# GEOGRAPHY FORM THREE WORK.

**TOPIC ONE:** **STATISTICAL MEHODS**

**By Prof. Ogoti Robert Maxwell**

- Methods of presenting statistical data that we learn in form three are:
  - ✓ Compound/ cumulative bar graphs.
  - ✓ Proportional circles
  - ✓ Pie charts
  - ✓ Proportional divided circles.

## 1. Compound/ Cumulative Bar Graphs.

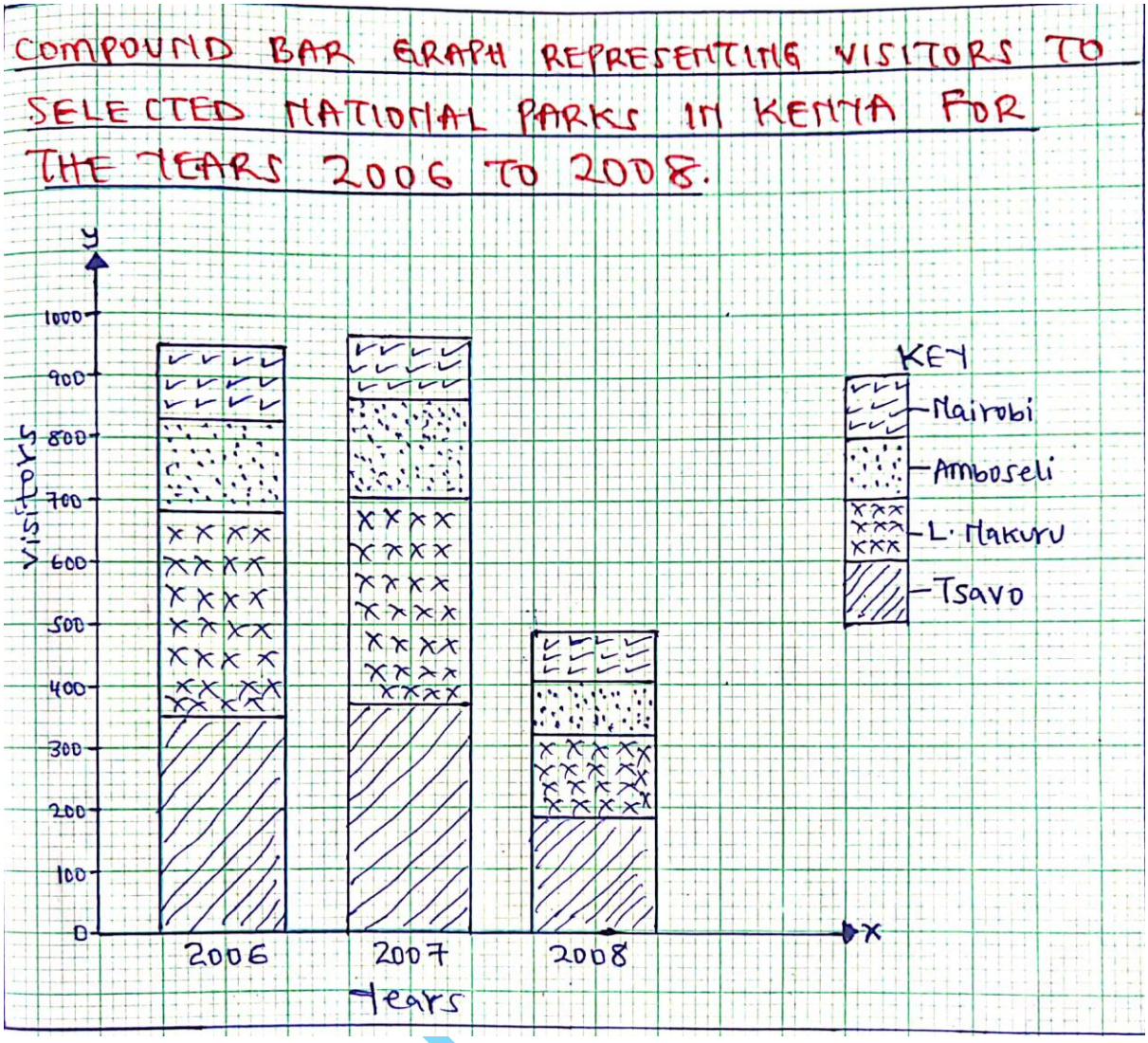
- Comprise of one or more bars drawn vertically or horizontally with each bar subdivided so that each portion represents a component of the data that makes the whole.
- Where two or more bars are drawn, each bar is separated with an equal space between them.
- Suitable for presenting data depicting the total value of several items.

**Example.**

Kcse 2017: The table below shows the number of visitors in '000' to selected national parks in Kenya for the years 2006 to 2008.

| PARK/ YEAR | 2006 | 2007 | 2008 |
|---|---|---|---|
| NAIROBI | 102 | 93 | 92 |
| AMBOSELI | 153 | 156 | 82 |
| TSAVO | 354 | 372 | 182 |
| LAKE NAKURU | 327 | 347 | 138 |
| **TOTAL** | **946** | **968** | **497** |

Draw a compound bar graph to represent the number of visitors to selected national parks in Kenya. Use the scale of 1cm to represent 100,000 visitors.




## Interpretation of Compound bar Graphs.

- Observe the trend of the bars. Look for the total of the variables of each bar in the period given.
- Compute the trend of an individual variable against the successive totals of each bar.
- Comment on the trend of each variable.
- From the interpretation, suggest possible reasons to explain the trend of the variables obtained.

NOTE: **The following interpretation can be deduce from the drawn compound bar graph;**

- ✓ Kenya received more tourists in the year 2007.
- ✓ Kenya received few tourists in the year 2008.
- ✓ Tsavo national parks received highest number of tourists for the years 2006 to 2008.
- ✓ Lake Nakuru is the second national park visited by many tourists.
- ✓ Tsavo national park received highest number of tourists in 2007.
- ✓ Nairobi national park received lowest total number of tourists.
- ✓ Number of tourists who visited Nairobi National park reduced from 2006 to 2008.

**Advantages of using compound bar graphs to represent statistical data** –kcse 2017

i. They give clear visual impression.
ii. They allow easy comparison.
iii. They are easy to interpret.
iv. They can be used to represent a wide range of data.

**Disadvantages of using compound bar graphs.**

i.) It consumes a lot of time when drawing.
ii.) It fails to show trend/ change of quantities/ values.
iii.) It is difficult to interpret when many bars are drawn.
iv.) It is difficult to read exact values at a glance.
v.) Represents a few variables/ items.

**Assignment.**

The table below shows contribution of various energy sources in Kenya in thousand dollars.

| Type of power | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|
| Hydropower | 130 | 100 | 100 | 110 |
| Geothermal | 120 | 140 | 160 | 170 |
| Thermal | 30 | 50 | 40 | 30 |
| **Total** | **280** | **290** | **300** | **310** |

a) Using a scale of 1cm represent 50,000 dollars, draw a compound/ cumulative bar graphs.
b) Give analysis and interpretation of the drawn graph.

## 2. PROPORTIONAL CIRCLES.

- This method employs the use of circles of various sizes to represent different sets of data.
- Each circle is drawn to a size proportional to the total value of data it represents. For example, the smallest value is represented by the smallest circle while the largest value is represented by the largest circle.

a) **Use of circles with diameters proportional to the total values.**

i. Round off the totals to the nearest thousands to obtain round figures for ease of working.
ii. Select a suitable scale for the diameter which will in turn be proportional to the total values.
iii. Use the radii figures to draw the different circles.

**Example.**

**Kcse 2018:** The table below shows value of export earnings of selected crops from Kenya (Ksh. Millions).

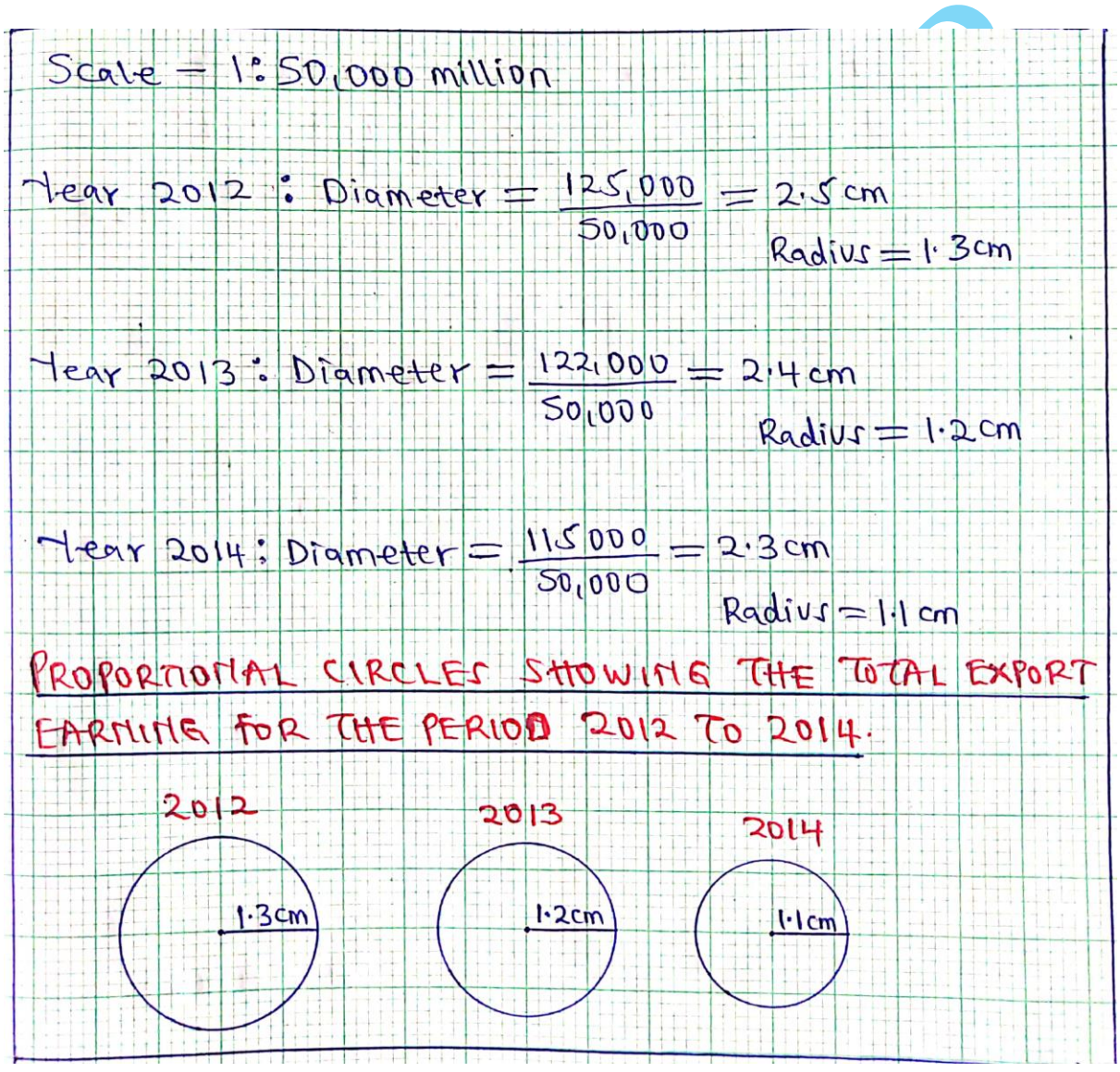
| CROP | 2012 | 2013 | 2014 |
|---|---|---|---|
| TEA | 101441 | 104648 | 93996 |
| COFFEE | 22271 | 16328 | 19913 |
| SISAL | 1184 | 1020 | 1325 |
| TOTAL | 124896 | 121996 | 115234 |

Draw proportional circles to represent the total export earnings during the period of 2012 to 2014. Use diameter method.

Solution.

Round off the totals.

| YEAR | TOTALS | ROUND OFF |
|---|---|---|
| 2012 | 124,896 | 125,000 |
| 2013 | 121,996 | 122,000 |
| 2014 | 115234 | 115,000 |




**Analysis and interpretation of proportional circles** –kcse 2018

i.) The total export values for the selected crops was highest in 2012.
ii.) The total export value had a decline for the consecutive years.
iii.) 2014 registered the lowest export value.
iv.) Total exports value for the three years has very little significant difference.

b).**Use of Circles with Areas Proportional to the total values.**

- The proportional circles may be drawn by drawing circles whose areas are proportional to the square roots of the absolute values.
- Find the square roots of each set of data.
- Choose a suitable scale for the use in calculating the different radii of the circles. The scale should neither be too big nor too small. This is to ensure that the sizes of the circles is convenient.
- Then draw circles using the different radii.

**Example.**

The table below shows total sugar production by five factories in Kenya from 2015 to 2018.

| FACTORIES | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|
| MUMIAS | 192,556 | 212,455 | 249,550 | 262,986 |
| NZOIA | 124,500 | 144,660 | 150,500 | 182,800 |
| CHEMELIL | 120,460 | 139,550 | 140,400 | 142,200 |
| SONY | 100,500 | 110,624 | 120,340 | 136,450 |
| WEST KENYA | 50,600 | 521,240 | 55,650 | 574,194 |
| TOTAL | 588,616 | 659,429 | 716,440 | 781,855 |

Draw proportional circles to represent the total sugar production by factories in Kenya during the period of 2015 to 2018. Use area method.

Solution.

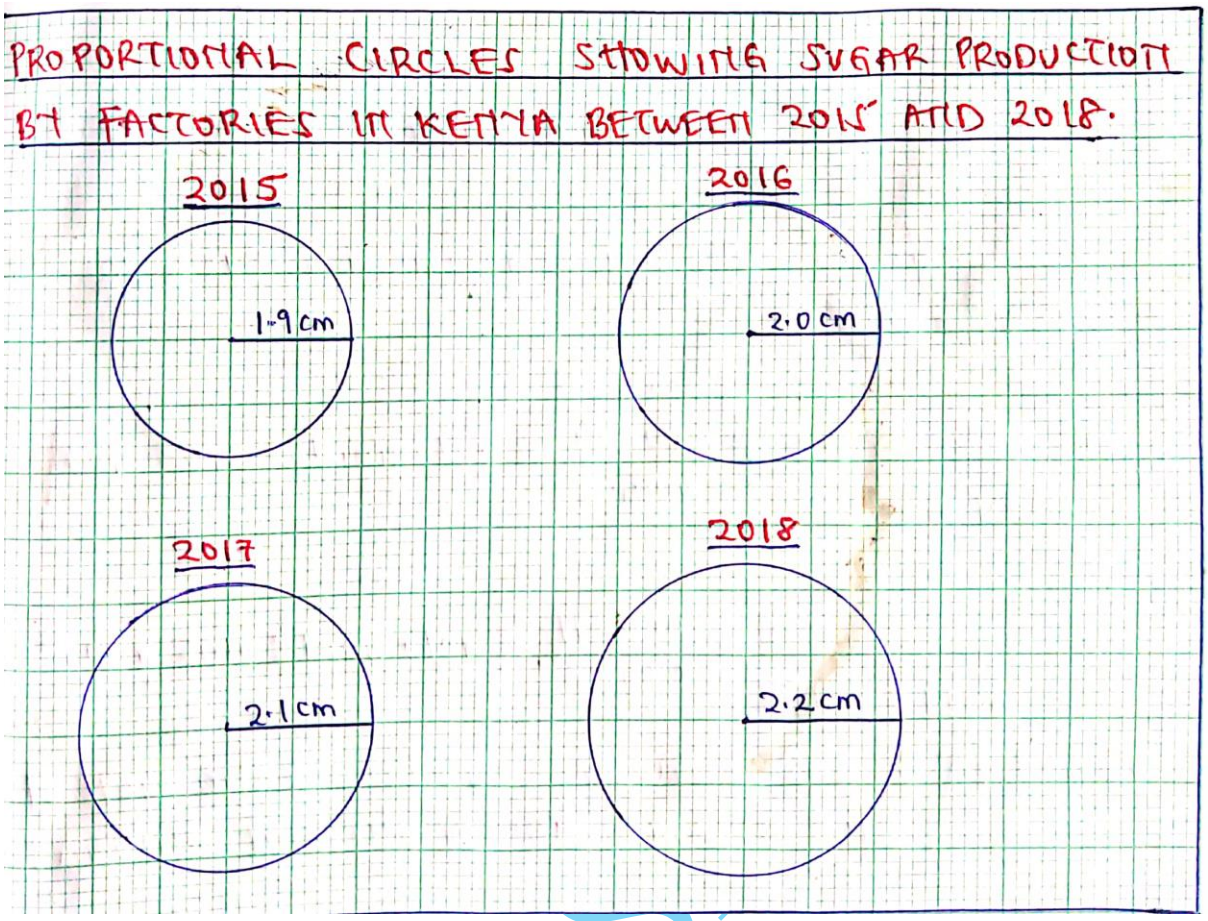
- Get the square root of the total value for each year i.e.

Year 2015: $\sqrt{588,616} = 767.2$

- Choose a suitable scale to get radius i.e. 1cm represent 400 units

$$\frac{767.2}{400} = 1.9\text{cm}$$

| YEAR | TOTAL VALUE | SQUARE ROOT VALUE | RADIUS (cm) |
|---|---|---|---|
| 2015 | 588,616 | 767.2 | 1.9cm |
| 2016 | 659,429 | 812.1 | 2.0cm |
| 2017 | 716,440 | 846.4 | 2.1cm |
| 2018 | 781,885 | 884.2 | 2.2cm |




## Advantages of proportional circles.

- ✓ Give clear visual impression.
- ✓ Easy to construct.
- ✓ Easy to interpret.
- ✓ Allow comparison.

