Illustration plunge pool



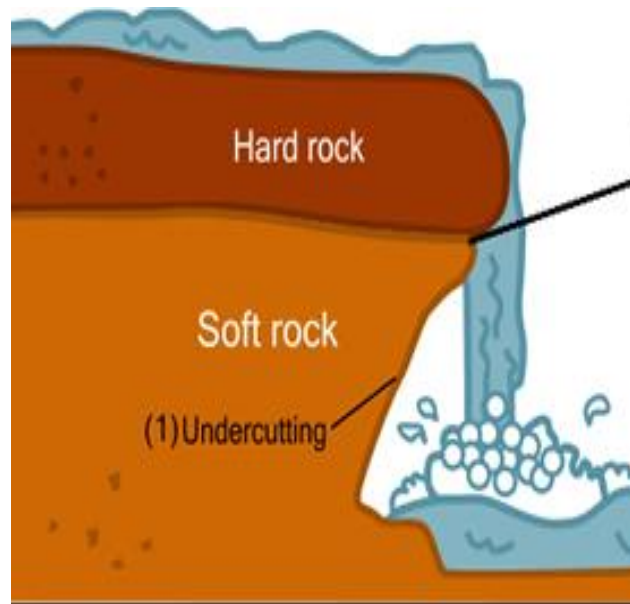
Plunge pool is formed under the following conditions.

- Large volume of water which increases the rivers' competence.
- Steep gradient resulting into high erosive power of the river due to increased velocity.
- Large amount of abrasive tools like pebbles and boulders to grind the bed
- Difference in rock resistance in the river's flow from a hard rock to soft rock thus drilling deeper underground.

Plunge pools are found along sezibwa falls, Ssipi falls, Kisizi falls and upper Tana river.

Waterfalls

Waterfall is a point in a river or stream where water flows over a vertical drop or a series of steep drops. Waterfalls are common in the upper course/youthful stage but can also occur in any part of the river profile. Some of the main water falls in Africa include Victoria Falls along river Zambezi, Murchison fall on River Nile and Sezibwa falls along River Sezibwa.



Causes/conditions for formation of waterfalls

- (i) A sharp change in the resistance of rocks i.e. from a hard to soft rock. The hydraulic action of water massively erodes away softer rocks ahead of the hard rocks thus causing a change in gradient which forms a waterfall. Examples are Bujagali and Owen falls (Nalubale) or when there is an uplift of the land.

- (ii) Faulting across the river bed may lead to vertical displacement of rocks along the fault lines. In this case a river flows from high to a low elevation thus a waterfall. Murchison fall along R. Nile was formed in this way.
- (iii) It is also formed where a larva barrier or landslide cross a river where it may initially form a lake. Then a water fall is likely to form at the over pill from the lake where the river drops over the edge of the barrier e.g. Lily falls in Madagascar is formed this way.
- (iv) Waterfalls may also be formed at the point where the river enters the sea at cliff line. A fall may develop near the mouth of a river if wave erosion out backs the cliff face or where the sea level has fallen. Examples occur in Cameroon Lobe river where Lobe falls were formed when it plunges over directly into the sea.
- (v) Waterfalls may also be formed due to river rejuvenation at the Knick point.

Importance of water falls

These can be positive or negative

Positive importance

- (i) Potential for HEP generation e.g. Bujagali and Owen falls along R. Nile in Uganda.
- (ii) Tourist attraction due to beautiful scenery formed e.g. Murchison falls
- (iii) Sporting and recreation
- (iv) Study purpose

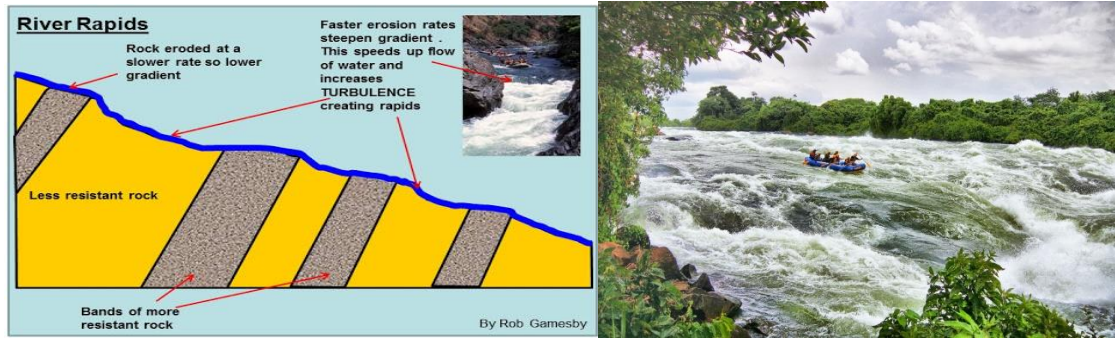
Negative importance

- (i) Lead to hindrances in navigation e.g. on river Nile
- (ii) Hindrance in fishing

Rapids.

These are sections of the river characterized by rough and fast flowing water in a river where the bed is steep and rocky. Rapids form due to pronounced vertical erosion of the river bed which exposes hard rock outcrops and as water moves, it tends to be whitish in appearance.

Examples include e.g. Bujagali falls.



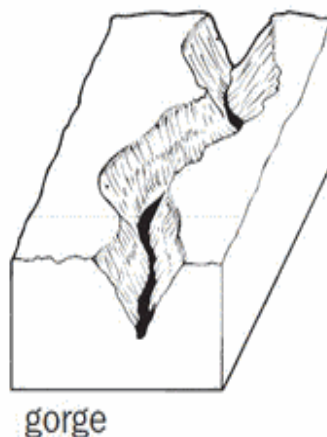
Gorge/canyon

A **Gorge/canyon** is a deep narrow V-shaped river channel (valley) with high vertical walls. It's formed by vertical erosion in an area of relatively resistant rocks when a river flows at a very fast speed. Gorges tend to wind between interlocking spurs of highlands e.g. there is gorge near Murchison Fall on R. Nile. Other examples include the Manambolo gorge in Malagasy and the fish river canyon (gorge) in Namibia and Mitano gorge through which R. Birira flows

A gorge may be formed where a water fall slowly retreats up-stream though head ward erosion usually along a fault line. As the river retreats, it forms a gorge for example *Murchison gorge created by Murchison falls*.

A gorge may also be formed where a river flow across a region subjected to slow up- lift. This forces the river to erode vertically at the same rate of up-lift so that the river maintains its course of flow or base level. The gorge formed in this manner is called antecedent gorge *for example the Great Ruaha river gorge in Iringa highlands in Tanzania*

Illustration showing Gorge.



Conditions for formation of a gorge

- (i) Vertical erosion due to rapid flow of river water over relatively resistant rocks like lime stone in youthful stage of the river
- (ii) River rejuvenation leading rejuvenation gorge where a river incises itself into the land surface due to a fall in base level e.g. Lupata Gorge along R. Zambezi
- (iii) Gorges may also be formed due to outflow cut by a river draining a lake e.g. Lower Congo Gorge near Kinshasa.
- (iv) Antecedent gorges are formed where a river has cut across a zone of rocks that are being slowly uplifted e.g. antecedent gorges along the Great Ruaha River in Tanzania
- (v) Superimposed gorges are formed where a river is superimposed onto a zone of hard rocks from a former covering rock layer e.g. Sabaloka Gorge along River Nile in Sudan.
- (vi) Some gorges have been formed due to waterfalls retreating upstream e.g. Batoka Gorge below Victoria falls on R. Zambezi.

MIDDLE/MATURE STAGE OF THE RIVER.

This is the area between the upper course and the old stage. It is some time called middle/valley stage.

A river in this stage has the following characteristics;

- The river flows against a gentle gradient/ slope
- speed is moderate
- huge volume of water and load in the channel because many tributaries are contributing,
- lateral erosion dominates
- the river flows in a wide V-shaped valley because of lateral erosion on the valley sides,
- meanders begin to form due to erosion on concave bank and deposition on the inner bank.