## Disadvantages of proportional circles.

- ✓ Difficult to read values at a glance.
- ✓ Time consuming when drawing.
- ✓ Represents a few variables/ items.

## Assignment.

The table below shows population of some counties in the lake region of Kenya in the last four census.

| COUNTY | 1989 | 1999 | 2009 | 2019 |
|---|---|---|---|---|
| SIAYA | 500,700 | 641,055 | 715,951 | 842,304 |
| HOMABAY | 608,123 | 764,987 | 800,009 | 963,794 |
| BUSIA | 456,098 | 483,442 | 500,000 | 598,252 |
| KISII | 503,765 | 687,092 | 756,900 | 968,879 |
| KISUMU | 850,754 | 906,997 | 1,078,121 | 1,152,000 |
| TOTAL | | | | |

Draw proportional circles to represent the total population of some counties in the lake region of Kenya.

a) Use diameter method.
b) Use area method.

## 3. PIE CHARTS/ DIVIDED CIRCLES/ PIE GRAPHS.

- These are circles drawn and subdivided to represent statistical data.
- Each segment of the circle represents a given component of the data.
- The size of the segment is equivalent to the quantity of the value of the component.

### Types of pie charts.

- Simple pie charts.
- Proportional divided circles.

### A simple Pie Chart (Divided Circle).

- This involves drawing a circle of a convenient size representing a complete set of recorded data.
- The circle is then sub-divided with each segment representing a component of the set data.
- Each component is calculated as a percentage of the whole and then converted to degrees.

### Example.

**Kcse 2020:** The table below shows estimated production of selected crops in Kenya in 2013.

| Crop | Production (Number of bags). |
|---|---|
| Maize | 38,900,000 |
| Beans | 6,100,000 |
| Sorghum | 1,800,000 |
| Millet | 700,000 |

Source: Economic Survey of Kenya, 2014.

Using a radius of 5cm, draw a pie chart to represent the data in the table above.
Show your calculations.

$38,900,000 + 6,100,000 + 1,800,000 + 700,000 = 47,500,000$

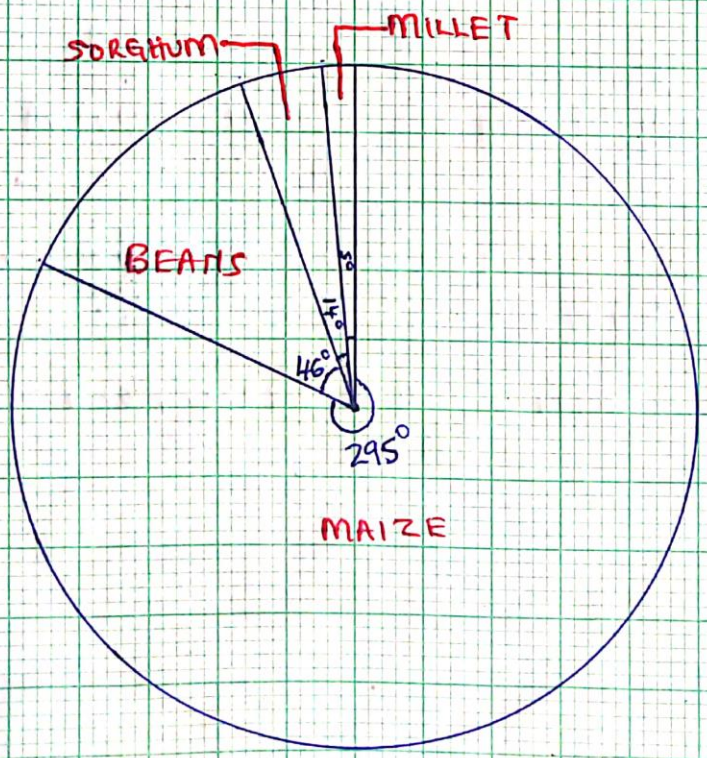
$\text{Maize} = \frac{38,900,000}{47500000} \times 360^\circ = 294.8^\circ = 295^\circ$

$\text{Beans} = \frac{6,100,000}{47,500,000} \times 360^\circ = 46.23^\circ = 46^\circ$

$\text{Sorghum} = \frac{1,800,000}{47,500,000} \times 360^\circ = 13.64^\circ = 14^\circ$

$\text{Millet} = \frac{700,000}{47,500,000} \times 360^\circ = 5.30^\circ = 5^\circ$

A PIECHART REPRESENTING ESTIMATED PRODUCTION OF SELECTED CROPS IN KENYA IN 2013.



## Interpretation of simple pie charts (Divided circles).

- The circle in this case represents the total value of variables. From the circles, it is easy to establish the contribution of a variable in percentage.
- From the pie chart it is also possible to suggest the possible reasons responsible for variation in the data.

**Advantages of using a pie chart to represent Geographical data** –kcse 2022

- ✓ It is simple to construct/ draw.
- ✓ It is easy to compare various components within a circle as they are all represented by angles.
- ✓ It gives clear visual impression of individual components.
- ✓ It easy to read/ interpret.
- ✓ It represent wide range of data.

**Disadvantages of using simple pie chart to represent statistical data** –kcse 2020

- ✓ It consumes a lot of time in calculations/ measurement of angles/ construction.
- ✓ It is difficult to accurately measure/ draw small angles.
- ✓ It fails to show trend/ change of quantities/ values.
- ✓ The angles fails to show the actual value of the variables.
- ✓ It is difficult to interpret when many sectors are drawn.
- ✓ It is difficult to extract exact value without calculations.

## Assignment.

**Kcse 2022:** The table below shows sales of selected crops in tonnes, grown in Kenya between years 2015 to 2017.

| Crop | 2015 | 2016 | 2017 | Total |
|---|---|---|---|---|
| Tea | 399,200 | 473,000 | 439,900 | 1,312,100 |
| Maize | 295,300 | 265,800 | 239,200 | 800,300 |
| Wheat | 227,300 | 215,900 | 156,900 | 600,100 |

Source: Economic Survey of Kenya, 2018.

Draw a pie chart to represent the data on selected crops sales shown on the table above. Show your calculations.

## PROPORTIONAL DIVIDED CIRCLES.

- This is a case where two or more divided circles are drawn with each circle representing a separate set of statistical data.
- The sets may have different total quantities or value.
- The size of the circle is proportional to the total quantity or value of the set of data being represented. The proportionately drawn circles are then subdivided just like the simple pie charts.

**Construction of proportional divided circles take the following steps:**

i.) Find the square roots of the totals for each set of data.

ii.) Using the figures obtained in (i) above, find a suitable scale for the radii of the circles taking care that the circles do not become too large or too small.

iii.) For each set of data, calculate the percentages and angles as in simple pie charts.

iv.) Draw the circles using the scale in (ii) above then insert the details just like in simple pie charts, labelling each component. In each of the circles, shade the same components in the same way as above.

v.) Give the proportional divided circles a title and a key.

**Example.**

The table below shows causes of death in countries X, Y and Z in 2017.

| Country | HIV/AIDs | Road accidents | Drug abuse | Total |
|---|---|---|---|---|
| X | 10,000 | 2,000 | 2,400 | 14,400 |
| Y | 3,000 | 4,100 | 1,000 | 8,100 |
| Z | 500 | 270 | 130 | 900 |

Draw proportional divided circles.

Solution.

Sizes of the circles: $\sqrt{14,400} = 120$

$\sqrt{8,100} = 90$

$\sqrt{900} = 30$

Scale: let 1cm represent 20.

Radius of circle for country X = $\frac{120}{20}$ = 6cm

Radius of circle for country Y = $\frac{90}{20}$ = 4.5cm

Radius of circle for country Z = $\frac{30}{20}$ = 1.5cm

**COUNTRY X**

HIV/AIDs : $\frac{10,000}{14,400} \times 360^{o} = 250^{o}$

Road accidents : $\frac{2,000}{14,400} \times 360^{o} = 50^{o}$

Drug abuse: $\frac{2,400}{14,400} \times 360^{o} = 60^{o}$

**COUNTRY Y**

HIV/AIDs : $\frac{3,000}{8,100} \times 360^{o} = 133^{o}$

Road accidents : $\frac{4,100}{8,100} \times 360^{o} = 182^{o}$

Drug abuse: $\frac{1,000}{8,100} \times 360^{o} = 45^{o}$

**COUNTRY Z**

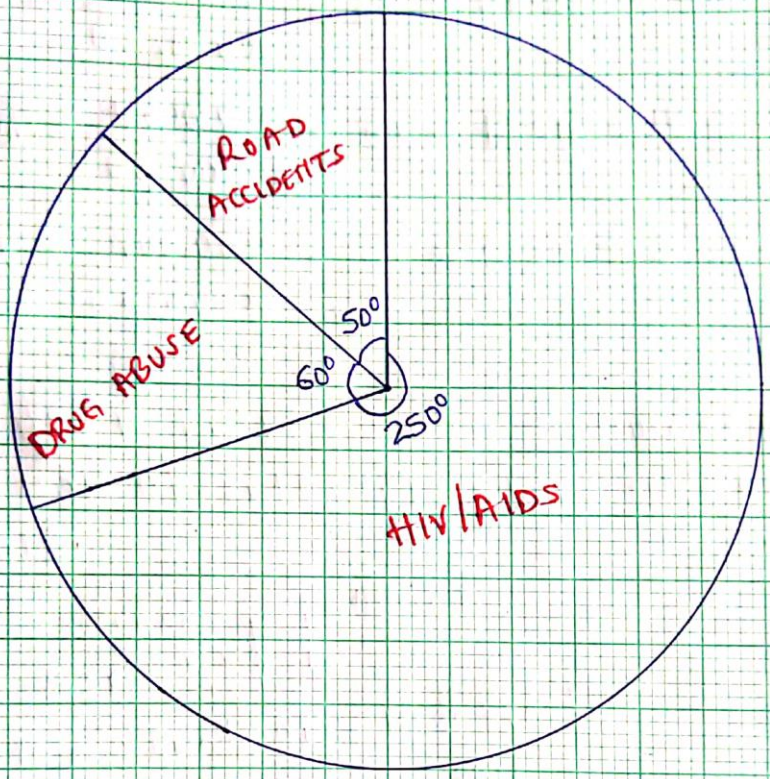
HIV/AIDs : $\frac{500}{900} \times 360^{o} = 200^{o}$

Road accidents : $\frac{270}{900} \times 360^{o} = 108^{o}$

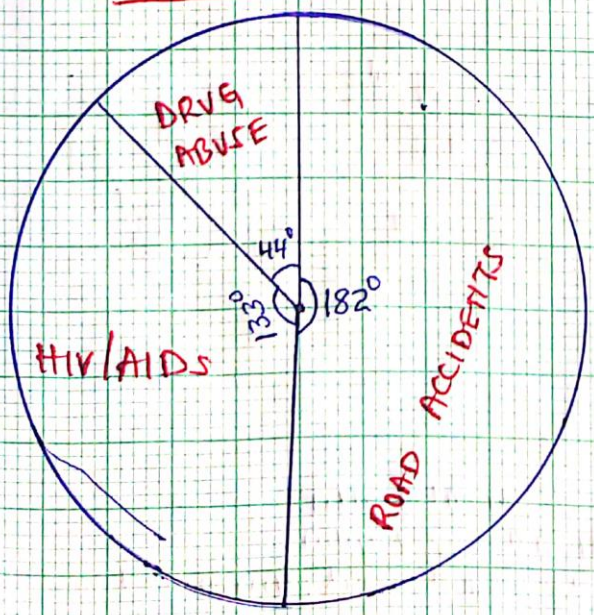
Drug abuse: $\frac{130}{900} \times 360^{o} = 52^{o}$

PROPORTIONAL DIVIDED CIRCLES SHOWING THE CAUSES OF DEATH IN COUNTRIES X, Y AND Z.

COUNTRY X




COUNTRY Y




COUNTRY Z

## Interpretation of Proportional Divided Circles

- The circles represent the proportion of the variable in each category.
- The segments in each circle describe the nature of the variable.
- In the proportional circles given HIV/AIDS which presently has no cure is the leading cause of death is the countries X, Y and Z.
- The size of the circle represent the total number of deaths, country X has the highest number of deaths followed by countries Y and Z.

### Advantages of proportional divided circles.

- ✓ Easy to draw/ construct.
- ✓ Easy to read/ interpret.
- ✓ Gives clear visual impression.

### Disadvantages of proportional divided circles.

- ✓ Time consuming while constructing/ calculating.
- ✓ Values cannot be read at a glance.
- ✓ Represents a few variables/ items.

### Assignment.

The table below shows beverage production in three counties in Kenya in 2021.

| County | Coffee | Cocoa | Tea | Total |
|---|---|---|---|---|
| Kericho | 1,000 | 800 | 700 | 2500 |
| Muranga | 225 | 600 | 400 | 1225 |
| Nyeri | 250 | 50 | 100 | 400 |

Draw proportional divided circles.



**"END OF TOPIC ONE"**

# MAPWORK

## PART ONE: INTRODUCTION.

- A map is a representation of the whole or part of the earth surface on a flat surface like a piece of paper, a wall, clothes e.t.c.
- Map work is the ability to read/ interpret/ analyse/ draw maps for better understanding of relief, drainage and various human activities on maps.

### Types of maps.

#### a) Topographical map.

- It is one which shows a selected number of physical and human features and their distribution on the earth surface.
- It is drawn by specially trained people called cartographers.
- It is drawn from air or aerial photographs and ground surveys.
- Topographical maps are used to answer question six of geography paper one (312/1).

**Characteristics of topographical maps.**

- ✓ They are drawn to scale.
- ✓ They are medium scale map sizes (1:50,000).
- ✓ They have a map title and map name.
- ✓ They have marginal information.
- ✓ They represent a small area such as a village/location.
- ✓ They depict physical features (relief, drainage, vegetation) and human activities (social and economic).

#### b) Atlas/ projected map.

- It is a collection of many maps bound in one volume, resembling a book showing different physical features and human activities.

**Characteristics of Atlas Maps.**

- ✓ They are used to represent a large area such as a country/continent/World in a small sheet of paper.
- ✓ They are drawn on a very small scale.
- ✓ They may represent specific or general information in an area.

#### c) Sketch/ outline map.

- Refers to rough drawings showing specific information which the user requires to see e.g. A sketch map of Africa showing distribution of Major Fold Mountains.

## Characteristics of a good sketch map.

- ✓ It is neat and clear.
- ✓ Has a title.
- ✓ It is enclosed in a frame.
- ✓ Has compass direction showing north.
- ✓ Has a key to explain symbols and signs used.
- ✓ It is roughly drawn/ not drawn to scale.

## Uses of maps.

i. They **show direction and location of places and phenomena** on the earth surface.
ii. They **show human and economic activities** like settlement patterns, land-use, communication network, mining areas, forestry and fishing.
iii. They **indicate physical features** like relief and drainage patterns.
iv. They **show weather trends** like rainfall distribution, temperature and climatic regions.
v. They **show political and administrative boundaries** hence useful for land ownership.
vi. They are **useful in military strategies** to pin-point the enemy's position.
vii. They are **used to find distance** between places.

## PART TWO: MAP READING.

## Marginal information on a map.

- Refers to details bordering the area covered by the map/ Information outside the map margins.
- They include;
  - ✓ The title
  - ✓ The scale
  - ✓ The compass direction
  - ✓ The key/ legend
  - ✓ Map sheet number and series
  - ✓ Date and edition
  - ✓ Grid systems
  - ✓ Publisher and copy right
  - ✓ Conversion table
  - ✓ Index to adjoining sheets

- **Type of map provided** –kcse 2017
  - Topographical map because it shows both physical and human features which are drawn to scale.

- **Name of the map/ sheet name;**
  - It is found at the top middle part of the sheet written in bold letters e.g.Taita hills, Busia, Kisumu East.

- **Title of the map/ sheet title;**
    - Usually printed on top left hand side of the map extract containing scale and country e.g. Kenya 1:50000 or East Africa 1:50000
    - **Type of information contained on the sheet title;**
        - ✓ Region where the map was developed.
        - ✓ The ratio scale.

- **Map sheet number/ map edition/ map series;**
    - They are mostly found in a small box on top right corner of the map provided.
    - **Sheet number** identifies the map sheet from the other sheets in the same group e.g. 115/1- Yimbo
    - **Map edition** shows the year when the map was published/ printed e.g. 1971
    - **Map series** shows the group of maps to which a particular map sheet belongs e.g. Y73 (D.O.S 423)

| | |
|---|---|
| Series | Y73(D.O.S.423) |
| Sheet | 115/1 |
| Edition | 1971 |

**How to identify a map.**

i. Map series e.g. Y73(D.O.S 423)
ii. Map sheet e.g. 115/1
iii. Map edition e.g. 1971
iv. Map name e.g. YIMBO

## Scale

- It is a ration between the map distance and the corresponding ground distance.
- Types of scales include:
    - ✓ **Representative Fraction scale/Ratio scale.**
    - ✓ **Linear scale.**
    - ✓ **Statement scale e.g. 1cm represent 0.5km**
- On topographical maps, scales are expressed in two forms only that is **linear scale** and **Representative fraction scale**.
- **Types of scales used in the map** –kcse 2021

- Linear scale e.g. 0 1 2 3 4 5 km
- Representative fraction (RF)/ Ratio scale e.g. 1: 50,000

- **Conversion of scale to statement scale** –kcse 2023

RF ⟶ 1:50000

1km — 100,000cm

?? — 50,000cm

50,000cm

————— X 1km = 0.5km or ½ km

100, 000cm

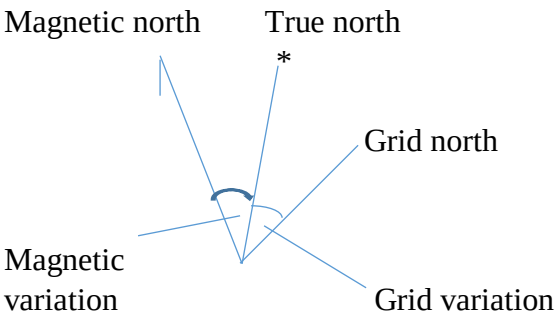
Therefore, statement scale = 1cm represent ½ km or 0.5km

- **Contour interval;**
  - ✓ It is the difference in value between two consecutive/ adjacent contours.
  - ✓ Found at the key written as V.I= 20m or V.I= 50ft

- **Index to adjoining sheets;**
  - It is a square containing nine small squares.
  - The area covered by the map is shown at the centre and the bordering regions.
  - Always write the sheet number then the name e.g. an area bordering Funyula to the south is **131/1- Ganjala**

| | | |
|---|---|---|
| 116/2<br>KISOKO | 117/1<br>BUMAYENGA | 117/2<br>BUMALA |
| 116/4<br>NAKHASIKO | 117/3<br>FUNYULA | 117/4<br>NAMALO |
| 130/2<br>BUDALANGI | 131/1<br>GANJALA | 131/2<br>NAMASALI |

**The compass direction;**



- **Magnetic variation** is the angular difference between magnetic north and true north e.g. –kcse 2019

  Busia map - 2º 21'
  Taita hills map - 0º 30'

- **Magnetic declination** is the rate at which the angle between the true north and magnetic north changes with time as indicated on the map centre.

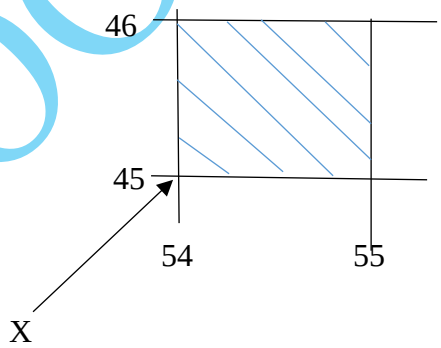
  **QUIZ: Magnetic declination of Taita Hills map is 0º 30' as at 1991. What is the magnetic declination as at 1995?**

  **Solution**

  Year difference = 1995 – 1991 = 4 years
  1 year = 5'
  4 years = 4 x 5' = 20'
  Magnetic declination as at 1995 = 0º 30' + 20' = 0º 50'

- **Grid variation** is the angle between grid north and true north.

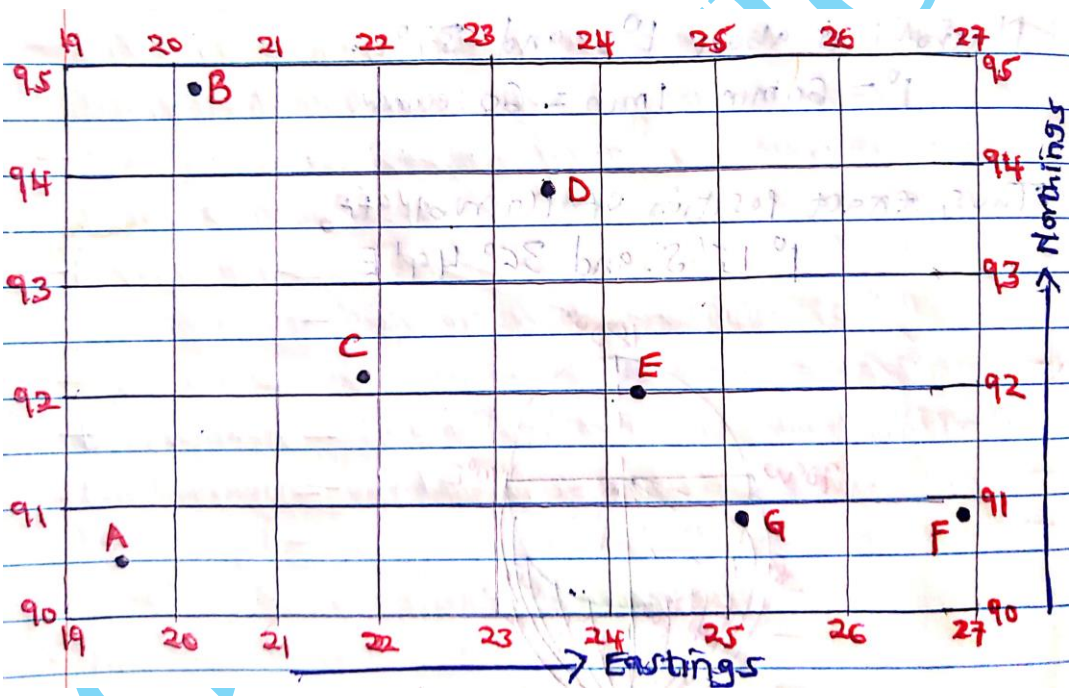
- **Grid reference system;** -kcse 2023
  - Grid lines are vertical and horizontal parallel lines whose intersections form **Grid Squares** on a topographical map/ It is the intersection of Easting and Northing forming equal Square called **Grid square.**
  - Eastings are vertical lines whose values increase to the East.
  - Northings are horizontal lines whose values increase to the North**.**
  - Grid square reading begins from the **South West corner.**
  - Location of a place/ a feature using Grid reference can be expressed as:
    - ✓ **Four figure grid reference.**
      - Give the easting reading first i.e. 54
      - Give the northing reading last i.e. 45
      - The four grid reference of point X is **5445**



✓ **Six grid reference.**

- Give the first two Easting readings then estimate the third digit i.e. **547**
- Give the first two Northing readings then estimate the third digit i.e. **453**
- The six-figure Grid Reference of point P is **547453.**
- Use **a ruler/a set square or graph paper** to subdivide the Grid Square into **10 equal** parts for both Easting and Northing. This is to provide accurate reading for the **third** values for easting and northing.

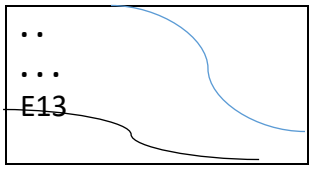
**Examples.**




Solution.

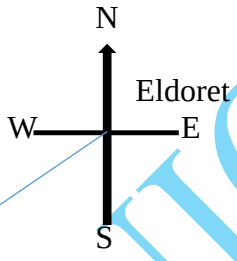
| Points | Four G.R | Six G.R |
|---|---|---|
| A | 1990 | 195905 |
| B | 2094 | 202948 |
| C | 2192 | 218922 |
| D | 2393 | 236938 |
| E | 2492 | 244920 |
| F | 2690 | 268908 |
| G | 2590 | 252908 |

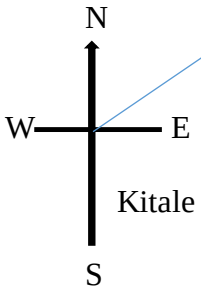
- **Naming features found on the grid reference** –kcse 2023




✓ River
✓ Road E13
✓ Huts/ houses/ settlement

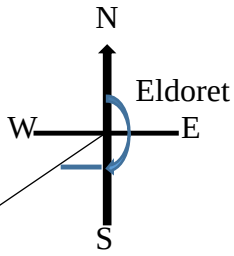
- **Direction and Bearing**

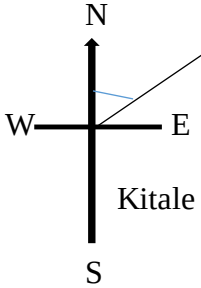



- Direction of Kitale from Eldoret is **South West.**
- Direction of Eldoret from Kitale is **North East.**

- **Bearing** is the direction of a place given in form of an angle/ degrees e.g.



- Bearing of Kitale from Eldoret is 090º + 090º + 045º = **225º**
- Bearing of Eldoret from Kitale is **045º**

- **Calculation of Distance** –kcse 2021
  - What is the length of the section of the railway line west of easting 00 to Kisumu station? (Give your answer in kilometres)

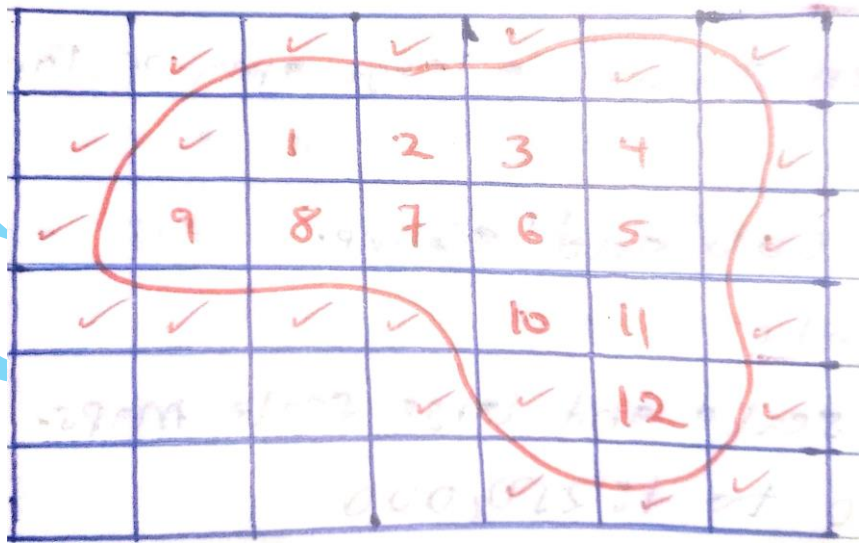
    6.6±0.1km

  - Measure the length of the all – weather road (bound surface) B2 /1 from the junction at grid reference 947911 to the edge of the Map, grid reference 947967.(Give your answer in kilometers) (2 marks)

    *7.2km± 0.1 (7.1 – 7.3 )km*

- **Administrative boundaries** –kcse 2019
  - It shows the administrative units/ authorities found in the area covered by the map.
  - It is shown using different boundary symbols e.g. Country (s), province (s), County (s), District (s)
  - The learner is advised to check on the **key** to familiarize with the various boundary symbols used in the area covered by the map.

- **Calculation of area**




Complete squares = 12

Incomplete squares = 22

Area = complete squares + $\frac{\text{incomplete squares}}{2}$

= 12 + 22/2 = 12 + 11 = 23.0 $km^2$

- **Longitudinal and latitudinal extent**

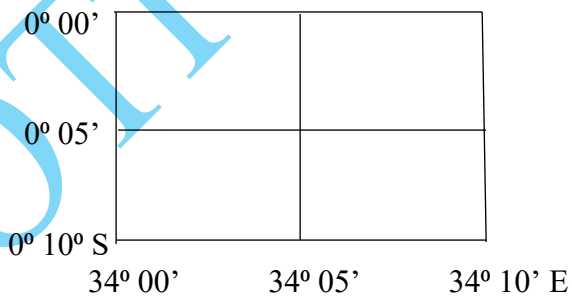
a. **Latitudinal extent.**

- On topographical map, Latitudes are found on the **vertical sides** of the map Sheet e.g. N or S.
- Latitudes are marked in degrees and minutes and their values increase**s** **southward or northwards** depending on the hemisphere.
- Latitudinal extent of the map begins from the **lowest value** to the **highest value** on the vertical sides of the map.
- Direction South or North must be quoted to score.

b. **Longitudinal extent.**

- On topographical map, longitudes are found on the **horizontal sides** of the map sheet.
- Longitudes are marked in degrees and minutes and their values increases **Eastward.**
- Longitudinal extent of the map begins from the **left end** to the extreme **right end** on the horizontal sides of the map.
- **Direction (E)** must be quoted for it to score.

**Example.**




For the above diagram;

- **Longitudinal extent** is 34º 00’E to 34º 10’E
- **Latitudinal extent** is 0º 00’S to 0º 10’S
- **Longitude and latitude of south west corner of the map** is 34º 00’E, 0º 10’S

## PART THREE: MAP INTERPRETATION

### Interpretation of physical features.

- Physical features on a map include Relief/ natural landforms, natural vegetation and drainage.

#### 1. Landforms/ Relief features.

- Relief refers to the nature/ appearance of the landscape/ surface of the earth: whether dissected, rolling, hilly or mountainous.
- Landforms can be depicted by the use of contours, conventional signs and names of depicted features.
- **The most commonly used methods of representing relief on topographical maps are;**
  I. Use of contours.
  II. Spot heights.
  III. Trigonometrical stations.
  IV. Cliff and Rock Drawing.
-

**a) Dissected landform**

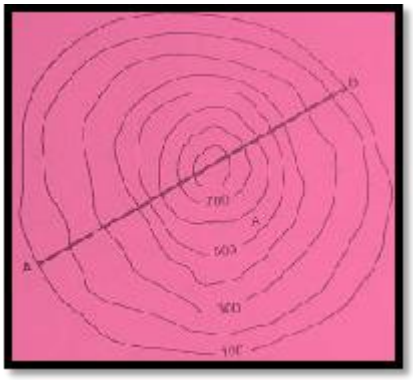
- It is a landscape that has been deeply cut by eroding rivers/streams into the earth's surface.
- On topographical maps, such a landscape is shown by curved or irregular contours. The more crooked the contours, the more rugged the earth's surface.

**b) Rolling landform/ undulating relief.**

- It has gentle slope represented by spaced contours.
- It is characterized by absence of high peaks and rivers flowing in pronounced valleys.

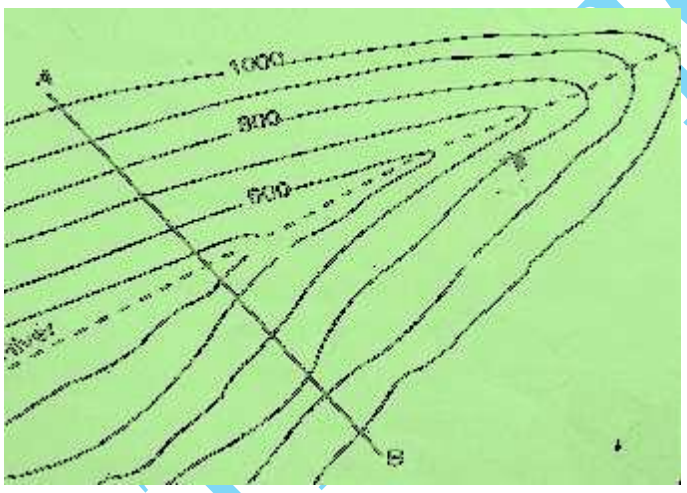
**c) Hilly or Mountainous Landform.**

- It is a rugged landscape. The gradient is steep and valleys are narrow.
- On topographical maps, they are represented by circular or near circular/ concentric contours whose values increase towards the top of the hill.



### d) Valley.

- This is a low area usually cut out by a river/ stream between areas of higher ground.
- It is represented on topographical map with contours that are U/ V shaped with their apex pointing towards the higher grounds.

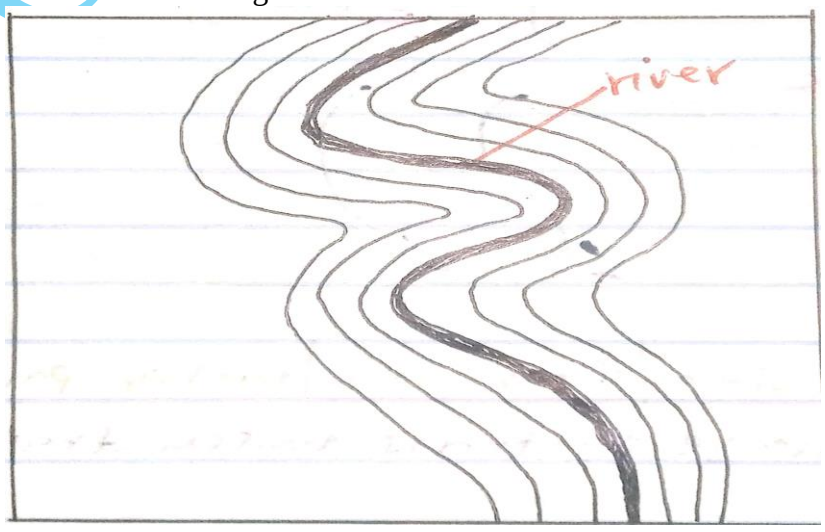


### e) Spurs.

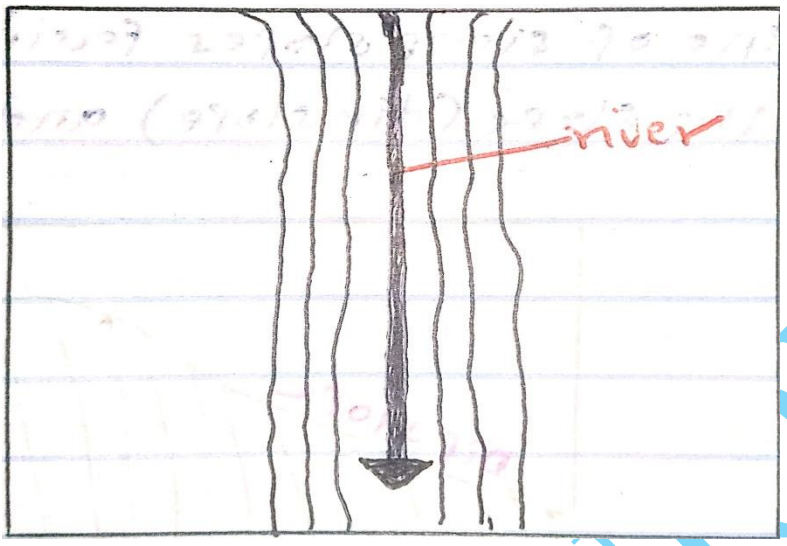
- This is a piece of raised land jutting into a valley or a projection of land from a mountain or ridge.

Types

i) **Interlocking spurs-** Refers to land projecting into a river valley where the river tends to follow a winding course around the obstacles.