Major landforms in this stage include; meanders, bluffs/ river cliffs and slip-off slope

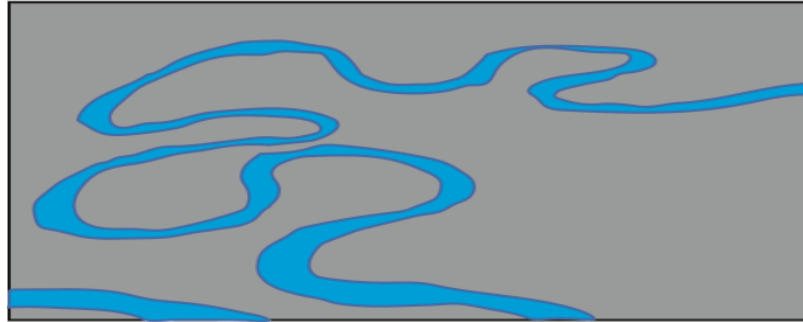
Meanders

Meanders

These are curved bends of a river's channel which continuously swing from side to side in wide loops. They form in both the mature and the old stage of a river. Meanders are largely due to the river's load it carrying and the low gradient which leads to deposition of the load.

They are formed by alternate under cutting and deposition leading to formation of concave and convex river bends. The constant erosion of the concave banks which produce a river cliff and the deposition on the convex banks forms a slip off slope. Best examples can be seen on river Rwizi in Mbarara, R. Mpanga in fort portal, river semiliki etc.

Meander



conditions for formation of meanders

- They are formed in the middle and lower/old stages of a river due to a decrease in gradient leading to reduction in speed of the river and river competence.
- Meanders may occur when a river avoids an obstacle or hard rock.
- Presence of large and excessive load within the river. When such loads are deposited along river bends, it begins to meander.
- Reduced competence
- Erosion of the concave sides causes cliffs while the deposition on the convex side cause slip-off slopes. They occur on R. Rwizi, Semuliki, Mpanga and R. Ngaila on the Kano plain

Theories that explain development of meanders

- Reduced gradient along the river's bed leads to reduced speed of the river. Once the speed is reduced the river energy reduces leading to deposits in the valley. Accumulation load causes the river to meander.
- Siltation along the river reduces the gradient causing the river to look for steeper gradient creating bends
- The existence and occurrence of hollows and shallow sections on the river floor i.e. pools and rifles that encourage meanders.

- Presence of alternate soft and hard rocks; easy erosion of soft rocks relative to hard rocks encourages river meandering
- Meanders also develop to minimize time and energy.

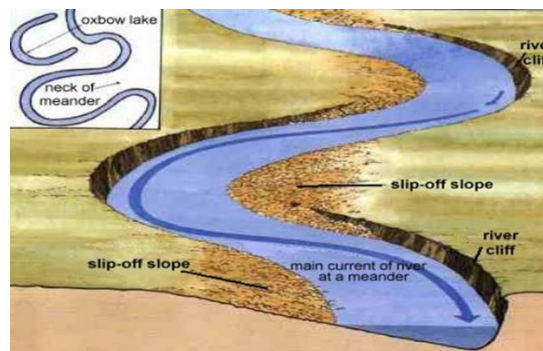
Bluffs or cliffs

Bluffs or cliffs are also formed within the mature stage. Bluffs are cut Spur end that extended down into the river valley. They are formed when a river erodes laterally to widen its valley. The river erodes more its concave banks and eventually it shifts direction of flow towards the convex bank.



Slip-off slope

This is a gentle slope on the convex side of the river channel. It is formed due to constant deposition of eroded sediments from the concave side by lateral erosion which are later deposited on the opposite inner side (convex) bank of the curve.



THE OLD/SENILE/LOWER STAGE OF THE RIVER

This part includes the area where the river ends or pours its water. It is sometimes called the senile stage/ last/ flood plain stage.

A river in this stage has the following characteristics;

- The river flows against a low gradient,
- the speed is very low,
- river carries more load and less water,
- deposition is more active in this stage than erosion
- river flows in a wide broad /u shaped valley.

Major landforms formed in this stage include; flood plains, ox-bow-lakes, meander scars, levees, braided channel, deltas and alluvial fans.

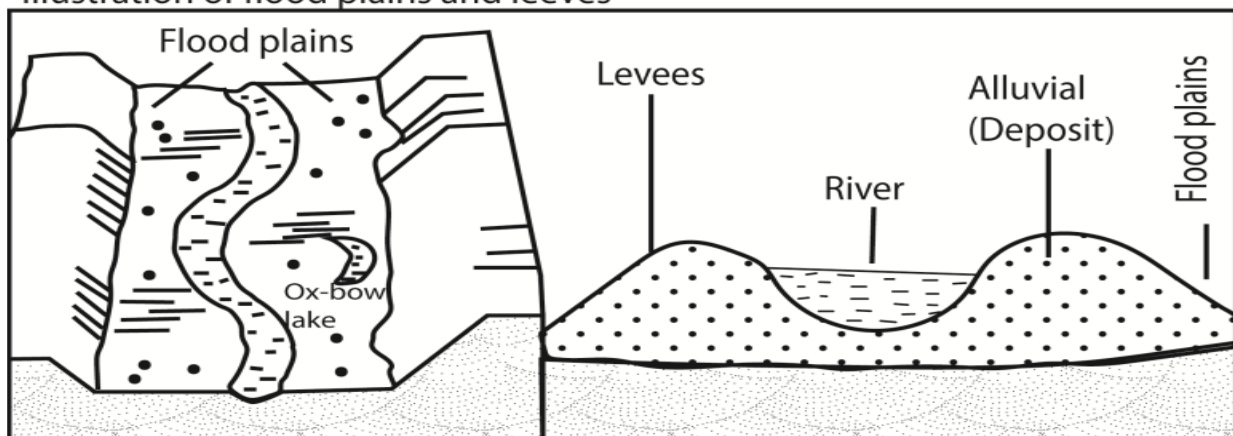
Flood plain

A **flood plain** is gently is gently sloping plain of alluvium covering the valley floor down in which the river flows in a meandering channel. It's usually flanked by ox-bow lakes formed along meander loops. Flood plains are formed when a river widens its valley by eroding on the concave bank and depositing on the convex bank. With time spur ends are cut thus widening the valley and depositing sediments in it.

Alternatively flood plains are formed when a river floods over its banks. The water spreads over the wide valley plain and sediment are deposited in the valley. Each time the river floods, and additional layer of sediments are deposited in the valley which later builds up the flood plain.

Examples are found on R. Rwizi in Mbarara.

Illustration of flood plains and levees



Levees

Levees are raised ridges-like embankments composed of sediments on the sides of a river channel within the flood plain. They are formed when sediments a river deposits on the bank

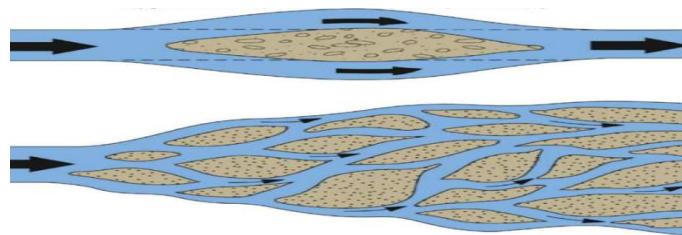
accumulate over a time due to continued floods. They may raise a few feet above the flood plain. Examples are found on R. Malaba and Yala and on Kano plain of Kenya.

Braided channel

A **Braided channel** is a wide shallow channel in which a stream, subdivides into a series of inter-connecting small channels separated by deposits.

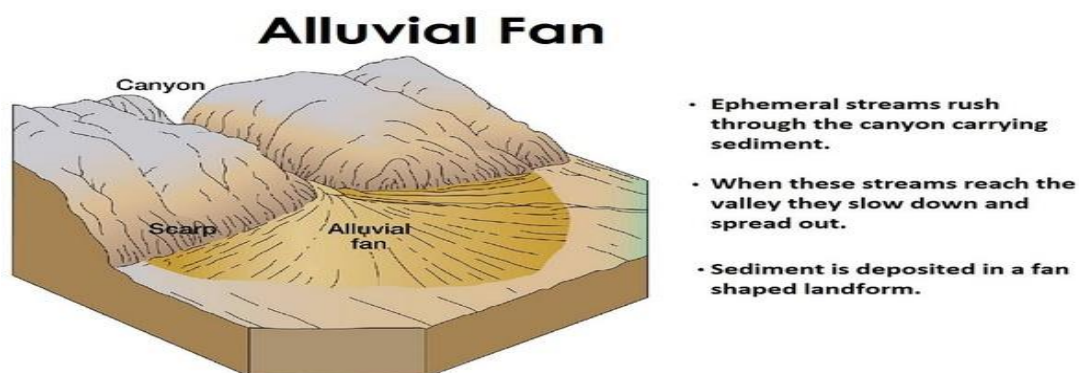
They are formed when a river carrying large quantities of load reduce its competence. This leads to deposition of the load on the river bed in series. Once these accumulate, they form sand bars which separates the river into numerous streams.