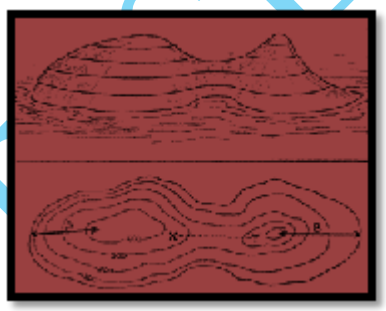


ii) **Truncated spurs-** Occur in glaciated highlands where tips of interlocking spurs are trimmed off by moving glaciers along V-shaped valley.



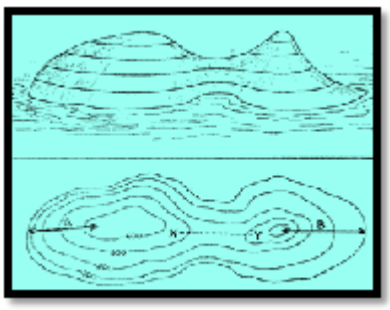

### f) Pass.

- A pass is a narrow deep gap that lies between high hills/mountain areas.
- They are shown on a map by the absence of contours between high areas but with a transport route passing through them.



### g) Saddle/col.

- A col (saddle) is a small depression on a hilly area that is located between hills on a ridge.
- It is represented on topographical map by a gap between two hills without contours shown on them.

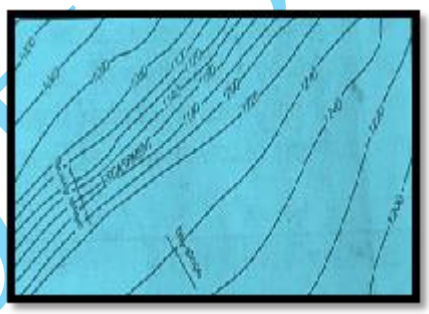


### h) Ridge.

- A ridge is a roughly narrow and elongated hill with steep slopes on all the sides.
- The top of the ridge may either be level or rugged with several hills forming in a range.
- Ridges are shown on topographical maps by closely packed contours descending on both sides.

### i) Escarpment.

- This is a relatively continuous line of steep slopes dipping to/ facing the same direction.
- It exhibits a gentle slope on one side and a short steep slope on the other/opposite side.
- On topographical map, an escarpment is shown by closely spaced contours on the steep (scarp) slope but the contours become more widely spaced further down the slope on the gentle slope.

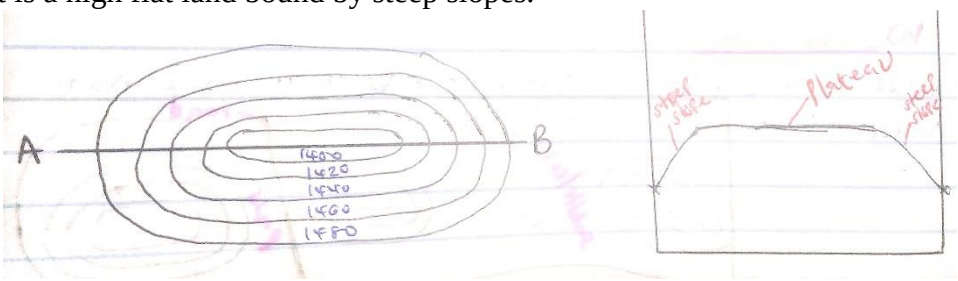


### j) Watershed/ divide/ interfluve/ water-parting.

- This is a high point which separate head-waters of two or more drainage basins. It can be on a ridge, plateau, hill or escarpment.
- It is shown on a map by sources of rivers flowing from a high area downhill to different directions as shown below.

### k) Plateau.

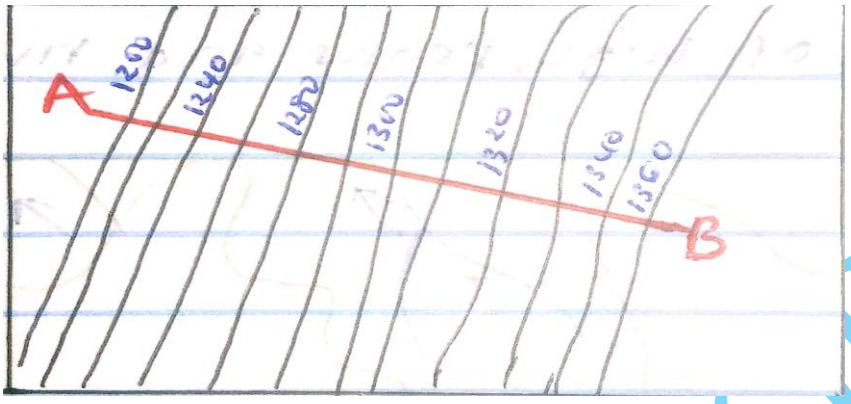
- It is a high flat land bound by steep slopes.



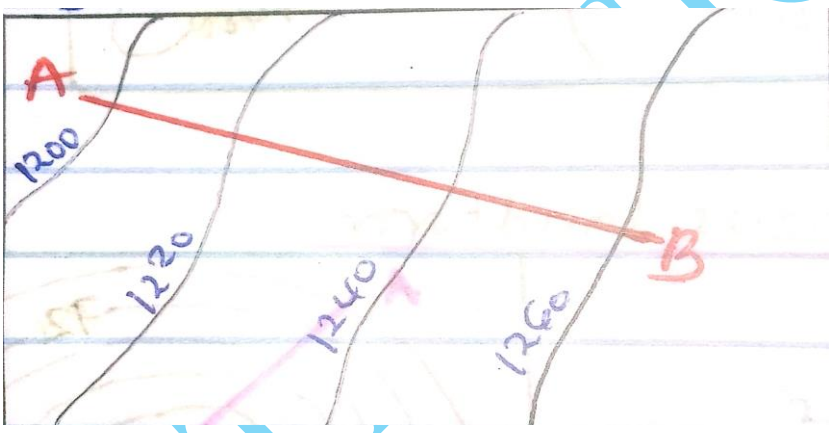
## l) Slopes.

- This is an inclination/slant/gradient of the land.

### i) Steep slope.

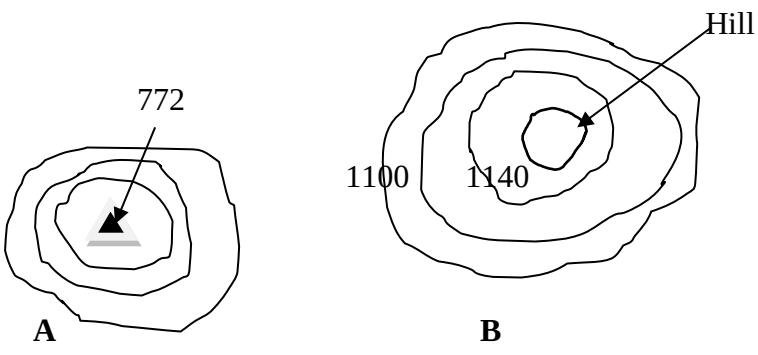



### ii) Gentle slope.




## Height of features.

- The height of features such as a hill is approximated by the value of the nearby **trigonometric station** or the value of a **spot height** at that point. Such values are **exact height** and are picked directly.
- Incase approximation is done from **contours**, the value of the highest contour is picked, then any value ranging from 1-19 is added for it to score.



- **Height of hill A** is **7**72m (exact height).
- **The highest point of hill** marked B is **Between 1161m-1179m.**

**Description of relief on Topographical map** –kcse 2018/ 2023

i. Name the relief features found in the area covered by the map e.g.
   - The area covered by the map has relief features like hills, valleys, ridge and escarpment.

ii. Give the location of each relief features e.g.
   - The area has several river valleys.
   - There are many hills in the area covered by the map e.g. Mgange hills/ Mragua hills.
   - There are depressions occupied by the lakes Sare/ Victoria.
   - There are many ridges in the northern part.
   - There is rugged landscape in the western part.

iii. Identify the main relief feature and give its location e.g.
   - There are many hills in the area covered by the map.

iv. Identify types of slopes in the area covered by the map giving their location e.g.
   - The eastern part of the area is generally gently sloping.
   - The north western part of the map has steep slopes.

v. Give the general slope of the land e.g.
   - The land slopes from West to East.
   - The land rises from East to West.

vi. State the highest and lowest parts of the area covered by the map e.g.
   - The highest point is 2208 metres.
   - The lowest point is 620 metres.

**Must have accurate values to score.**

## 2. Vegetation.

- Appropriate symbols may be used in the Key of the map to show different types of vegetation.
- **Types of natural vegetation found in the area covered by the map** –kcse 2023
   - Woodland, scrub, scattered trees, riverine trees, papyrus swamp vegetation, thicket
- **Description of vegetation on topographical map** –kcse 2021
   - Most of the forest vegetation is found in the western part.
   - There are patches of forest in the eastern part of the area covered by the map.
   - Patches of woodland vegetation are found in the central and western part of the area covered by the map.
   - Scrub vegetation is mainly found in the northern part of the area covered by the map.
   - There are few scattered trees in the Northern part of the area covered by the map.
   - There are riverine trees along river sagana.

- There is papyrus swamp vegetation in the southern part of the area covered by the map.

### 3. Drainage.

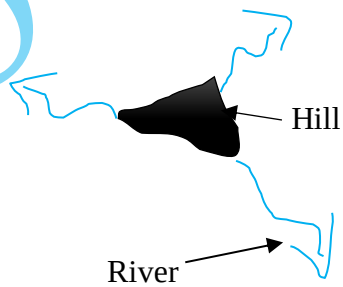
- These are physical/natural water features that are found on the earth's surface/ area covered by the map.
- Drainage features on topographical maps are mainly shown by blue colour.
- **Types of rivers;**
  - **Perennial/ permanent rivers-** Are shown on a map with continuous blue lines.
  - **Intermittent/ seasonal/ indefinite rivers-** Are shown on a map with broken blue lines.
  - **Disappearing/ vanishing rivers-** Are shown on a map with blue lines which end abruptly.
- **Drainage patterns** –kcse 2020

#### A. *Dendritic drainage pattern*

- The tributaries converge on the main river at an acute angle forming a shape like that of a tree and its branches called **dendritic drainage pattern.**

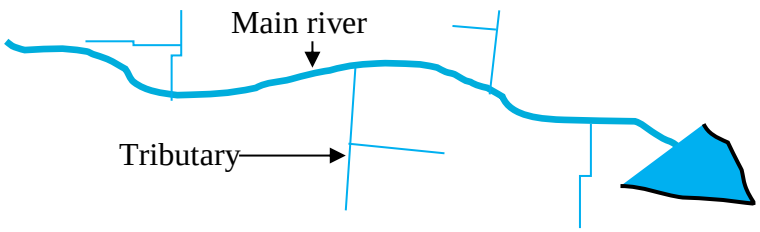

#### B. *Radial drainage pattern.*

- Rivers flow outward from a central point like a mountain downstream.
- This resembles the spokes of a bicycle wheel forming **Radial drainage pattern.**



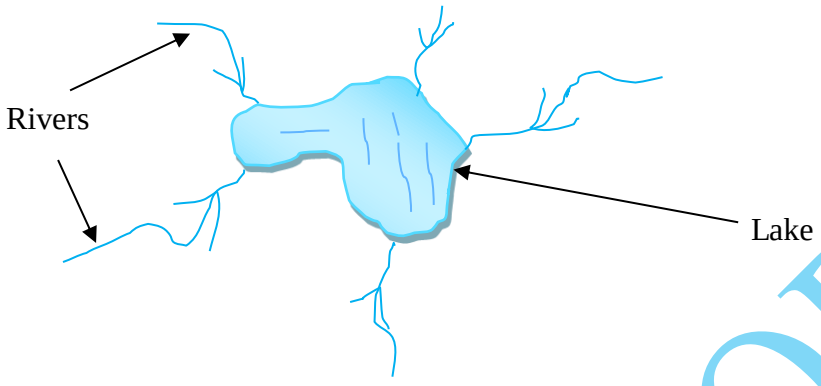

#### C. *Trellis/Rectilinear drainage pattern.*

- The main river and its tributaries form a rectilinear pattern called **Trellis drainage pattern.**



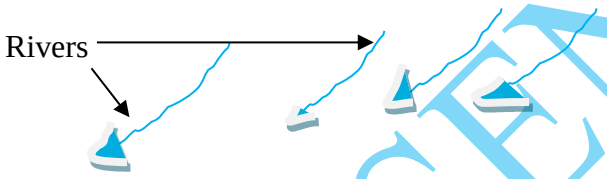
### D. *Centripetal* drainage pattern

- Many rivers flowing from different directions discharge their water into an inland basin like a lake/ swamp/ sea forming **centripetal drainage pattern.**



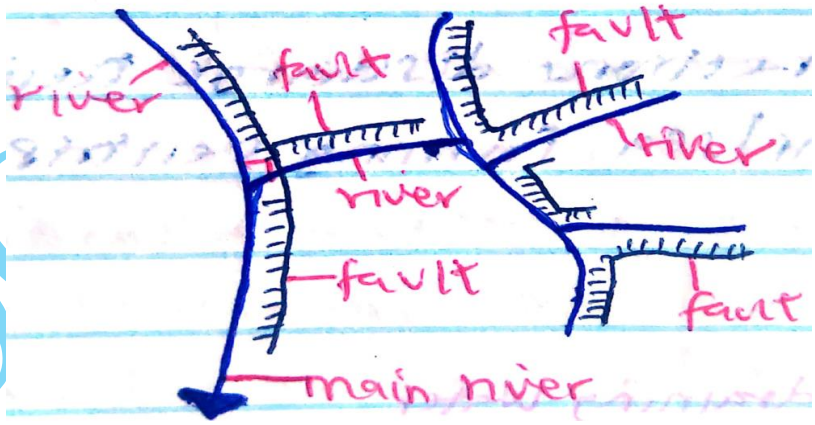

### E. *Parallel drainage pattern.*

- Rivers flow along the parallel joints/ faults.
- Rivers run parallel to each other forming **parallel drainage pattern.**




### F. *Fault guided* drainage pattern.

- The fault guides the direction of flow of the river and tributaries.
- Tributaries joins the main river at right angles forming **fault-guided drainage pattern.**




**Description of Drainage on topographical map** –kcse 2019/ 2017

a) Name the drainage features found in the area covered by the map e.g.
   - The area covered by the map has drainage features like rivers/ lakes/ swamps/ reservoirs

b) Identify the main drainage feature i.e.
   - The main drainage features are rivers.

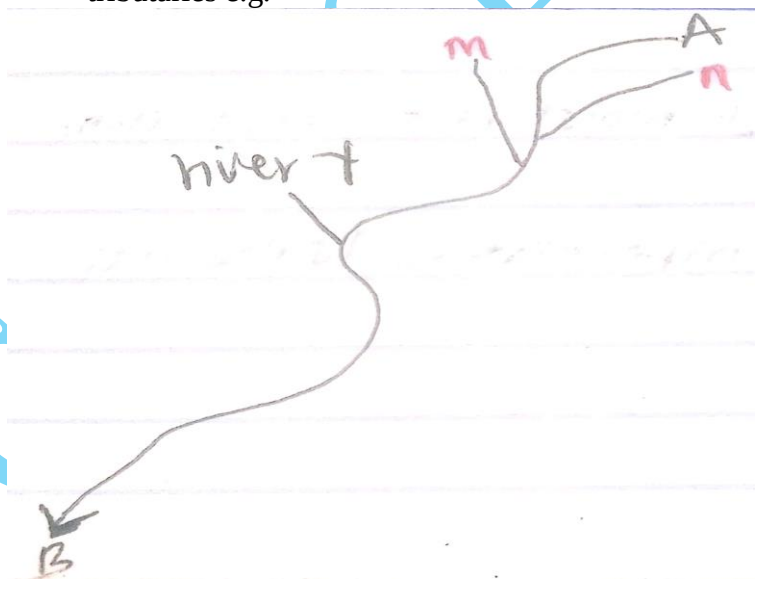
c) Put more emphasis on rivers by stating nature of the rivers/ its tributaries/ drainage patterns/ source/ mouth/ riverine trees i.e.

- The area has many, permanent, rivers.
- The main river is River Yala.
- There are many seasonal rivers/ indefinite rivers.
- Some rivers have tributaries.
- Some rivers form dendritic drainage pattern along River Yala.
- Most rivers originate from north western part of the area covered by the map/ forest/ highlands.
- Most of the rivers are draining into Lake Victoria.
- There are disappearing/ vanishing rivers.

d) Name drainage features and their location i.e.
- There is a pond (grid 3891)
- There is a waterhole (grid 2882)
- There are man-made reservoirs/ dams along river Yala.
- There are papyrus swamps/ seasonal swamps at the central part of the area covered by the map.
- There are lakes- Lake Sare/ Lake Victoria in the southern part of the area covered by the map.

**Characteristics of a long profile of a river** –kcse 2009

- Consider the following- source/mouth/ meanders/ interlocking spurs/ swamps/ riverine trees/ drainage pattern/ nature of the river/ tributaries e.g.




- ✓ The river is permanent/ premier.
- ✓ River Y has two main tributaries, m and n.
- ✓ River m flows from north western part.
- ✓ River n flows from north eastern part.
- ✓ River Y originate from point A.
- ✓ River Y drain into B.
- ✓ River Y has meanders.
- ✓ Some parts of the long profile have a steep gradient.
- ✓ There are raids/ waterfalls along River Y.
- ✓ Rivers m and n form dendritic drainage pattern with River Y.