But these streams later join to form a big stream. Examples are found on R. Nile between Malakal and Khartoum, R. Zaire, Kilombero and R. Tana.



Alluvial fan

An **alluvial fan** is a triangle-shaped deposit of gravel, sand, and even smaller pieces of sediment, such as silt. They are formed when a mountain Torrent deposits its load at a point where it enters into a main valley. Examples are found on Kilombero valley on Mahenge and UChungwe highlands in Tanzania. In Uganda there is Lume fan on R. Lume on the Semuliki Valley.

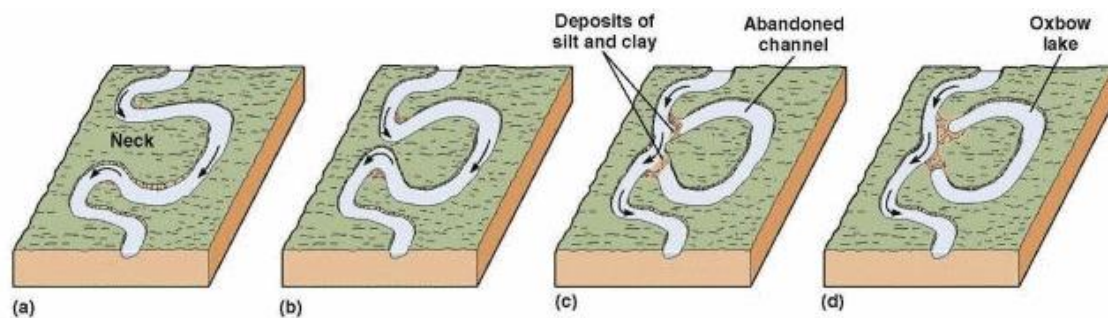


Ox-Ox-bow lakes

Ox-bow lakes are horse-shoes shaped lakes or poo that forms when a wide meander of a river is cut off, creating a free-standing body of water.

Ox – bows are formed along parts of the flood plain where meanders are sharp that only a narrow neck of land remains between the meander loops. During periods of floods, the neck may be broken through and the river may by pass the meander. Its eventually cut off by deposition at the old meander neck. If the ox bow lake is filled with alluvium, it will dry out hence leaving behind a meander scar.

Examples are found on R. Semuli, R. Rwizi, R. Tana, Ngaila, R. Nyando, Nzoia, Mkomazi and Rufigi in Tanzania.



Slip-off slope

Slip-off slope is a gently sloping relief feature made up of deposits on the convex bank of a meandering river channel.

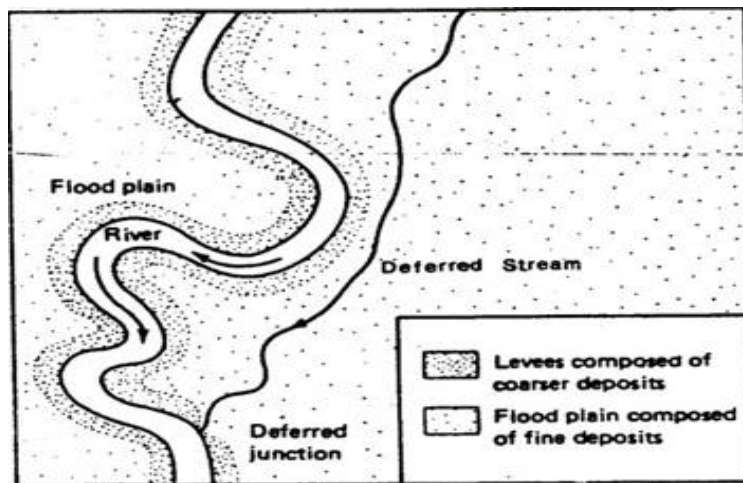
It's formed as a result of a river depositing sediments eroded from the concave bank on to the convex bank. When a river erodes sediments from the concave bank it creates a steep wall on that bank called a cliff. While when it deposits the sediment on the convex bank, it creates a gently sloping relief feature called the slip-off slope.

For example, on the eastern side of R. Nile (Busoga) around the source at Jinja is the slip-off slope while the raised wall on the western side (Buganda) is a cliff. In this case the slip-off slope is made up of boulders eroded from the concave bank.



Differed tributaries.

This is a tributary river forced to flow parallel to the main river for a long distance before rejoining the main river. When levees are formed on the banks of a river, they make it difficult for the tributaries to join the river they therefore flow by the sides of a river for several kilometers. They are therefore known as deferred tributaries and where they join the river is known as deferred confluence. *Examples are Found on R. Ngaila and Nyando flowing into Lake Victoria, southeast of Kisumu in Kenya.*



An estuary

An estuary is a deep submerged/ drowned river valley with a V- shaped cross profile pointing landward. Most estuaries are a result of submergence of lowland coasts due to a rise in sea-level. It is relatively clear of sediments and allows easy mixing of channel and sea/ lake water. Examples of estuaries exist on river Congo, Gabon, Gambia, cross river in Nigeria, river Sierra Leone, river Senegal e. t. c

Delta

A delta is a large flat/wetland that forms as a river empty its water and sediments into another body of water such as an ocean, lake or another river e.g. deltas are found on R. Omo as it enters L. Turkana and along R. Rufiji in Tanzania, the Nile delta in Egypt, Niger delta etc.

Deltas form under the following conditions

- Presence of large amounts of sediments within a river such as sand, gravel and silt
- Reduction in the gradient and speed of the river thus reduced competence
- Presence off a sheltered coast such that deposits laid are not washed a way

- Low tide currents such that the deposition is not carried away.
- Absence of obstruction or barrier like dykes at the mouth of the river.
- Presence of a shallow adjoining area/continental shelf along the sea where deposits are laid to accumulate.

Process of delta formation

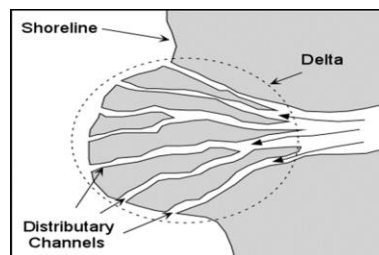
Where the river enters the water body, the water's flow decelerates, sediments drop out, and a delta forms, depositing a prism of sediment that tapers out toward the lake's interior. Progressive build-out of the delta through time leads to formation of sediments that are inclined in the direction toward the lake body.

Types of Deltas

- *The three main types of deltas are the arcuate, the bird's foot and the cusped/estuarine*

Arcuate deltas. This is the type of delta built by rivers with many distributaries carrying both fine and coarse materials. They are mostly composed of sediments of gravel and sand. This type of delta is in a triangular shape and rounded towards the sea. They have a number of tributaries for example Rufiji delta in Tanzania, tana and yala in Kenya, and semiliki delta at the southern tip of lake albert.

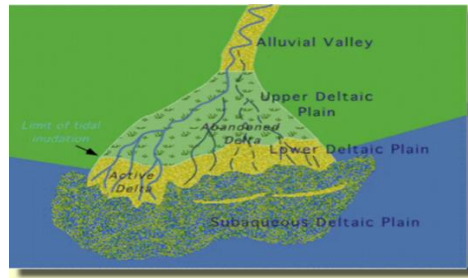
Illustration.



Estuarine delta.

This is a delta formed by rivers depositing materials in a submerged river mouth forming sand banks and islands around which wide several distributaries are formed.

Illustration.



Bird's foot delta.

This is formed by rivers carrying large loads of mainly fine materials into water where wave energy is low. A few very long distributaries boarded by levees shoot out from the shore. It resembles a foot of a bird. Examples can be found at the Mississippi delta, at river Nyando and miriu in Kenya.

Illustration



Lacustrine delta.

Is an island delta formed on the bank of a lake e. g; the Albert Nile delta.

Importance of Deltas

- Contain fertile soils for agriculture e.g. Nile delta in Egypt
- Were centres of early civilization e.g. Nile delta in Egypt
- Source of sand and gravel used in construction industry
- **Biodiversity hotspot:** The river Deltas boast some of the most biodiverse systems on the planet e.g. Sunderbans forests, one of the richest biodiversity hotspots in India.

Similarities between alluvial fan and delta

- Both are funnel shaped with apices at the source

- Both are made of sediments with finer materials deposited furthest while the coarse and heavy materials deposited near the apices.
- Both are formed at a point where gradient drops and velocity of the river is reduced.

Differences between alluvial fan and delta

- Alluvial fans develop on land away from the sea while deltas form at the mouth of a river where it enters into the sea.
- Alluvial fans have less distinct distributaries while deltas have marked distributaries
- Alluvial fans are formed in the youthful/mature stages of a river while deltas are formed in old/senile stage of a river.
- Alluvial fans are not flanked or associated with swamps, spits, bars, lagoons while deltas are associated or flanked with swamps, lagoons, bars, etc.
- Deposits in alluvial fans are mainly coarse material while deposits in deltas are mainly fine sediments
- Formation of deltas is determined by a number of factors such as presence of sheltered bay, absence of obstruction, absence of tidal currents and differences in salinity between the depositing rivers and the sea. However, such factors are not applicable to alluvial fans.

Summary of conditions that lead river deposition

- A drop in river's gradient leads to reduction in the river's speed, competence or energy to carry its load.
- An increase in the width of a river valley causes a reduction in speed leading to deposition
- Deposition occurs when a river enters into a stationary water body such as sea, lake and/or ocean because the speed of water reduces due to increased friction.
- Deposition takes place when fresh water enters salty water because clay particles and silt coagulate, become heavy and thus settle.
- Excessive evaporations lead to deposition because reduction in volume reduces the competence of the river to carry the load e.g. in river Omo in northern Kenya

- Increase in the concentration of load due to surface runoff, land slide and domestic wastes in urban areas.
- Nature of river bed; rough river bed characterized by potholes and rapids tends to traps the load leading to deposition

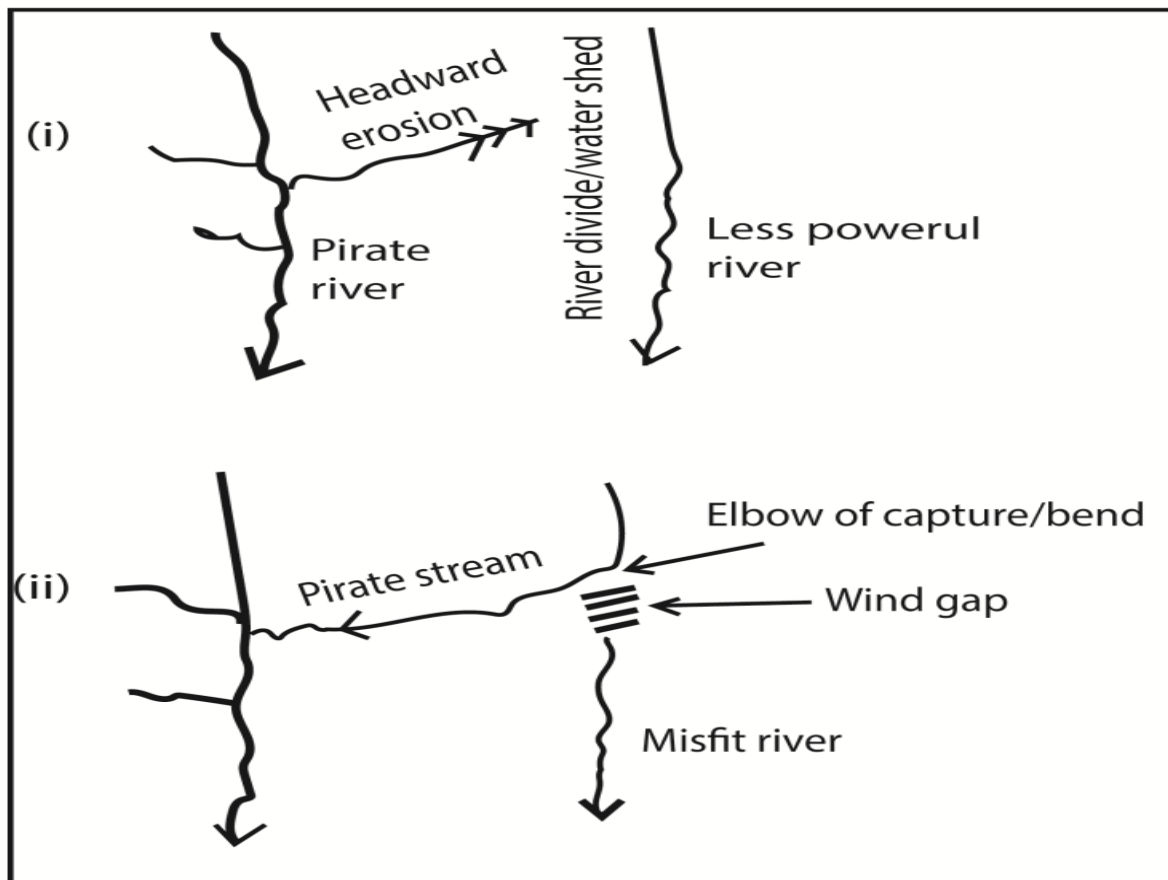
RIVER CAPTURE

River capture/stream piracy occurs when a stronger river flowing in a deep channel arrests the waters of an adjacent weak river

Is the process whereby one river course is diverted into a system of an adjacent powerful river which is able to erode into the valley more rapidly than its weaker neighbor.

Examples of capture include

Tiva capture in Eastern Kenya where lower Tiva captured upper Tiva, a former tributary of R. Galana, R. Aswa captured captured R. Pager, R. Ruizi captured R. Shaya, R. Wasa captured R. Nyaboroga in fortportal.



Factors leading to river capture

River capture occurs where there are 2 adjacent rivers/ share a watershed moving in the same direction; e.g. R. Aswa and R. Agogo. One river has more erosive power than the others e.g. a powerful R. Nile capture the weak rivers i.e. R. Okole, Tochi and Arocha.

1. **Differences in stream power/energy for vertical erosion**, where one powerful river and a less powerful one are flowing adjacent to each other on homogeneous rocks. The more powerful river erodes its bed faster by headward erosion and captures the waters of another eg R.Nile captured the waters of rivers Tochi, Okole and Arocha in this way.

2. **Differences in rock hardness**, A river flowing over soft rocks deeply cuts its valley by headward erosion into the valley of one flowing over hard rocks, capturing it. River Wasa flowing on soft rocks captured river Nyaboroga in Fort portal.

3. **Earth movements** e.g. uplift and down warp along the course of one river may lead to river capture. A river flowing over a down warped channel, may extend its valley by headward erosion and captures the waters of an adjacent weaker river flowing over an uplifted channel. Reversed rivers of Rwizi, Katonga, captured weaker adjacent rivers (streams) when Western Uganda was uplifted.

4. **Influence of river rejuvenation due to changes in sea base level**. A rejuvenated river eroding along a steeper gradient may extend its valley into that of a weaker adjacent river.

5. Gradient/nature of slope where a capturing river/stream is flowing over a steeper slope than its victim e.g. R. Zambezi.

6. **Rock jointing**, where the capturing river is flowing over well jointed rocks, is able to deepen its valley, while the captured river is on massive rocks.

7. **Volumes of water possessed by the rivers**. The capturing river may have more water than its victim and so will have greater ability to erode than its neighbor/victim. i.e greater head ward erosion e.g. the Volta than its victim.

8. **A difference in the altitude / base level** e.g. R. Zambezi. This is when two/ more rivers are a bit near each other but when one has got a higher level of water. Hence it will go on eroding the soil which separates both rivers. Time will come when it will pull the water of the river with the lower base level.

9. **Influence of rock joining.** A pirate stream/river is flowing over well jointed rock may undertake head ward erosion, deepens its valley and eventually captures a weaker river flowing on massive rocks.

- A pirate stream flowing in a short and direct course can easily capture a weaker river flowing in a long and circuitous course

Process of river capturing

- The more powerful river erodes vertically faster than weaker one thus flows at lower level than the other.
- The more powerful river erodes its valley towards the other river's valley through head-ward erosion. Eventually, the powerful river joins valley of weaker river
- The powerful river diverts the head waters of the weaker river into its channel
- The diversion of the headwaters is called river capture.

LAND FORM FEATURES FORMED DUE TO RIVER CAPTURE

1. Elbow of capture

This is a marked bend formed at a point where the head waters of the captured stream flow into the capturing tributary. It is a right-angled bend.

3. Wind gap

This is a dry valley of the beheaded stream below the point of capture. The floor of this valley is normally lined with alluvial deposits or gravel.

4. Misfit

This is the valley of the beheaded stream which having lost its head waters, will be reduced in volume, causing it to appear too small for its valley.

5. Incised valley / Gorge

Under cutting of the pirate river near the point of capture due to increased water volume produces a steep and deep valley / rejuvenated valley / Gorge.

6. Formation of Knick points

This is a sharp break in the slope created near the point of capture due to rejuvenation. Water flows down steeply on this knick point resulting into a water fall.