## Description of climate on topographical map.

- **Evidences likely to suggest that the area covered by the map receive low rainfall are;**-kcse 2019
    - ✓ Presence of scattered trees.
    - ✓ Presence of scrub vegetation.
    - ✓ Presence of seasonal rivers.
    - ✓ Presence of seasonal swamps.
    - ✓ Presence of reservoirs.
    - ✓ Presence of dams/ waterholes.
    - ✓ Presence of sisal plantations.
    - ✓ Presence of irrigation farming.

- **Evidences like to suggest that the area covered by the map receive high rainfall are;**
    - ✓ Presence of many permanent rivers.
    - ✓ Presence of forest e.g. Mt. Kenya forest to the North.
    - ✓ Presence of bamboo forest.
    - ✓ Growing of crops like tea/ coffee evidenced by tea/ coffee factories or plantations.
    - ✓ Dairy farming

## 4. Description of Settlement on topographical map –kcse 2019/ 2022

- Settlement refers to dwellings/ housing units/ huts in an area.
- THERE IS NO POPULATION IN SETTLEMENT (Quote by Sir Bernard Olang).
- **Nature of settlement-** many, few, linear or no.
    - ✓ There are **no** settlements on Nyando escarpment in the North East.
    - ✓ There are **many** settlements in Kisumu town.
    - ✓ There are **few** settlements in swamps.
    - ✓ There is **linear** settlement along the roads.

- **Pattern of settlement-** clustered, dispersed, linear
    - ✓ There are clustered settlements within the plantation.
    - ✓ There is dispersed settlement in the North East.
    - ✓ There is linear settlement along river Nzoia.

**Factors influencing the distribution of settlements in the area covered by the map** –kcse 2019

**a. Transport**
- ✓ Along the roads/ motorable tracks/ footpaths, there is linear settlement.
- ✓ At road junctions there are clustered/ nucleated settlements.

**b. Vegetation**
- ✓ There are no settlements within the woodlands/ papyrus swamp.
- ✓ Most of the areas covered by scrub/ scattered trees have clustered/ nucleated settlement.

**c. Relief**
- ✓ There are no settlements on hills.
- ✓ There are few settlements on steep sloping areas.
- ✓ There are many settlements on gently sloping areas.

- ✓ There are clustered/ nucleated settlements on the undulating land.

**d. Drainage**

- ✓ Areas that are well drained have many/ nucleated settlements.
- ✓ Areas that are poorly drained/ swampy have few/ no settlements.
- ✓ There are no settlements near most rivers.

## Economic activities carried out in the area covered by the map –kcse 2022

| ECONOMIC ACTIVITY | EVIDENCE |
|---|---|
| Transportation | Roads/ motorable track/ railway |
| Trade | Markets/ Trading centres/ shops |
| Quarrying | Quarries/ murram pit |
| Crop farming | cotton ginnery/ agricultural research stations/ sisal factory/ plantation |
| Mining | gold mine |
| Fishing | fisheries department/ fishing landing grounds |
| Lumbering | saw mills |
| Tourism | Aberdare national park/ lodge/ hotel |
| manufacturing/ processing | kagwe carbacid plant/ coffee factories |
| Milling | Flour mill |
| Communication | post office/ telephone lines |
| Forestry | forest/ forest station/ forest guard/ post |

## Economic function of a town.

- ✓ **Transportation centre** evidenced by roads.
- ✓ **Trading centre** evidenced by markets/ shops.
- ✓ **Communication centre** evidenced by post office.
- ✓ **Tourism centre** evidenced by game parks/ hotels/ camp sites.
- ✓ **Agricultural collector centre** evidenced by grain stores.
- ✓ **Industrial centre** evidenced by coffee factory/ ginnery.

## Social services offered in the area covered by the map –kcse 2018/ 2012/ 2016

| Social service | Evidence |
|---|---|
| Health services | dispensary/ health centre |
| Religious services | church/ mosque |
| Educational services | schools/ polytechnics |
| Administration services | chief's office/ DC |
| Rehabilitation services | rehabilitation centre/ prison |
| Security services | police post |
| Burial services | cemetery |
| Recreational services | sports club/ golf course |
| Water supply services | pump house/ water tank/ water tower |

## Social functions of a town.

- ✓ Educational centre evidenced by presence of schools.
- ✓ Health centre evidenced by hospitals.
- ✓ Religious centre evidenced by church/ mosque.
- ✓ Administration centre evidenced by chief's camp.
- ✓ Security centre evidenced by police post.

## TASK.

1. **Citing evidence from the map, explain three factors favouring livestock production** –kcse 2011
   - ✓ Presence of scrub vegetation/ scattered trees in the south suggest that there is natural pasture for livestock.
   - ✓ The presence of many rivers/ sources of water suggest that there is adequate water for livestock.
   - ✓ Availability of transport networks as shown by the roads/ motorable tracks for movement of livestock/ livestock products.
   - ✓ The many cattle dips for treatment of cattle show that there is access of veterinary services.
   - ✓ The area has high altitude above 1000m which provides cool conditions suitable for cattle rearing.
   - ✓ Dense settlement to provide market for livestock/ livestock products.
   - ✓ There are large trucks of land with few settlements in south east ensuring extensive area for grazing.
   - ✓ Availability of extension services to the farmers as shown by farmers training centre.
2. **Why construction of roads in the northern part of the map is difficult** –kcse 2011
   - ✓ The rugged relief/ steep slope/ many hills may necessitate road cutting/ many road bends.
   - ✓ Many rivers/ river valleys may lead to construction of many bridges/ culverts.
   - ✓ The high density of settlement may lead to high cost of compensation.
   - ✓ The presence of Rurie swamp/ swamps may lead to detouring of roads/ tracks.

3. **Citing evidence from the map, explain two factors favouring trading in the area covered by the map** –kcse 2023
   - ✓ The dense settlements show that there is high demand for goods/ market.
   - ✓ Presence of dense road network that provides means of transport for goods.
   - ✓ Presence of many markets/ trading centres/ shops provide opportunities for trade.
   - ✓ The area is economically productive as evidenced by tea/ coffee factory/ fisheries department/ cattle dip/ murram pit.

4. **Citing evidence from the map, explain four factors that may have influenced agricultural activities in the area** –kcse 2018
   - ✓ Presence of road transport to provide transport facilities.
   - ✓ The south eastern part receives low rainfall as evidenced by scrub vegetation suitable for sisal growth.
   - ✓ There is availability of labour due to dense settlement on the western part around Mgange/ Mragua.
   - ✓ The eastern part is sparsely settled/ widely spaced contours hence mechanization.

- ✓ The western part receives high rainfall as evidenced by forests/ permanent rivers which has influenced farming.
- ✓ Availability of veterinary services evidenced by cattle dip.
- ✓ Availability of advisory services to farmers evidenced by

## PART FOUR: MAPWORK DRAWINS & ASSOCIATED CALCULATIONS.

- These are sketches of sections, enlargement or reduction on a given part of a map.

### Enlargement and Reduction of Maps/Sections of Maps.

**1. Enlargement of map/ section of map.**

— This is increasing or magnifying of the size of a map of a given area.

— **Steps;**

- Identify the area to be enlarged first.
- Measure the length and width of the area to be enlarged i.e. 4cm by 3cm.
- Determine how many times the map is to be enlarged i.e. twice (2) or thrice (3).
- Get new measurements i.e.

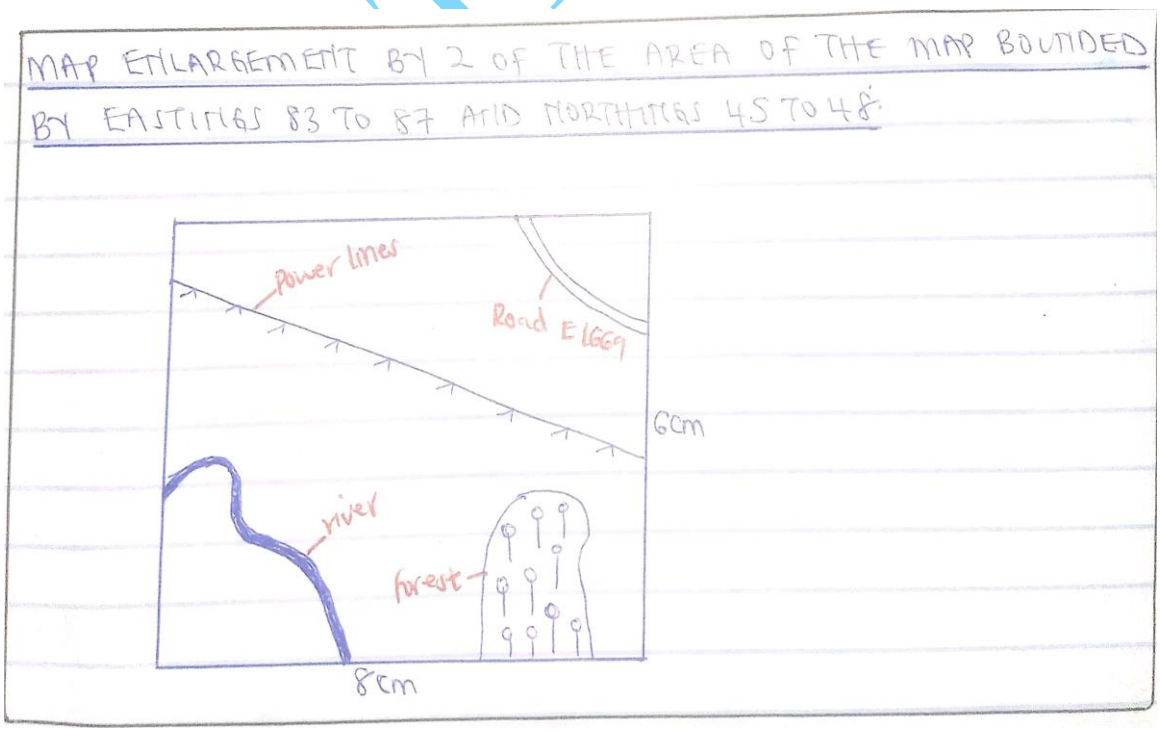
  Enlargement by 2: length= 4cm x 2 = 8cm

  : width= 3cm x 2 = 6cm
- Draw a rectangle with the new measurements on the graph paper.
- On it mark and label the required features with their exact location. DON'T DRAW A KEY.

**New scale.**

R.F/ ratio scale = 1:50,000

Enlargement by 2 = $\frac{1}{50,000}$ x 2 = $\frac{1}{25,000}$ or 1:25,000



## 2. Reduction of map/ section of map.

— This is reducing / decreasing of the size of a map of a given area.

— **Steps;**

- Identify the area to be reduced first.
- Measure the length and width of the area to be reduced i.e. 10cm by 18cm.
- Determine how many times the map is to be enlarged i.e. half (1/2) or third (1/3).
- Get new measurements i.e.

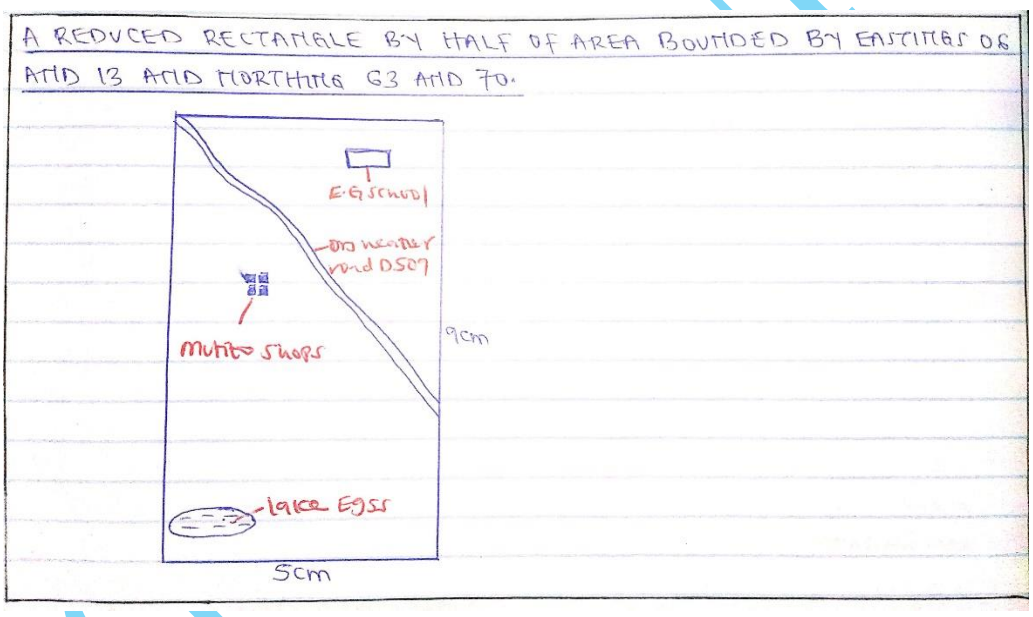
Reduced by half: length= 10cm x 1/2 = 5cm
: width= 18cm x 1/2 = 9cm

- Draw a rectangle with the new measurements on the graph paper.
- On it mark and label the required features with their exact location. DON'T DRAW A KEY.

**New scale.**

R.F/ ratio scale = 1:50,000

Reduced by 1/2 = $\frac{1}{50,000}$ x 1/2 = $\frac{1}{100,000}$ or 1:100,000




**NOTE:** Refer to kcse 2009/ 2013/ 2015/ 2021/ 2022 on how to draw a square/ rectangle representing a section of an area covered by the map.

## Drawing sections and profiles.

- **A section** is a vertical cut through soil, rock or landscape or the representation of the actual appearance of the landscape in a diagrammatic form.
- **Profiles** are longitudinal sections e.g. a river profile.

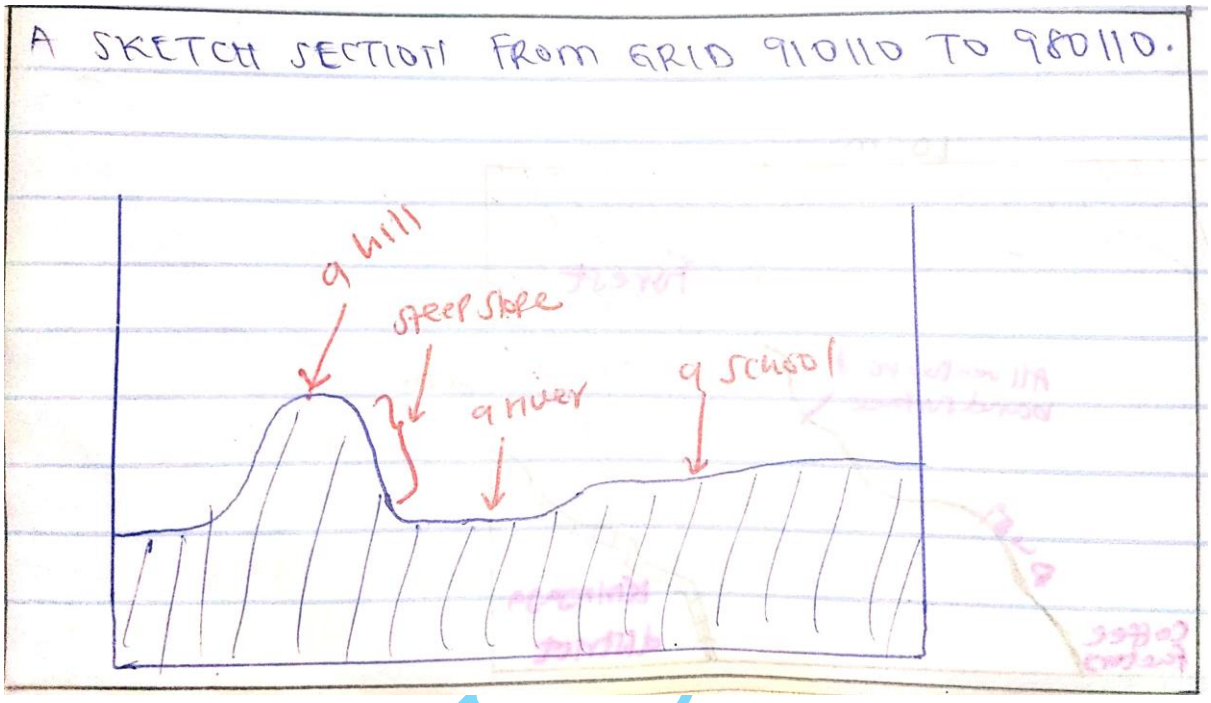
## Importance of sections in interpretation of maps.

- They enable one to determine the type of slope, whether even, concave or convex.
- They provide a comprehensive appearance of the landscape which can be of great assistance in construction.
- They enable us to determine intervisibility.
- They give a general impression of the physical appearance of the landscape.

## Types of sections.

### 1. Sketch Sections.

- These are sections which are not drawn to scale.
- They also represent the appearance of the landscape of a given area between two points.
- Sketch sections are drawn by simply estimating the general trend of the landscape.