7. Pirate river / stream

This is a river, through headward erosion, that captures waters of another nearby river.

8. Over fit stream / river

Is the river that appears too big for its present valley due to increased volume of water from the captured river/ stream.

Examples of river capture in east Africa include

- Lower Tiva captured upper Tiva River in eastern Kenya, formally a tributary of river Galana.
- River Aswa captured Agago, Moroto and Pager rivers in northern Uganda; reversed river- Rwizi, Katonga captured weaker adjacent rivers when Western Uganda uplifted.
- River Ruaha captured Pawaga drainage system in Tanzania.
- River Nile captured waters of river Tochi, Okole and Arocha etc.

RIVER REJUVENATION

River rejuvenation is the renewal of the erosive activity of the river within its old valley.

It is a situation where vertical and lateral erosion are increased and a river's ability to carry its load is increased and at the same time the spread of the river flow is increased.

CAUSES OF RIVER REJUVINATION

1. Climatic changes i.e. increased rainfall which increases the water discharge in a river valley which increases the river energy. This automatically leads to renewal of the river's erosive capacity.
2. River capture. This adds more water in the pirate stream /river which increases its erosive capacity due to the increased speed and volume of water eg lower Tiva captured upper Tiva river in Kenya.
3. Negative movement of the sea ie where there is a fall in the sea base level, this steepens a rivers gradient, forcing it to flow very fast, causing renewed erosion. In this case, a river is rejuvenated.
4. Earth movement also cause river rejuvenation. An uplift or up warping along a river's course, leads to steepened river gradient. This leads to fast movement of water, hence increased erosion.

5. Changes in the nature of the basement rock is also responsible for rejuvenation. When a river which was originally flowing over a hard-resistant rock, approaches a soft rock, its erosive power is renewed. It erodes away much of the soft rock, thus, deepening and widening its channel.

6. An increase in water discharge which increases the river's volume, speed and erosive capacity. This may be due to; melting of ice caps and tributaries joining the main river.

7. Decrease in the load of a river. As it enters a swamp, it deposits the load there. After there, its speed is increased and it renews its erosive capacity / rejuvenated.

8. Existence of obstacles in a river's course. After it passes the obstacles, it is rejuvenated.

9. Human activities like damming / construction of dams across rivers, holds back water in the reservoir behind, but at the same time, when the water is released in the turbines, it flows out with a high speed. Thus, rejuvenating the river's erosive power. Thus, dams along river Nile from Jinja to Egypt, cause its rejuvenation.

Effects/landforms due to river rejuvenation.

These include paired terrace's, Knick points, incised meanders and valleys within valleys.

Such landforms have been formed through four main processes namely; hydraulic action, corrasion, solution and attrition as a river's erosive ability is increased. Corrasion involves wearing away the river bed and banks by a river using its load like boulders, sand and stones as grinding tools. This happens when the load or boulders are swirling and grind the river bed to remove the rock fragments.

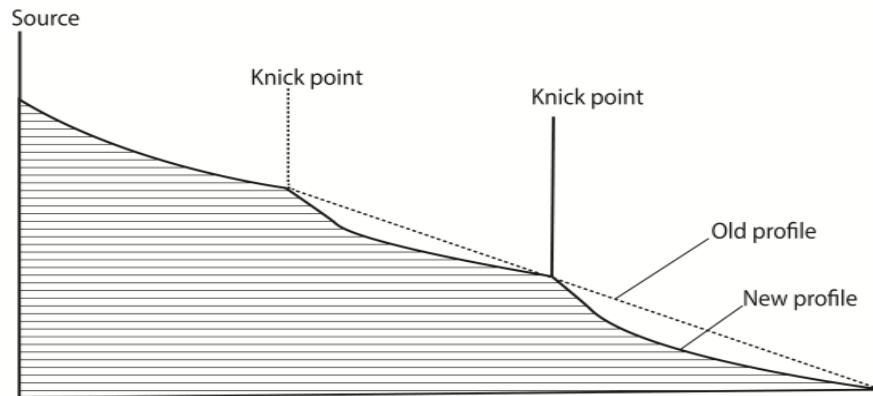
Solution involves the water washing away/dissolving away the permeable rocks like rock salts, limestone along its banks or bed. Such rocks are dissolved in the water and then washed away in solution form.

Hydraulic action is a process when a river erodes its channel and bed due to the force exerted on it by the weight of the water. Hydraulic action is most active on rocks which have been affected by weathering.

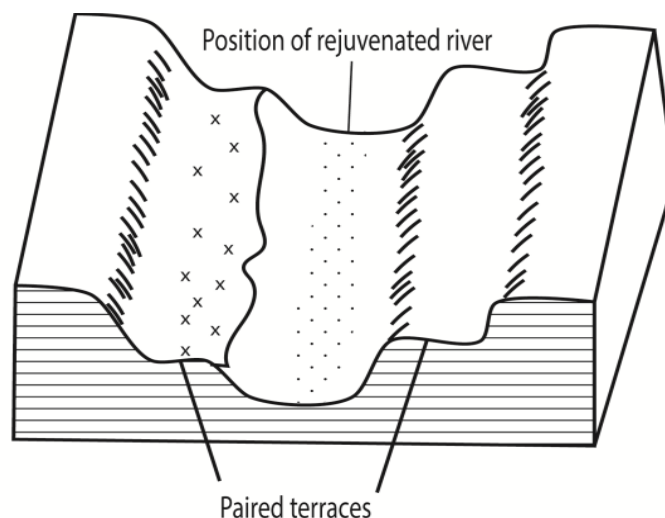
Attrition involves a double action of the load to erode the channel and also reduction in size they bump into each other thus becoming easy for the river to transport.

Knick point

Knick point is a sharp break of slope in the long profile of a river valley. It is a point in the river bed where the old river profile changes into a new river profile. Or a nick point is part of a river or channel where there is a sharp change in channel slope, such as a waterfall or lake.



Valley within a valley /rejuvenated gorge. This refers to a new valley which has been reshaped from the old existing valley. Along rivers where rejuvenation was fairly rapid and the fall in base level quite large, the effect may produce steep sided gorge within the former valley called valley within a valley e.g. R. Nyando



Stream terraces /paired terraces.

These are bench /step like strips of land found above a stream and its flood plain. They are benches cut in a rock or steps formed in sediments by deposition and subsequent erosion.

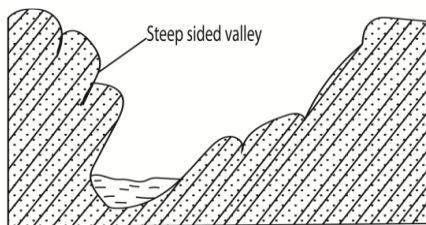
Originally, the river deposited a thick section of flood plain sediments. Then the river changed from deposition to erosion and cut into its old flood plain, parts of which remain as terraces above the river. These terraces are generally of equal height and are called paired terraces e.g. R. Nyando

Incised meanders.

These are steep deep gorges cut into a meandering channel. They are formed when there is rapid vertical erosion of a channel within a meandering river. This results to a meandering-valley with essentially no flood plains; e.g. R. Mwachin, Kombeni. Incised meanders are divided into two;

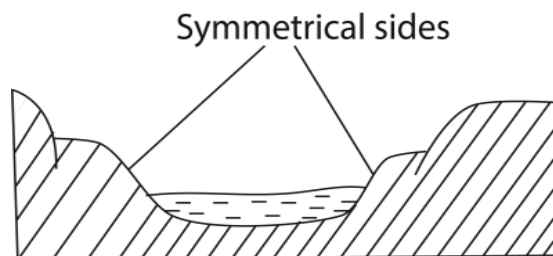
a. Ingrown meanders.

This is a valley with an asymmetrical cross-profile, where one side is steeper than the other. It normally develops on more resistant rocks when vertical erosion increases, e.g. R Mubuku near the Kasese-Fort portal road, R. Manafa near Busia, along the Tororo - Mbale road.



b. Entrenched meander.

These are valleys with steep sided symmetrical profiles. They develop on weak rocks where there's rapid lowering of the base level



c. Abandoned meander

These are meanders formed by rejuvenation along the flood plain during the formation of ox-bow lakes. The river cuts a new channel leaving the adjacent spur to form an isolated hill known as a

meander score. Abandoned meanders form minor and short tributaries for example are seen on the kano plains of Kenya.

Importance of river erosion and depositional features to human activities

Positive importance

- Waterfalls, rapids and narrow gorge are used for HEP
- Beautiful scenery of waterfalls, rapids, meander are tourist attraction sites
- River valleys have fertile soils for agriculture
- Delta such as that Semuliki contain petroleum deposits
- Delta and river valleys contain sand and clay as building materials
- The mangrove vegetation in the river Rufiji provide poles for construction
- Delta are used for fishing

Negative importance

- Rapids and waterfalls hinder transport.
- Deep valleys limit settlement
- Flooding limit agriculture and settlement

A GRADED PROFILE

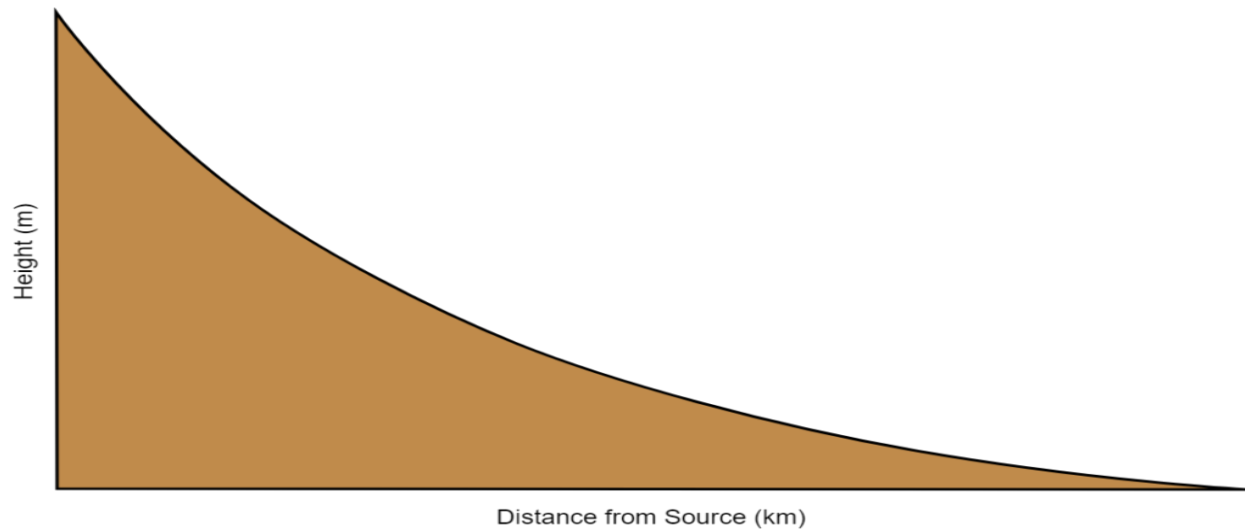
A graded profile refers to well-developed concave slope from a river's source to the mouth. It is sometimes referred to as a profile of equilibrium.

Rivers try to attain a smooth river profile which is neither steep nor gentle by undermining highlands and eroding away obstacles while at the same time depositing the eroded sediments from upslope into the valley so as to attain a graded profile.

Usually, concave from the source to the mouth where erosion is balanced with deposition. It is sometimes referred to as "profile of equilibrium". The load carried by the river exactly matches with its capacity to transport it.

Near the source, erosion is less than average because of the small volume of water. The curve is therefore steep.

In the middle, curve is pronounced. This is because many tributaries adding onto the river volume will have joined the river and thus the slope is deepened by vertical erosion.



However, no river in East Africa Not even the Nile has attained a graded profile.

Reasons for non-existence of a graded profile along R. Nile

Faulting within the river course. Faulting along the Karuma led to an increase in the erosion power of the Nile. This led to creation of a waterfall and depression (plunge and pool) thus a graded profile not formed

Changes in climate. River Nile flows through an area with different climatic characteristics. Such regions are characterized by heavy rain at the source (Jinja - L. Kyoga) and low rains towards the middle and old age. Such differences interfere with development of a graded profile.

Influence of river rejuvenation. When a river renews its erosion power there is increased erosion of the channel both vertically and laterally. The Nile has undergone rejuvenation at a number of stages for example around Karuma falls due to uplift it flows into a valley thus its speed is increased leading to the formation of potholes, plunge pool which interferes with development of smooth graded profile.

Change in the base level. Base level is the lowest point below which a river cannot erode. It is an imaginary line extending from the river mouth beneath the land whose altitude is zero.

The sea is the universal base while lakes are the local base level. R. Nile crossed Lakes Kyoga and Albert whose base level changes due to a rise/fall in water level due to climatic factors. Such changes interfere with the formation graded profile.

Example when the base level falls, the river gains momentum and so does more erosion; when it rises, the gradient of the river reduces leading to a reduction in the river's velocity hence deposition occurs.

Differences in rock hardness. Soft rocks are easily eroded to form a wide and deep river channel. On the other hand, rocks tend to resist a rivers erosive ability. Since R. Nile passes through a region with different hardness it has not been able to attain a graded profile. For example, rapids at Jinja resisted erosion and remain protruding on the river bed.

Presence or absence of vegetation and other obstacles. The presence of vegetation and hard volcanic Islands at Jinja between the 'source' of the Nile and Bujagali falls has led to braiding of R. Nile. Such circumstances have tampered with evolution of a graded profile.

River capture. When a river arrests the waters of another adjacent river the energy of the capturing river is increased this leads to increased down cutting/erosion at the point of capture. This destroys a graded profile. The Nile captured river Tochi, Okole and Arocha thus an increased in its erosive power

Human activities. Human activities like dam construction and irrigation tampers with the development of a graded profile. For example, construction of dam like Nalubale and Kiira dams increase deposition upstream and erosion down stream

DRAINAGE PATTERNS IN EAST AFRICA

Drainage pattern refers to the lay out /plan/structural arrangement of the river and its tributaries on the surface of the earth or drainage basin.

Drainage patterns can be divided into two;

- Accordant drainage pattern

- Discordant drainage pattern

Accordant drainage patterns.

This is where the river and its tributaries flow according to the slope of the land e.g dendritic drainage pattern, annular, radial, hooked, parallel, trellis etc. on the other hand,

Discordant drainage pattern refers to a situation where there is no systematic relationship between the river and the underlying rock type and structure for example Antecedent and Super imposed drainage patterns.

MAJOR DRAINAGE PATTERNS IN EAST AFRICA

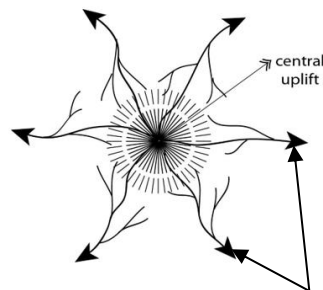
RADIAL PATTERN

This is a system where rivers and their tributaries flow outwards in all directions from a **central raised point** such as a dome or volcanic cone down wards. For example, a volcanic mountain, ridge or highland.

Radial pattern is associated with rivers originating from highland areas such as conical or dome shaped hills or mountain usually snow-capped, with a crater or caldera.

Examples include; rivers originating from mountain Rwenzori, Elgon, Kenya and Kilimanjaro, for Example River Sironko, Manafwa, Malaba and Nzoia on mountain Elgon.

Illustration



Rivers flowing outwards

Conditions for development

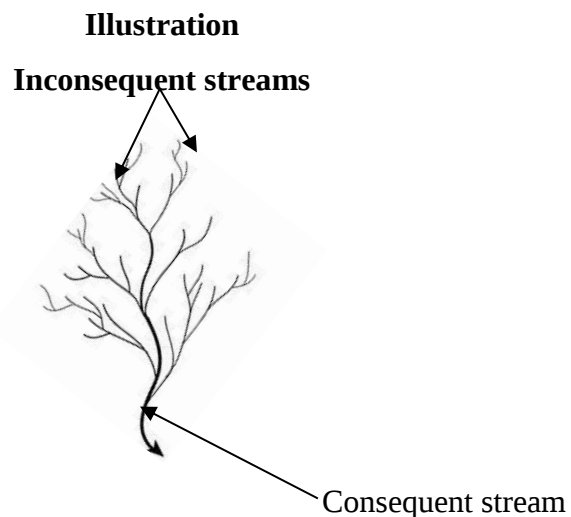
- Presence of a dome shaped uplands such as a volcanic mountain, ridge etc. to shed water in different directions.

- Nature of the slope. Radial pattern develops in rivers flowing down slope in all directions on steep slopes in highlands.
- Rock structure. Radial pattern develops in areas with hard homogenous rocks which offer uniform resistance and shape.
- Radial pattern also develops in areas receiving heavy precipitation in form of rain fall or glaciers in the catchment area to maintain stream flow until the pattern is complete

DENDRITIC PATTERN

Dendritic comes from a Greek word Dendron which means tree like. This is a tree-like pattern of drainage in which tributaries' coverage on the main stream from many directions and usually join the main river at acute angles (less than 90^0). It develops in gently dipping areas which influence the speed of river flow.