### 2. Cross Sections –kcse 2020/ 2023

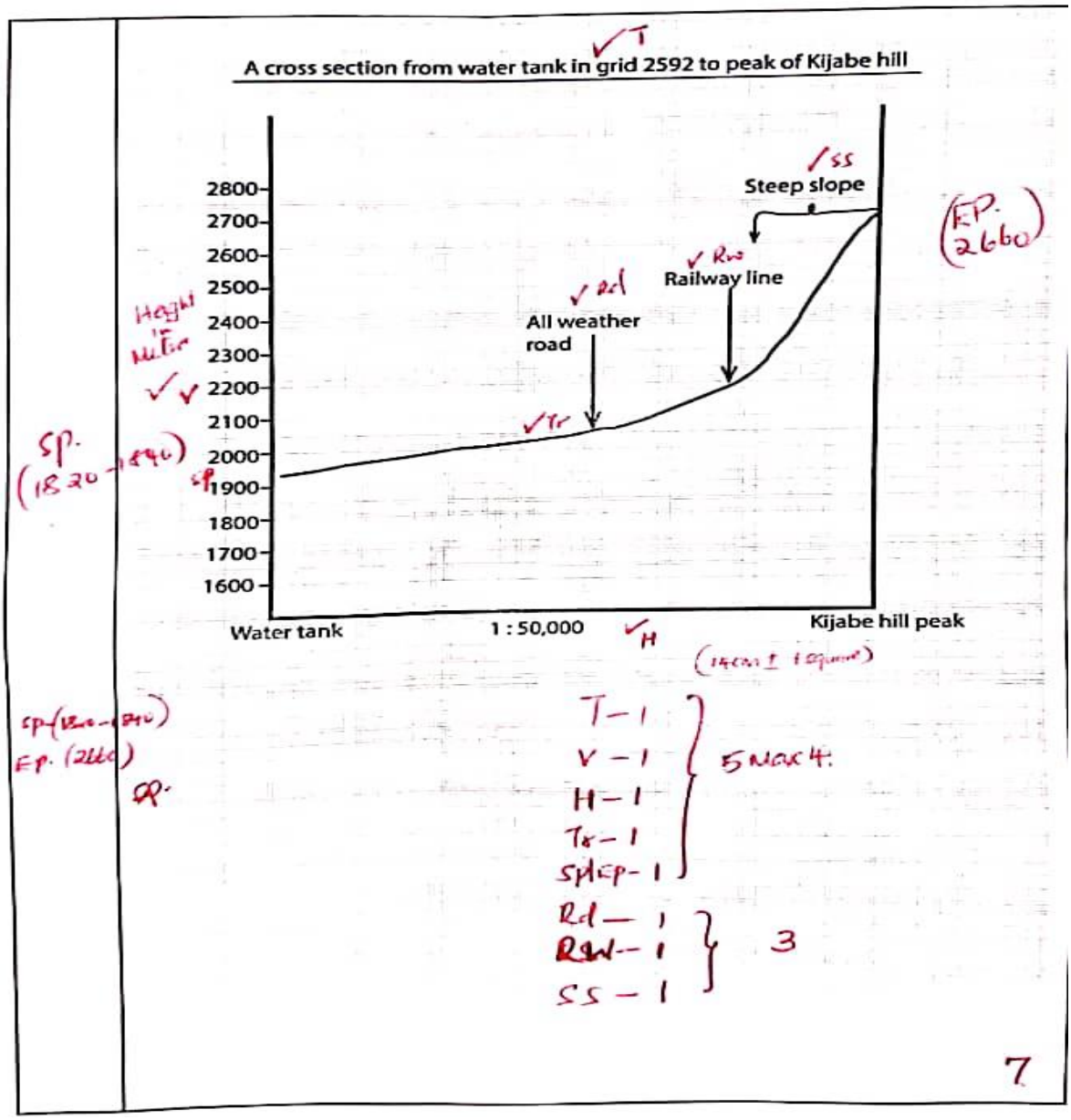
- **A cross section** is a diagrammatic representation of the variation between identified points along a straight line.

### Steps followed when drawing cross- Sections.

a.) Identify the two end points to be covered by the cross- section.
b.) Draw a light pencil line to join the two points.
c.) Then fold paper on the map by placing its straight edge along the line.
d.) Apply the strip of paper on the map by placing its straight edge along the line.
e.) While holding the paper very firmly, on it mark the two end points, then identify the heights of these two points and mark them on the paper.
f.) Mark on the paper the contours crossed by the line. Where there is a river mark with a depression sign, for example 'U' and where there is a hill mark with a special sign for example "n". This downwards and upward symbol will help you draw curves appropriately.
g.) Name any conspicuous features where they appear on the paper.
h.) Note the highest and lowest points crossed because these will determine your scale. Then calculate the amplitude of relief (The difference between the highest and lowest contour). This is important in determining the vertical scale.
i.) Then determine your vertical scale. When determining the vertical scale a suitable range is necessary.
j.) Draw equal lines on a fresh paper, preferably a graph paper and mark it A and B at both ends. Then draw the vertical lines at both ends. On them mark the heights

accordingly. Then remove the strip of paper from the map and place it on the line A and B on your graph paper. Hold the paper firmly and then transfer the information from it to the graph. Plot the heights on the graph. Finally draw a smooth curve to connect the points in form of a line graph.

k.) Annotate or Label the cross- section. When naming, use arrows. Do not draw anything on the section, whether it is a river show by arrows only. Note that the arrows must come from the top and not the bottom because the elevation is viewed from the ground and not underground.



## Vertical Exaggeration (VE).

- Vertical exaggeration is the ratio of the vertical scale to the horizontal scale.
- It is normally calculated after drawing the cross-section.
- The vertical scale is always larger than the horizontal scale and therefore it is always exaggerated.
  Given the vertical scale as 1cm represent 100m;

$$V.E = \frac{\text{vertical scale}}{\text{Horizontal scale}}$$

$$= \frac{\text{1cm represent 100m}}{\text{1:50,000}}$$

$$= \frac{\text{1cm represent 100m}}{\text{1cm represent 500m}}$$

$$= 1/100 \times 500/1 = 5 \text{ times}$$

**Interpretation:** This means that the vertical scale has been made unreal/exaggerated 5 times in relation to the horizontal scale to allow the features to be seen clearly.

## Gradient.

- This is the steepness of a slope between two given points expressed as a fraction or degrees.

$$\text{Gradient} = \frac{\text{Vertical rise}}{\text{Horizontal equivalent}}$$

Where **Vertical rise** is the difference between the highest and lowest contours between two points on a map.

**Horizontal Equivalent** is the distance between two points on the map.

$$= \frac{20m}{3.6km}$$

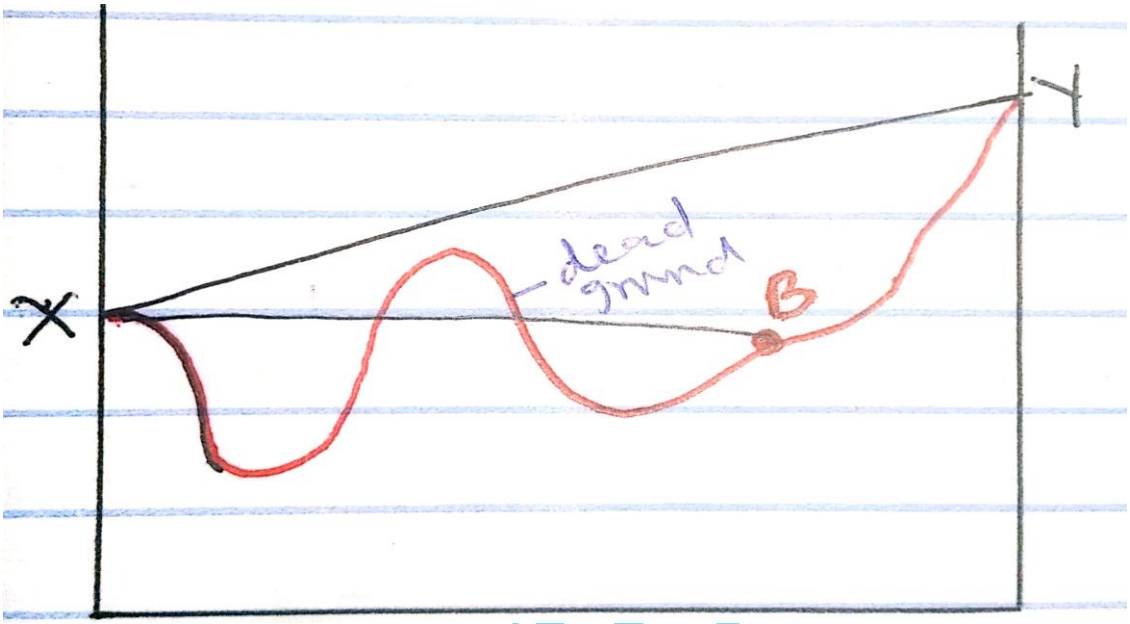
$$= \frac{20m}{3600m}$$

$$= \frac{1}{180} \text{ or } 1:180$$

**Interpretation:** This means that for every 180m travelled from point X to Y, the ground height rises by 1m.

## Intervisibility.

- It is the ability to see or view two points from either sides.
- The part which is not seen is **a dead ground.**




Points X to Y are intervisible.

Points X to B are not intervisible.



**"END OF TOPIC TWO"**

## TOPIC THREE: EXTERNAL LANDFORMING PROCESSES.

- They are also called **Exogenic** or **Exogenetic** processes.
- These are processes which originate from the earth's surface and are responsible for the sculpturing and shaping of the landscape.
- **Denudation** refers to all the processes of destruction, wastage and removal of parts of the earth's surface. They include weathering, mass wasting, erosion and transportation.
- **Erosion** is the wearing away of the land surface by various agents like running water, glacier, action of wind and transportation of all the rock materials that result.
- **External land forming processes include:**
    - Weathering
    - Mass wasting
    - Action of Rivers
    - Action of wind and waves
    - Glaciation

### WEATHERING

**Definition**-kcse 2023

- **Weathering** is the **breaking down/disintegration/ decomposition of rocks** at or near the earth's surface **in situ** (without movement) by physical or chemical processes.

### Agents of Weathering

a) **Heat**: - leads to differences in temperature exerting stress upon the rocks. It also influences chemical reactions within the rocks.
b) **Water**: - dissolves carbon (iv) oxide from the atmosphere to form a carbonic acid that dissolves rock minerals.
c) **Plants and animals**: - burrowing animals, plants' roots penetrate through cracks and joints.
d) **Wind**- loads carried by wind may hit against rock outcrop by abrasion leading to weathering.
e) **Movement of ice**- ice erosion by abrasion/plucking may lead to weathering.
f) **Man**- through his activities like mining/quarrying/road construction leads to weathering.

### Factors influencing weathering-kcse 2011

- ✓ Climate(Temperature and Rainfall)
- ✓ Nature of the rock
- ✓ Relief/angle of the slope
- ✓ Living organisms(flora and fauna)
- ✓ Time
- ✓ Human activities.

*(i)* *Climate of the area.*

- Equatorial regions that experience hot and humid climatic conditions are prone to chemical weathering.
- Physical weathering is more prevalent in areas with large diurnal temperature ranges, low rainfall and high evaporation rates.

*(ii)* *Nature of the rock*

- Dark colored rocks break up more rapidly compared to shiny or light-colored rocks because of their higher rates of absorbing heat.
- Fine grained rocks are greatly affected by chemical weathering compared to coarse grained rocks.
- Well jointed rocks easily break upon exposure to agents of weathering.

*(iii)* *Living organisms(plants and animals)*

- Hooved animals e.g. cattle/elephants trample on the surface rocks causing them to break and disintegrate.
- Plants such as mosses and lichens keep rock surfaces moist facilitating chemical decay.
- Activities of burrowing animals such as rodents and termites provide passage through which air and moisture can reach below the surface.
- Plants' roots may cause rocks to crack as they penetrate, breaking the rocks in the process.
- Bacteria may facilitate the decay of other organisms to produce organic acids that react with certain minerals in a rock and causing them to decay.

*(iv)* *Relief/angle of the slope.*

- On steep slopes, weathered materials are quickly removed by wind, water and ice; thereby exposing the rock surface to further or continued weathering.
- Gentle slopes allow accumulation of rock materials in one place covering the rock below and reducing the rate of weathering

*(v)* *Human activities.*

- Human activities such as digging, mining, quarrying, rock blasting and construction lead to break up of rocks thus weathering.

*(vi)* *Time.*

- Rocks that have been exposed to agents of weathering over a long period of time are deeply weathered compared to rocks exposed for a short duration.

**Types of weathering**-kcse 2020

(a) Mechanical or physical weathering
(b) Chemical weathering
(c) Biological weathering

## 1. Mechanical or physical weathering-kcse 2001

- **Mechanical weathering** is the physical breakdown of rocks into smaller particles without any alteration in their chemical composition.

**Causes of mechanical weathering.**

- ✓ Temperature changes
- ✓ Frost action
- ✓ Pressure release
- ✓ Rain water
- ✓ Crystal growth

***Processes of Mechanical/Physical Weathering***-kcse 2015

- ✓ Block disintegration
- ✓ Exfoliation
- ✓ Granular disintegration
- ✓ Frost action
- ✓ Crystal growth
- ✓ Rain water action/slaking
- ✓ Pressure release/unloading

### *(i) Block disintegration*

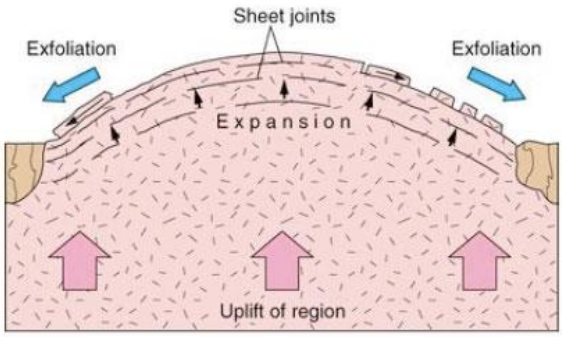
- This results from alternate heating and cooling, causing rock breakage along the lines of weakness into blocks.
- It is common in arid and semi-arid lands with large diurnal temperature ranges
- During the day, the temperatures are high causing the rocks to expand along the bedding planes and joints.
- At night, the temperatures fall leading to contraction of the rocks along the bedding planes and joints.
- This repeated expansion and contraction causes the rock mass to break along the lines of weakness into blocks thus *block disintegration.*

### *(ii) Granular disintegration*

- This results from alternate heating and cooling that make rocks to break into small particles/grains.
- During the day when temperatures are high, different minerals forming the rocks are heated and expand at different rates.
- At night, the minerals lose heat and contract at different rates.
- The repeated differential expansion and cooling causes strain and stress within the rocks causing individual rock grains to break off from the main rock mass as *granular disintegration.*

### *(iii) Exfoliation/Spalling/Onion weathering*-kcse 2012

- This results from unequal expansion and contraction of the surface and inside of the rock causing the rock to peel off in shells.
- In arid/semi-arid areas, there is large diurnal ranges of temperature.
- During the day, a homogenous rock is intensely heated.
- At night, the rock loses heat rapidly.
- The differential heating causes the outer layer to expand/contract faster than the inner layer.
- When this expansion and contraction takes place repeatedly, stress develops in the outer layer of rocks.
- Cracks appear on the surface layer.
- Eventually the outer layer peels off, a process called *Exfoliation.*
- The peeling off leaves behind a rounded mass of rock known as Exfoliation dome.




### *(iv) Frost action/Frost wedging (freeze and thaw action)*-kcse 2012

- Occurs due to repeated freezing of water into ice and thawing to water that penetrates deeper into cracks.
- In temperate/ high mountain areas, water may occupy crevices/ cracks in the rocks during the day.
- At night the temperatures drop below freezing point causing the water to freeze and expand exerting pressure in the cracks.
- During the day, temperatures rise causing the ice to melt thus releasing pressure in the cracks.
- This alternate freeze-thaw action weakens the rock causing it to disintegrate. This process is known as **Frost action/Frost wedging.**

### *(v) Pressure release/unloading/sheeting.*

- Deeply seated igneous and metamorphic rocks are under pressure from the overlying rocks.
- With time, denudation may remove the overlying rock layers and expose the underlying rocks at or near the earth's surface
- The upper parts of the exposed rocks expand slightly due to the reduced pressure.
- This leads to big shells rock breaking away from the parent rock. This process is known as **Pressure release/unloading**.

### *(vi) Crystal growth/Crystallization.*

- Occurs due to growth of salt crystals after evaporation of water that contained dissolved minerals from the cracks.
- During the long dry season, water in the rocks is drawn to the surface through capillary action.
- High temperatures make the water to evaporate depositing tiny salt particles in the rock cracks and pores.
- The salt crystals accumulate and grow inside, exerting pressure and widening the cracks further.
- Eventually the rock pieces fall off leading to weathering. This process is known as **Crystal growth.**

### *(vii) Slaking/Rain water action*

- This is **alternate wetting and drying**-kcse 2015
- During the wet season, surface rocks such as clay/shale absorb water causing them swell.
- During the dry season, these rocks dry out causing the outer surface to shrink.
- Repeated wetting and drying weakens the rocks leading to cracking/ slaking.
- These rocks break away from the main rock. This process is known as **Slaking/Alternate wetting and drying.**

**Quiz: Name three processes of mechanical weathering caused by temperature changes (3marks)**

- ✓ Exfoliation
- ✓ Granular disintegration
- ✓ Block disintegration

Kcse 2023: **Identify three ways in which temperature change influences physical weathering.**

- ✓ It causes block disintegration.
- ✓ It causes exfoliation.
- ✓ It causes granular disintegration.
- ✓ It causes frost action.