Examples of rivers displaying dendritic pattern include River Malagarasi, river Ruvuma and Rufiji in Tanzania, River Nzoia, Athi, Galana and Nyando in Kenya, River Okoth and Aswa in Northern Uganda.



Conditions for development

- Rock structure. Dendritic pattern develops in areas with massive homogenous rocks which offer uniform resistance to erosion for example crystalline rocks such as granites.
- Uniform erosion so that the tributaries join the main stream at acute angles.
- Presence of heavy and reliable rainfall in the catchment area to maintain stream flow until the pattern is complete.

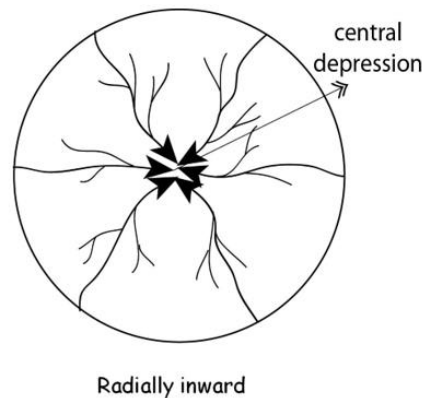
- All rivers and tributaries flow in valleys that are proportioned to their size.
- Relief. Dendritic pattern develops on gently dipping relief/slope to enable streams flow in one general direction.

CENTRIPETAL PATTERN

This is a system where rivers flow in wards towards a depression or basin usually a lake from the surrounding higher/ raised areas.

Examples of rivers displaying this pattern include river Katonga, Kagera and Nzoia flowing into Lake Victoria. River Molo, OlMulutan, Lobo and Arabel drain into Lake Baringo in Kenya.

Illustration



CONDITIONS FOR DEVELOPMENT

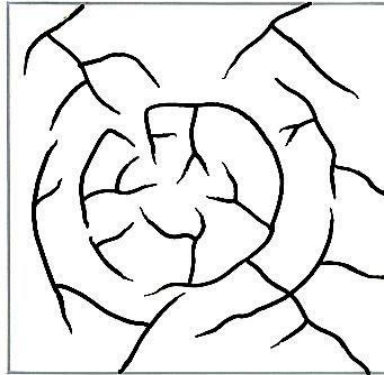
- Presence of a depression/central basin at a low elevation formed due to warping where rivers flow into from all directions and converge in the central point.
- The river flows in accordance to the slope of the land.
- Presence of heavy rainfall in the catchment area to maintain stream flow until the pattern is complete.
- presence of a gentle slope that facilitates river flow downwards towards the basin.
- massive homogenous rocks which offer uniform resistance to erosion and promote headward erosion.

ANNULAR PATTERN

This is a system where tributaries join the main stream at sharp angles but in a series of curves for example around a crater or caldera or around dissected dome.

Examples of rivers displaying this pattern include rivers flowing around Ngorongoro crater in Tanzania.

Illustration



conditions for development

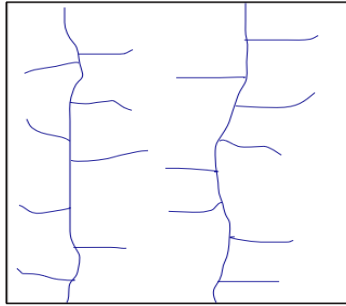
- The river must be flowing sharply in a series of curves in a volcanic area
- There must be a dissected plateau /dome with alternating hard and soft rocks or faulted zones where streams erode valleys in less resistant strata.
- Presence of a dome/crater/basin.
- Presence of heavy and reliable rainfall to maintain stream flow until the pattern is complete.
- There should be a large catchment area.
- Rivers must flow in concentric curves

TRELLIS / RECTANGULAR DRAINAGE PATTERN

This is a system where tributaries join the main river at approximately right angles (90^0). The main area is called the consequent river and the tributaries subsequent.

Examples of rivers displaying this pattern include river Aworanga, Tochi and Achwa in Northern Uganda west of Gulu town, and river Kericho in Kenya.

Illustration



CONDITIONS FOR DEVELOPMENT

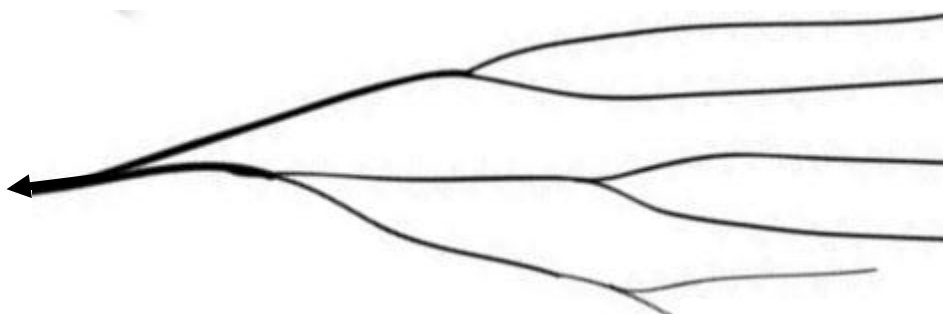
- Rock structure. Trellis pattern develops in areas of heterogeneous rocks in alternating hard and soft rocks lying at right angle to the general slope.
- Nature of the slope. Trellis pattern develops on gentle slope for the main stream and steep sloping areas for the tributaries.
- Presence of reliable rainfall in the catchment area to maintain stream flow until the pattern is complete.
- There must be a large catchment area to provide ample water for streams to flow continuously
- Tectonic movements. trellis drainage patterns can also occur in faulted regions where the river will take the shuttered rocks of the fault line as soft rocks hence it will flow along fault lines thus joining at right angles
- Trellis pattern also develops in areas where river capture took place or takes place

parallel pattern

This is a pattern where the main river and its tributaries flow more or less parallel to each other from the same water shed.

Examples of include Nkusi and Hoima from mountain Rwenzori flow parallel to each other before joining Lake Albert.

Illustration



conditions for development

- It develops in areas with steep elongated slopes such as escarpments.
- Rock structure. Parallel pattern develops in areas of uniform or heterogeneous rocks
- Relief. It develops in areas of steep elongated slopes such as escarpment or gentle slopes.
- Develops in areas of heavy rainfall to supply water for stream flow until the pattern is complete.
- The rivers follow the slope of the land downwards e.g rivers flowing down the western edge of the Butiaba escarpment

Hooked or barbed pattern

In this pattern, the tributaries appear to flow in the opposite direction to the main river and look like a hook or a barb. They enter the main river at an acute angle.

Examples include river kafu, katonga and kagera in Uganda and the Rwizi river.

Conditions for development

- Usually develop in areas of river capture where drainage reversal occurs.
- Develop in areas of heavy rainfall

DISCORDANT PATTERNS

A discordant pattern refers to where there is no close relation between the rocks and the drainage pattern exhibited by rivers. The major discordant drainage patterns include;

Antecedent drainage pattern.

It involves a river which developed and established a pattern on landscape which was later uplifted by earth movements. The river conditions to flow in its original direction by eroding a gorge in the landscape.

Illustration

The uplift must be slow enough for the river to maintain its course in the path of the rising ground or land. The river must also be powerful enough to erode vertically downwards as fast as the rising land and therefore develops a gorge. Antecedent river patterns are therefore older than the landscape over which they flow e.g. R. Malagarasi on Tanzania.

Super imposed drainage pattern.

This is the pattern that develops on a landscape which is afterwards is removed or changed. It's now super imposed or on top of a previously buried and completely different rock structure eg if sedimentary rocks are covering a folded rock structure as shown below.

Illustration.

When the sedimentary rocks are removed by erosion, the folded rocks below are exposed. The river is normally expected to flow through the synclines or valleys. However, it may manage to maintain its course and cut across the anticlines by developing gorges. Super imposed drainage is therefore younger than the landscape over which it flows.

To what extent has relief influenced the development of drainage patterns in East Africa?

Drainage pattern is s the layout/plan or arrangement made by a river and its tributaries on the landscape (Drainage basin) over which it flows.

- **Radial drainage pattern** – A pattern in which rivers and their tributaries flow from a common peak/dome shaped structure various direction like the spokes of a bicycle wheel. It is common in dome shaped uplands like mountain Elgon, Mahanta etc.