## 2. Chemical Weathering.

- **Chemical weathering** is the breakdown of rocks by alteration of the chemical composition of the minerals that make up the rock structure.
- During chemical weathering:
  *i.* New minerals may be formed
  *ii.* Some minerals may undergo chemical change
  *iii.* Some minerals may dissolve in water

### Causes of chemical weathering.

- ✓ Presence of moisture (or water)
- ✓ Presence of gases
- ✓ High temperatures

### Processes of Chemical Weathering- kcse 2006

- ✓ Hydrolysis
- ✓ Solution
- ✓ Carbonation
- ✓ Hydration
- ✓ Oxidation

***(i) Hydrolysis-*** kcse 2015

- This is a process in which hydrogen ions/hydroxyl ions in water react with mineral ions in a rock.
- This reaction leads to formation of new chemical compounds in the rocks.
- With alteration of the original minerals, the rock becomes weak and disintegrates/decays. This process is known as **hydrolysis.**

***(ii) Solution***

- Occurs when soluble minerals within the rock dissolve in water and come out.
- The minerals in rocks change from solid to solution state.
- This weakens the rocks hence disintegrate. This process is known as **solution.**

***(iii) Carbonation-***kcse 2015

- This involves rain water dissolving carbon dioxide in the atmosphere forming a weak carbonic acid.
- The carbonic acid reacts with calcium carbonate in limestone rocks to form calcium bicarbonate solution.
- This leads to the weakening/disintegration of the rock. This process is known as **carbonation.**

*(iv)* ***Hydration***-kcse 2012

- Occurs when some minerals in the rock take up water, causing them to swell and disintegrate.
- Certain minerals in a rock absorb water causing them to expand.
- As they swell, the rock mass expands creating internal stress within the rock that leads to disintegration of the rock. This process is known as **hydration.**

*(v)* ***Oxidation***-kcse 2012

- Occurs when iron in rocks react with oxygen in the presence of moisture leading to rusting away.
    - Oxidation takes place in rocks that contain iron.
    - The iron combines with oxygen forming iron oxides.
    - Such rocks change colour and crumble easily/disintegrate. This process is known as **oxidation.**

## 3. Biological weathering

- **Biological weathering** is the breakdown of rocks due to action of living organisms such as plants and animals.
- These organisms break down the rocks through physical and chemical processes.

*i.* ***Action of Plants***-kcse 2020

- Roots of plants/trees penetrate into the joints/cracks of rocks widening them hence causing the rock to disintegrate.
- Mosses and lichens moisten rock surfaces facilitating chemical weathering.
- Plants decompose/rot forming organic/ humic acids which causes rock decay/ disintegration.
- Widening of cracks and joints by plant roots allows water and air to enter into the rocks hence accelerating weathering.
- Plants absorbs minerals from rocks and this weakens the rocks causing them to disintegrate.

*ii.* ***Action of Animals***

- Burrowing animals such as rabbits, moles, termites and earthworms lead to mechanical weathering by breaking up the rocks through digging.
- Hooved animals like cattle and elephants exert pressure on the rocks as they walk directly on them leading to breaking and disintegration.
- Some animals also excrete chemical substances/acids that when in contact with the rocks may lead to chemical weathering
- Decaying animal remains give off organic fluids that may react with the rocks and lead to chemical weathering.

### *iii. Human Activities*

- Rocks are broken up when they are blasted with explosives in quarries.
- Rocks are also scooped and carried away during open cast mining.
- Air pollution leads to the formation of acid rain which causes chemical weathering when it falls on rocks.
- Bush fires caused by human heat rocks and cause exfoliation.
- Rocks are affected by chemicals released into the environment by industrial activities.
- Movement of heavy machinery like caterpillars/trains breaks up rocks.
- Clearing of vegetation to create room for settlement exposes the rock to agents of weathering.

## Significance of weathering.

### 1. Positive effects.

*i.* It is the initial stage of soil formation supporting crop growing.
*ii.* It produces other natural resources e.g. bauxite – (aluminium ore) and clay used in brick making
*iii.* It weakens the surface rocks making them easier for mining/quarrying.
*iv.* Some weathered rocks e.g. the granitic tors are of tourists' attraction thus sources of foreign revenue.
*v.* It reduces rock size forming rock blocks used for building and construction.

### 2. Positive effects.

i. It destroys existing landforms forming new ones making landscape ugly limiting settlement.
ii. When weathered materials are moved by agents of erosion, they may block transport networks like roads and railway.
iii. Weathered materials may be transported and deposited in dams hence causing siltation.
iv. Weathered rocks may weaken thus becoming susceptible to mass wasting like rock fall which may cause death of people and destruction of properties.

# MASS WASTING

**Definition:-** kcse 2023

- **Mass wasting** is the down slope movement of weathered materials under the influence of gravity.
- **Mass movement** is the movement of weathered materials down the slope after lubrication by rain water or snow melt.

**Ways in which materials move down the slope.**

- ✓ Creeping
- ✓ Flowing
- ✓ Sliding
- ✓ Falling of rocks
- ✓ Slipping

**Factors Influencing Mass Wasting**-kcse 2012/2013

**a) The angle of the slope**-kcse 2012/2018

- Movement of weathered material is faster on steep slopes than on gentle slopes due to the influence of gravity.

**b) Climate of an area**-kcse 2012/2018

- Weathered material in areas receiving heavy rainfall move faster since wet materials have less cohesion.
- Alternate freezing and thawing encourages movement of weathered materials down the slope.

**c) Nature of the rock**-kcse 2022

- Massive rocks overlying weak rocks move/ slide faster along the slope.
- Large rocks are likely to be overcome by gravity more easily than finely weathered materials.
- Steeply dipping rocks will easily experience movement.
- When materials contain a lot of water they are lubricated/ saturated and become susceptible to rapid movement.

**d) Vegetation cover in an area** –kcse 2012

- Surfaces with vegetation experience less mass wasting because it binds weathered material together.
- Bare surfaces are more likely to experience mass wasting because there is no vegetation to bind the materials together.

**e) Earth movements**-kcse 2020

- Volcanic eruptions/earthquakes cause tremors which may trigger displacement of materials/wide spread mass wasting.

**f) Human activities** –kcse 2022

- Ploughing/ clearing of vegetation/ mining/ quarrying affect the stability/ loosen the surface materials causing their movement downslope.
- External forces from moving vehicles/ earth tremors from explosives shake the ground causing some materials to move downslope.

## Types of Mass Wasting

1. Slow mass wasting
2. Rapid mass wasting

### 1. Slow Mass Wasting

- It is the slow movement of weathered materials down a slope under the influence of gravity.
- The movement is gradual and hardly noticeable most of the time.
- It is also called **creep.**

**Types/Processes of slow mass wasting**-kcse 2007/2009

- ✓ Soil creep
- ✓ Talus creep
- ✓ Solifluction
- ✓ Rock creep

#### a) Soil Creep.

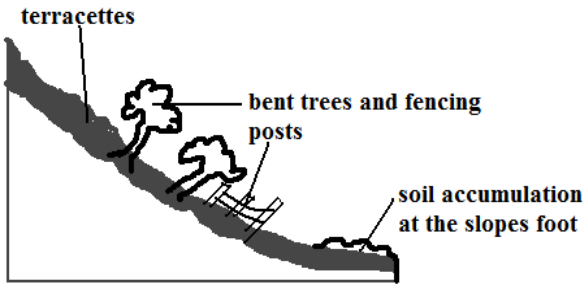
- It is the slow and steady movement of soil and other fine materials along a gentle slope.

**Causes of soil creep**-kcse 2007/2018

- ✓ **Temperature change** causes soil particles to expand and contract hence they shift position downslope.
- ✓ **Alternate wetting and drying of the soil** whereby when it rains, the soil wet becoming compact and upon drying, soil particles become loose and shift their position down slope.
- ✓ **Moisture/rainwater** acts as lubricant to soil particles causing their movement down slope.
- ✓ **Trampling and burrowing of animals** have a trigger effect on soil particles on the upper part to shift downslope.
- ✓ **External forces such as shaking by earthquakes**/explosives/heavy vehicles have a trigger effect which causes down slope movement of soil particles.
- ✓ **Huma activities like ploughing down the slope** causes soil particles to shift their position downslope since the soil is disturbed and loosened.
- ✓ **Freezing of soil water** expands the soil pores and when water thaws, the soil particles fall by gravity and may shift position downslope.

**Indicators of the occurrence of soil creep**-kcse 2012

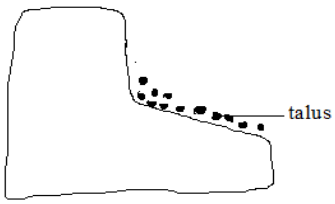
- ✓ Telephone/fence poles that are inclined down a slope.
- ✓ Bent tree trunks
- ✓ Accumulated soil at the foot of a slope/behind walls/on roads/railways.
- ✓ Existence of bare rock/exposed upper slope.
- ✓ Presence of dipped rock strata in the direction of the slope.
- ✓ Presence of overhanging banks above roads or rivers.
- ✓ Presence of slope retreat.
- ✓ Presence of a ribbed or stepped pattern across the slope.




**Quiz:** State four effects of soil creep (4marks)

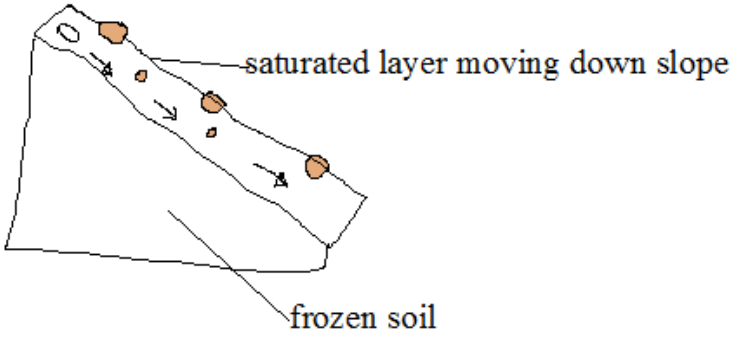
**b) Talus Creep/Scree creep.**

- It is a slow movement of granular rock debris down a slope under the influence of gravity.
- It occurs on mountains located in areas where temperature fluctuate below and above the freezing point.
- Freeze-thaw action along joints of rocks results in the breaking off of angular rock pieces of different sizes from the rock mass.
- The resultant angular rock fragments move slowly down the slope due to gravity in a process known as **Talus creep/Scree creep.**
- The presence of melt water lubricates rock fragments facilitating their down slope movement.



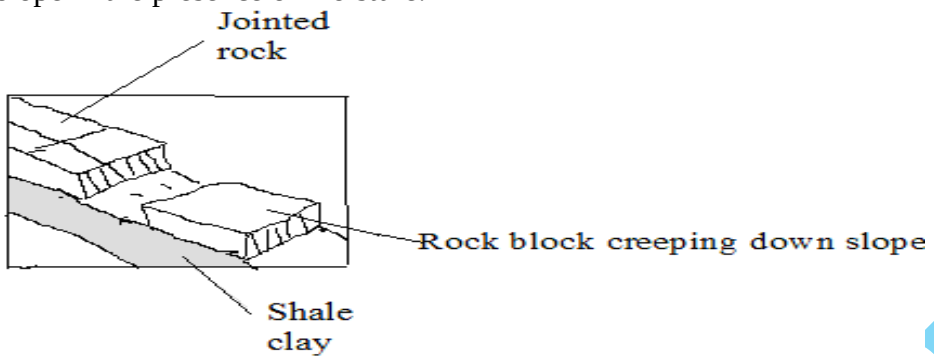

**c) Solifluction**-kcse 2018

- It is a slow movement of saturated soil, gravel and weathered rock materials down a moderate gentle slope under the influence of gravity.
    - In moderately/gently sloping areas during winter water in the soil freezes thus freezing the soil.
    - When the weather becomes warm, the top soil thaws.
    - Overtime the top soil becomes saturated with water while the sub-soil remains frozen (permafrost).
    - The saturated mass of top soil creeps over the frozen ground (permafrost). This process is known as **solifluction.**



### d) Rock Creep.

- It is the slow movement of individual rocks which lie on clay at a very low speed down slope in the presence of moisture.




### 2. Rapid Mass Wasting.

- It is a sudden and fast movement of weathered materials down a slope under the influence of gravity.
- It is common on steep slopes.
- It occurs in various forms like;
    - Flowage
    - Sliding
    - Falling

**Factors that trigger rapid mass wasting.**

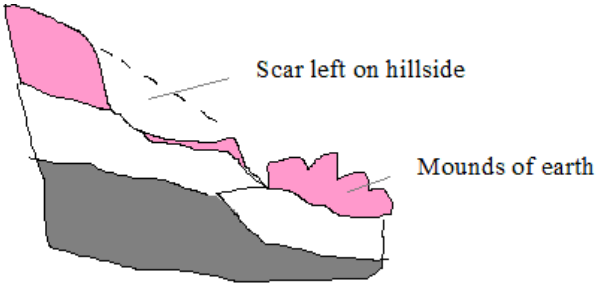
- ✓ Collapse of a dam
- ✓ An earth tremor/Earthquake
- ✓ Burrowing of animals
- ✓ Quarrying
- ✓ Felling of trees from a hill side
- ✓ Ploughing up or down a slope

**Processes of Rapid mass wasting**-kcse 2022

**(a)** Earthflows
**(b)** Mudflows
**(c)** Landslides
**(d)** Avalanche

### a) Earth Flows-kcse 2020

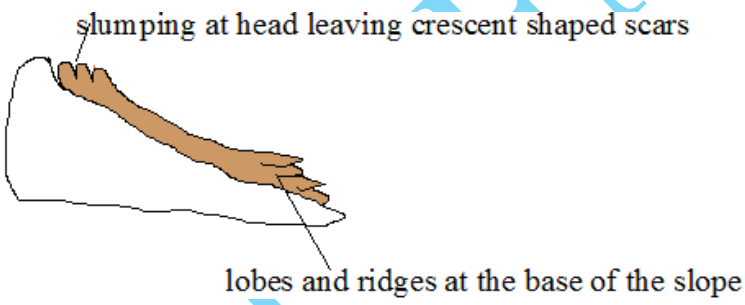
- **An earth flow** is a sudden and rapid flow of saturated loose weathered materials down a steep slope.
    - It occurs in humid conditions.
    - It occurs on moderate slopes.
    - Materials on the surface get saturated with water.
    - They flow/slide down the hill under the influence of gravity.
    - They leave behind shallow scars.
    - They form small bench like terraces at their destination. This process is known as **Earth flows.**




**b) Mud Flows**-kcse 2009

- It is a rapid flow of saturated soil and other weathered rock materials down a steep slope under the influence of gravity following established valleys.
    - Wet and loose soil materials saturated with water will move down the hill.
    - As the semi-liquid mud collects more materials, it becomes heavier until it comes to rest at the foot of the slope. This process is **Mudflows.**

- **Factors influencing mudflows are;**
    - ✓ Presence of loose/unconsolidated materials on the earth surface.
    - ✓ Presence of steep slopes.
    - ✓ An abundant but intermittent supply of water.
    - ✓ Scarcity of vegetation for faster movement.




**c) Land Slide/Land slip**

- It is a rapid movement of a large mass of earth and rocks down a hill with little or no flowage of materials.

**Causes of Landslides**-kcse 2009

- ✓ Steep slopes which allow soils to move down easily.
- ✓ Presence of loose soil/absence of firm rock which means that soils are easily destabilized.
- ✓ Occurrence of earthquakes which interferes with stability of soils.
- ✓ Heavy rains facilitate movement of materials downslope.
- ✓ Deep undercutting of the base of a steep slope by a river/road construction.
- ✓ Melting of ice may cause large masses of ice embedded with rocks to move down a slope at high velocity.

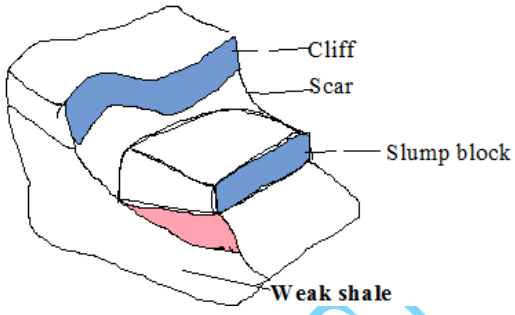
**Forms/Types of landslides**-kcse 2018

i. Rock slump/slip
ii. Debris slide/Earth slide/Soil slip
iii. Debris fall
iv. Rock fall

v. Rock slide
vi. Avalanches
vii. Rain wash/Downwash

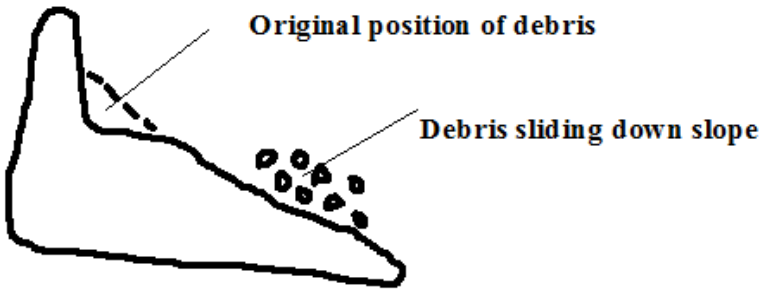
**i)** Rock Slump/Slip-kcse 2020

- It occurs on very steep concave slopes.
- A massive sedimentary strata overlying weak rock materials e.g. clay.
- The underlying rock material is saturated with water.
- This causes undercutting/breaking off of the overlying rock materials.
- The large mass of rock and loose materials shear/tear away along the concave plane.
- The rock materials slide downhill causing **a slump.**
-




**ii)** Debris Slide/Earth slide/Soil slip.

- It is the sudden downhill movement of accumulated rock debris and other loose material downhill as a whole.