- **Dendritic drainage pattern** – a pattern where rivers and their tributaries create a tree like plan/layout, with tributaries joining the main stream from many directions at more or less acute angles. It's the most, common type of drainage pattern in East Africa, such as river Apwac in Kalongo area, Tana river, river Namatale etc.
- **Rectangular drainage pattern (Trellis)** – a pattern where the main stream takes sharp, more or less rectangular bends and tributaries join it at more or less right angles such as river pager and tributaries, river Athi, river Mayanja, river Kato-Wasswa in Mityana-Mubende area etc.
- **Centripetal pattern** – where rivers flow from the rims of surrounding higher areas (Basin) into a common depression where there is a lake or Swamp such as Lake Victoria and Kyoga, lake Baringo etc.
- **Annular pattern** – where streams join at sharp angles arranged in a series of curves around dissected uplands, craters / calderas such as Ngorongoro, Bukigai area (hill) in Bududa etc.
- **Parallel pattern** – where streams and their tributaries flow down slope more or less parallel to each other such as river Nkusi and Hoima on the other Butiaba scarp, river Rukoki, chalanga and Kamulikwizi in Kassese area.
- **Barbed/ hooked pattern** – a pattern where stream tributaries flow in opposite direction to the main river, before joining it at more or less acute angles to form a hooked or barbed pattern. This pattern is associated with drainage reversal as is the case of river Katonga, Kafu, Kagera etc.

The existence of relief has influenced the development of various drainage patterns in many ways and these include:

- Steep slopes on volcanic cones such as Mt Suswa in Kenya, Mt Elgon etc. favor the development of radial drainage pattern. The steep slopes accelerate down ward movement of water and erosion of rocks to create channels along which rivers flow. Steep slopes such as escarpments lead to parallel drainage patterns.

- Gently dipping slopes favor the development of dendritic pattern. Gently sloping areas encourage the dendritic drainage where the consequent (major) and subsequent (minor) streams flow in the direction of the initial slope over which the pattern was established such as river Malagarasi Victoria Nile, Rufiji etc.
- Existence of hills separated by inside valleys lead to the development of trellised drainage as seen from Mayanja Kato and Wasswa in Mityana-Mubende area.

Rock nature/ structure

- Jointed/ faulted rocks have encouraged the development of rectilinear/ trellis drainage patterns as seen on river Mayanja-Kato and Wasswa, pager, Awa and Galana.
- Alternate soft and hard rocks demarcated by joints almost at right angles to the general slope encourage trellis drainage patterns.
- Soft and hard rocks lying side by side encourage the development of parallel drainage pattern, where rivers flow by side of each other but with limited chances of joining e.g. river Nkusi and river Hoima.
- Homogeneously uniform/crystalline igneous rocks lead to the development of dendritic patterns, radial patterns. Uniform rocks enable the rivers to erode uniformly creating a variety of tributaries.

Tectonism has encouraged the development of drainage patterns in East Africa;

- Warping- Areas affected by up warping and down warping such as the Victoria-Kyoga basin/depression, which later encouraged several rivers from different directions to flow into the basin, formed centripetal, drainage pattern.
- Faulting encouraged the formations of joints and fault lines which later promoted the formation of rectilinear/rectangular or parallel patterns.
- River capture system encourages the development of drainage pattern over time especially where a strong river arrests the water of a weak neighboring river, into its own channels.

This encourages the development of barbed/ hooked drainage patterns, Dendritic patterns etc.

- Climate in form of reliable rainfall equally accounts for the development of drainage patterns in East Africa. Existence of reliable rainfall in a drainage basin/catchment area is necessary to support the evolution and continued existence of a river and its tributaries which may form several patterns like radial, trellis, dendritic etc.

Vegetation

Rainfall interception, soil erosion, and infiltration rates are just a few ways vegetation impacts these patterns. River channels may become braided or meandering when dense vegetation reduces surface runoff and promotes infiltration. Over time, changes in land use and deforestation can influence drainage patterns.

Revision questions

1. Study the photograph provided below and answer the questions that follow:



- a) Draw a landscape sketch of the area shown in the photograph and on it mark and name;
 - i. Any two river erosional features.
 - ii. Physiographic regions
 - iii. River cliff.
 - iv. Vegetation types. (08 marks)
- b) Describe the process responsible for the formation of any one river erosional land form shown on the photograph. (06 marks)
- c) Explain the importance of the features shown on the photograph to the economic development of East Africa. (05 marks)
- d) Explain the problems faced by the people living in the area (04 marks)
- e) Giving a reason for your answer, identify any one area from East Africa where the photograph could have been taken. (02 marks)

2. Study the photograph provided below and answer the questions that follow:



(a). Draw a landscape sketch of the area shown in the photograph and on it mark and name;

- v. Rapids.
- vi. Boulders.
- vii. River cliff.
- viii. Vegetation types.

(06 marks)

(b). State and account for the stage of the river

(04 marks)

(c). Describe the process responsible for the formation of the drainage feature in the middle ground

(05 marks)

(d). Describe the process responsible for the formation of the boulders

(03 marks)

(e). With evidence, Explain the problems faced by the people living in the area

Shown in the photograph

(05 marks)

(e). Giving a reason for your answer, identify any one area from East Africa where the photograph could have been taken.

(02 marks)

3. Study the photograph provided below and answer the questions that follow:



- a) Draw a landscape sketch of the area shown in the photograph and on it mark and name;
 - i. Braided channel.
 - ii. Land uses.
 - iii. Relief regions.
 - iv. Vegetation types. (08 marks)
- b) Describe the process responsible for the formation of the feature shown in the middle ground of the photograph. (06 marks)
- c) State and account for the stage of the river shown in the photograph above (04 marks)
- d) With evidence, Explain the problems faced by the people living in the area
- e) Shown in the photograph (05 marks)
- f) Giving a reason for your answer, identify any one area from East Africa where the photograph could have been taken. (02 marks)

4. Study the photograph provided below and answer the questions that follow:



- a) Using a tracing paper, draw a sketch of the area shown on the photograph and on it, mark and label;
 - i. River meander.
 - ii. Slip off slope.
 - iii. River cliff.
 - iv. Meander loop and Neck
 - v. Forested area.
- b) Describe the processes responsible for the formation of the river meander identified in (a) (i) above.
- c) Explain the importance of the features shown on the photograph to the economic development of East Africa. (05 marks)
- d) Explain the problems faced by the people living in the area (04 marks)
- e) Giving a reason for your answer, identify any one area from East Africa where the photograph could have been taken. (02 marks)

5. Study the photograph provided below and answer the questions that follow:



- a) Using a tracing paper, draw a sketch of the area shown on the photograph and on it, mark and label;
 - i. Ox-bow Lake.
 - ii. River.
 - iii. River neck.
 - iv. River distributary
 - v. Forested area.
- b) Explain the processes responsible for the formation of the ox-bow Lake identified in (a) (i) above.
- c) State the importance of the drainage feature shown on the photograph.
- d) Giving reasons to support your answer, suggest an area in East Africa where the photograph could have been taken.

6. Study the photograph provided below and answer the questions that follow:



- a) Draw a landscape sketch of the area shown in the photograph and on it, mark and label:
 - i) river meander,
 - ii) flood plain,
 - iii) river cliff
 - iv) slip off slope.
- b) Describe the processes that led to the formations of the features identified above.
- c) Explain the:
 - i) economic importance of the features shown in the photograph
 - ii) problems being faced by the people living in the of the area.
- d) Giving reasons to your answer, suggest an area in East Africa where the photograph could have been taken from

7. Study the photograph provided below and answer the questions that follow:



- a) Draw a landscape sketch of the area shown in the photograph and on it mark and name;
 - i. Delta.
 - ii. Relief regions
 - iii. Distributary
 - iv. Bay.
 - v. Vegetation type.
- b) Describe the process responsible for the formation of the delta channel shown on the photograph.
- c) State and account for the stage of the river shown in the photograph above
- d) Explain the importance of the features to the economic development of East Africa.
- e) With evidence, Explain the problems faced by the people living in the area shown in the photograph
- f) Giving a reason for your answer, identify any one area from East Africa where the photograph could have been taken.

8. To what extent has the nature of the rock influenced the development of drainage patterns in East Africa.

9. Account for the development of the following drainage patterns in East Africa

- Dendritic,
- annular and
- rectangular

10. Describe the similarities and differences between deltas and alluvial fans.

11. a) Differentiate between cross profile and long profile of the river.

b). describe the formation of the features in the senile stage.

12. explain the causes and effects of river capture in east Africa.