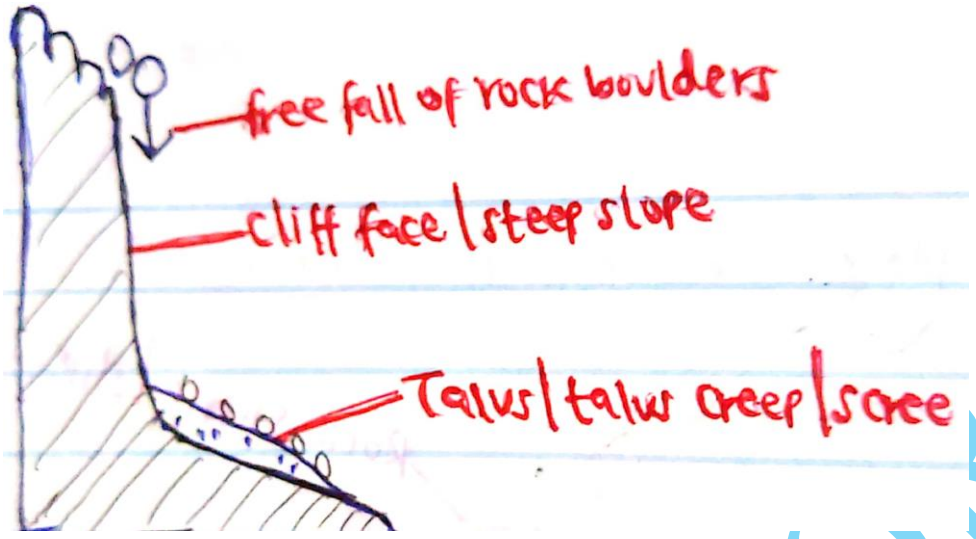



**iii)** Debris fall.

- It is the sudden free fall of debris from a vertical or hanging cliff to the base of the slope.

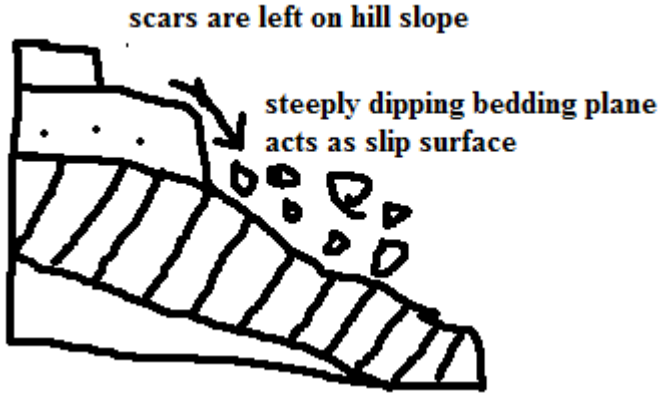
**iv)** Rock fall-kcse 2020

- It involves free fall of detached rocks down a steep/vertical slope.
- They may fall directly downwards or bounce and roll down the slope.
- It may occur due to freeze-thaw process/loosening action of plant roots/heating and cooling/Earth movements. This process is **Rock fall.**



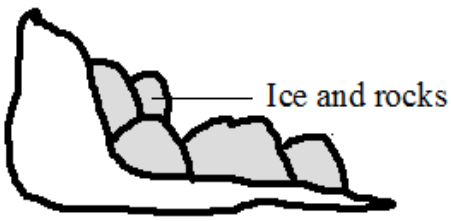

**v)** Rock Slide.

- It is the movement of a mass of rock sliding down a gentle slope which is facilitated by water lubrication of the surface.




**vi)** Avalanche-kcse 2020

- It is the sudden slipping and falling of a large mass of snow, ice and loose rock materials down a mountain side.
    - It occurs when a fresh fall of snow is not firmly consolidated hence slides over the older snow/ice rapidly.
    - The thawing action of ice lubricates weathered rock and large ice blocks making them slide downhill rapidly. The process is **Avalanche.**




**vii)** Rain Wash/Down wash.

- It is the movement of unconsolidated materials down slope due to rain splash, run-off and overland flood.
- It is common on slopes with little or no vegetation.

## Types of Down wash

**a) Sheet wash/Sheet flooding.**

- It is the uniform removal of soil over a large area on a slope by heavy rainfall.

**b) Gulleying**

- Removal of soil through wide and deep channels called gullies due to running water on soft rocks.

## Effects of Mass Wasting-kcse 2007

### 1. Positive effects

**(a)** It forms beautiful sceneries like avalanches which attract tourists earning a country foreign exchange-kcse 2009
**(b)** Materials from landslides may create a barrier across a river valley forming a lake that provides water for irrigation/domestic use.
**(c)** Rock materials deposited at the base of slopes form deep, well drained soils supporting crop growing-kcse 2009
**(d)** Rock fall also provide stones/boulders used in building and construction.
**(e)** Some rock debris contain mineral deposits hence promoting mining.
**(f)** Areas affected by mass wasting have become centres of research.
**(g)** Areas prone to mass wasting have encouraged environmental conservation strategies like afforestation/gabion building/agroforestry/reafforestation.

### 2. Negative effects-kcse 2018

(a) Soil creep may destroy walls built across the slope when creeping soil exerts pressure on them.
(b) It leads to destruction of vegetation.
(c) It leads to blockage of rivers/disruption of flow of rivers reducing volume of water downstream.
(d) It leads to exposure of land to agents of soil erosion.
(e) It leads to loss of life when people/animal are buried under large quantities of rock waste.
(f) It leads to formation of scars on the land/derelict land destroying the beauty of land.
(g) Earthflows/mudflows cause siltation of dams reducing its capacity to hold more water.

Quiz: kcse 2022- **Explain the effects of mass wasting on the environment** (8marks)

- ✓ Landslide may cause rivers to change their course reducing the water volume downstream.
- ✓ Mass wasting leads to formation of derelict land with scars which spoils the beauty of the environment.
- ✓ Mass wasting leads to slope retreat.
- ✓ Some mass movement bury people and animals under large materials leading to loss of lives.
- ✓ Landslides cause damage to property when materials cover roads/ farms/ homes.
- ✓ Movement of materials downslope facilitates the loosening of the top soil increasing erosion.
- ✓ Mass movement may create sceneries that may become tourist attractions.
- ✓ Materials from a landslide may create a barrier across a river valley thus leading to eventual formation of a lake.

……THE END……

# THE HYDROLOGICAL CYCLE.

## Definition –kcse 2017

- **Hydrological cycle** is the continuous movement of water from the air to the earth surface and back to the air.

## Processes of hydrological cycle.

### 1. Input process.

- The main input process in hydrological cycle is **precipitation.**
- **Forms of precipitation are** rainfall, dew, mist, fog and snow.
- **Conditions for the formation of precipitation are;**
  - ✓ Air must be saturated.
  - ✓ Contain hygroscopic particles like dust, salt particles, pollen grains, gases and smoke.
  - ✓ Air must cool below its dew point.

### 2. Output processes.

- The major output processes in hydrological cycle are;

a) Evaporation.

- It is the loss of water vapour from the earth surface/ open water surfaces into the atmosphere.
- The rate of evaporation depends on;
  - **Availability of moisture at the surface of the earth (humidity)**. Wet surfaces result into higher rates of evaporation and vice versa.
  - **Increase in temperature** leads to higher evaporation rate.
  - **Wind** i.e. the higher the wind speed, the higher the evaporation rate and vice versa.
  - **Sunshine duration**. Longer hours of sunshine increases the period of the process of evaporation and vice versa.
  - **Characteristics of water**. Evaporation from sea/ salty water is less than evaporation from fresh water.

b) Transpiration.

- It is the loss of water vapour from vegetation/ plants to the atmosphere.
- Transpiration rate depends on;
  - Time of the year. Transpiration rate is high during dry season.
  - The type and the amount of vegetation cover in the region.

**NOTE: Evapotranspiration** is the loss of water vapour from both open water surfaces (sea/ ocean/ lake) and plants to the air.

### 3. Internal transfer process.

- It is the extensive movement of water which takes place in the atmosphere, land and oceans.
- It redistribute water so that the inputs and the outputs are kept in balance.
- The major internal transfer of the hydrological cycle includes;

**a) Interception.**

- It is the process by which the first rain drop of a storm will fall on trees or plants which shelter the underlying ground.
- When the rain persists, the water may reach the ground in the following ways;

- Through fall i.e. water flowing down the trunk of the vegetation before reaching the earth surface.
- Secondary interception i.e. water is temporarily stored on the vegetation by any undergrowth.

### b) Surface run-off/ overland flow.

- This is the excess water flowing away over the earth surface which is incapable of absorbing all the rain after very heavy rainfall.
- The excess water flows over the earth surface into lakes, swamps, seas and rivers.

**Factors influencing the occurrence of surface run-off** –kcse 2017

- ✓ **The amount of rainfall.** There should be sufficient rainfall to make the soil saturated in order to allow excess water to flow on the earth surface.
- ✓ **The gradient of the land.** The gradient of the slope should be steep to allow flow of water by gravity.
- ✓ **The nature of the rock/ soil.** The rocks/ soils should be impermeable to allow for limited infiltration and percolation for the excess water to form surface run-off.
- ✓ **The water table.** The water table should be high to reduce infiltration and allow surface run-off.
- ✓ **Vegetation.** Absence of vegetation will increase the rate of run-off.
- ✓ **Human activity.** Construction of pavements or roads in built up areas prevent infiltration and arouse surface run-off.

### c) Infiltration.

- It is the process by which rain water seeps into the ground vertically through the surface rocks like sandstones and limestones.
- It is the vertical seeping of water into the earth surface to the lower layers through pores/ joints/ cracks that are in rock.
- The speed at which water is absorbed into the soil through infiltration is called **infiltration capacity/ infiltration rate.**
- **Infiltration depends on;**
  - ✓ The amount of water already in the soil.
  - ✓ The porosity and the structure of the soil.
  - ✓ The type of the soil.
  - ✓ The amount and seasonal changes in the vegetation cover.

### d) Percolation.

- It is the process by which water below the earth surface moves horizontally through the rocks.

## 4. Storage process.

- Once water is on the earth surface, it may be stored in many forms like;

### a) Surface water storage.

- Rain water reaches rivers through rain falls, surface run-off, ice flow and springs.
- River water then flow towards surface storages like seas, oceans, lakes and swamps.

### b) Ground water storage.

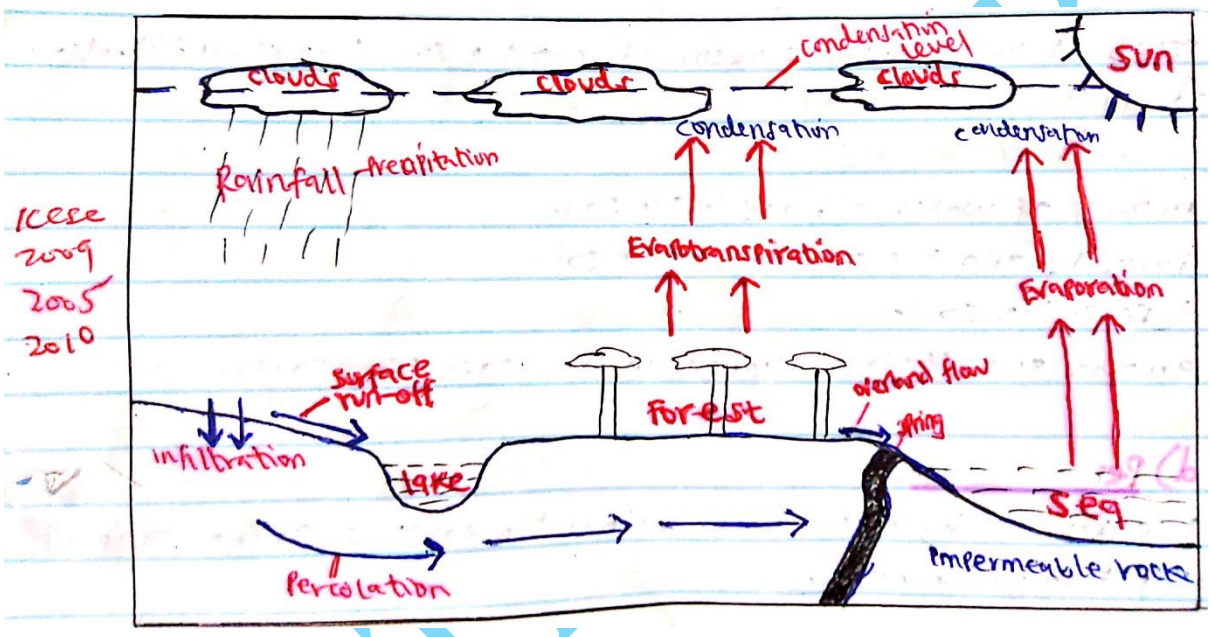
- This is the water that collects above an impermeable rock or fills all the pore spaces in rocks creating a zone of saturation.
- It is the zone that forms the water table.

### c) Cryosphere.

- It refers to the water stored in the vast ice covered regions of the world.
- Water enters this storage through snow fall.

**Kcse 2014:** Give three processes in the hydrological cycle.

- ✓ Evaporation/ evapotranspiration/ moist air rising.
- ✓ Condensation/ moist air cooling.
- ✓ Infiltration/ percolation.
- ✓ Interception.
- ✓ Surface run off/ overland flow.
- ✓ Precipitation/ rainfall/ snow fall.




**Significance of the hydrological cycle** –kcse 2017

i.) Evapotranspiration increases water in the atmosphere which forms rain that provide water for irrigation/ crop farming.
ii.) It helps to regulate the surface water/ underground water and water in the atmosphere.
iii.) It provides underground water through percolation.
iv.) Large rivers drain into oceans and lakes to form water bodies.
v.) It controls the elements of weather such as temperatures, humidity and rainfall.
vi.) Water evaporates from the ground causing drying up of water bodies/ causes arid conditions.
vii.) Water vapour maintains heat energy in the atmosphere.
viii.) Moisture in the atmosphere influences solar/ terrestrial radiation.

……END……

# ACTION OF RIVERS.

## Definition of terms associated with rivers

- ***A River*** is a natural stream of water flowing in a valley on the surface of the earth.
- ***River source*** is where the river originates from.

**Sources of a river** –kcse 2008

- ✓ Lakes
- ✓ Melting ice/ snow
- ✓ Springs
- ✓ Swamps
- ✓ Surface run-off
- ✓ Oceans/ sea
- ✓ Mountains/ highlands
- ✓ Marshes

- ***River mouth*** is the end point/ terminus of a river in its lower course.

**Possible river mouth.**

- ✓ Lakes
- ✓ Oceans
- ✓ Seas
- ✓ Swamps
- ✓ Deserts

- ***River system*** is a composition of the main river and all its tributaries.
- **Streams** are rivers that are small in size.
- ***Tributaries*** are small rivers/ streams flowing into main rivers.
- ***Confluence*** is a point at which a tributary joins the main river.
- ***Drainage*** is the process of removing water from one area to another through natural streams.
- ***Drainage basin/ water catchment area*** is a unit area of land which is drained by a river and its tributaries–kcse 2005
- ***A watershed/ a river divide*** is a line/ boundary of dry land separating two drainage basins –kcse 2005
- ***Interfluves*** are high areas in between the tributaries.
- ***A river channel/ river valley*** is a groove/ furrow through which the river water flows. Its size depends on;
  - Volume of water flowing through it.
  - Load carried by the river.
  - Velocity of the water.

- ***River discharge*** is the amount of water passing through a particular point on the river's course.
- ***River regime*** is the seasonal fluctuation/ variation in the volume of water in the river.

Factors influencing river regime.

- ✓ Seasonal precipitation/ rainfall.
- ✓ Change in temperature/ melting of ice.
- ✓ Nature of rocks/ permeability of rocks.
- ✓ Characteristics of vegetation along river valley.

- ✓ Rate of evaporation/ evapotranspiration.

NOTE: At any point a long a river, the side towards the source is called **upstream side** and the one towards the mouth is called **downstream side.**

## Types of Rivers.

a.) **Permanent River** is a natural mass of flowing water in a valley on the earth surface throughout the year.

b.) **Seasonal/ intermittent river** is a natural mass of flowing water in a valley on the earth surface during some periods of the year e.g. rainy season.

c.) **Disappearing river** is a natural mass of flowing water in a valley that ends up abruptly on the earth surface.

## The work of a River.

- This involves **erosion**, **transportation** and **deposition.**

### 1) River Erosion.

- It involves the wearing away of the earth's surface through the action of naturally flowing water/rivers.

### Factors that influence the rate of river erosion –kcse 2023

i. ***Volume of the river water*** i.e. the larger the river volume, the greater the force of moving water and hence the greater the erosion and vice versa.
ii. ***Nature/ amount of load*** i.e. large and hard load cause more erosion compared to smaller and finer load.
iii. ***The gradient of slope/ velocity*** i.e. steep slopes increases river velocity hence high river erosion and vice versa.
iv. ***Nature of the river bedrock*** i.e. river beds with less resistant rocks/ soft rocks are easily eroded compared to hard rocks.

NOTE: Load is the material carried by a river.

### Ways in which river water flows on its channel.

i. **Laminar flow** is the flow of river water that is smooth, slow and does not mix with itself.
ii. **Turbulent flow** is the flow of river water that is rough, fast and mixes together. It is characterized by eddies and rapids.
iii. **Plunge flow** is the flow of river water in a deep depression in a stream bed at the base of a waterfall.
iv. **Helicoidal/ corkscrew flow** is the flow of the river water in a meander. Leads to formation of slip-off slopes and river cliffs.

## Ways/ Processes of River Erosion.

### i. *Hydraulic action/ Quarrying process.*

- This is where **a river uses the force of the moving water to remove loose rock materials** from the river banks and river beds.
- Some of the river water surges over into cracks/ crevices of rocks found along river banks and beds scooping out rock particles and then transport them downstream. This process is **hydraulic action.**

### ii. *Attrition* –kcse 2012

- As rock materials are transported by a river downstream, they constantly collide against each other.
- The materials gradually wear down or reduce in size. This process is **attrition.**

### iii. *Corrasion/Abrasion* –kcse 2018

- This is where a river uses its load as a tool of erosion.
    - The materials are used by the river as tools for scouring.
    - The load is hurled by the water against the banks and dragged along the river bed.
    - The load chips off the rocks on the bank and river bed.
    - The load being dragged smoothens the river bed.
    - The eddy currents rotate the load in the hollows on the river bed widening into potholes. This process is **Abrasion/ corrosion.**

### iv. *Solution/ corrosion* –kcse 2018

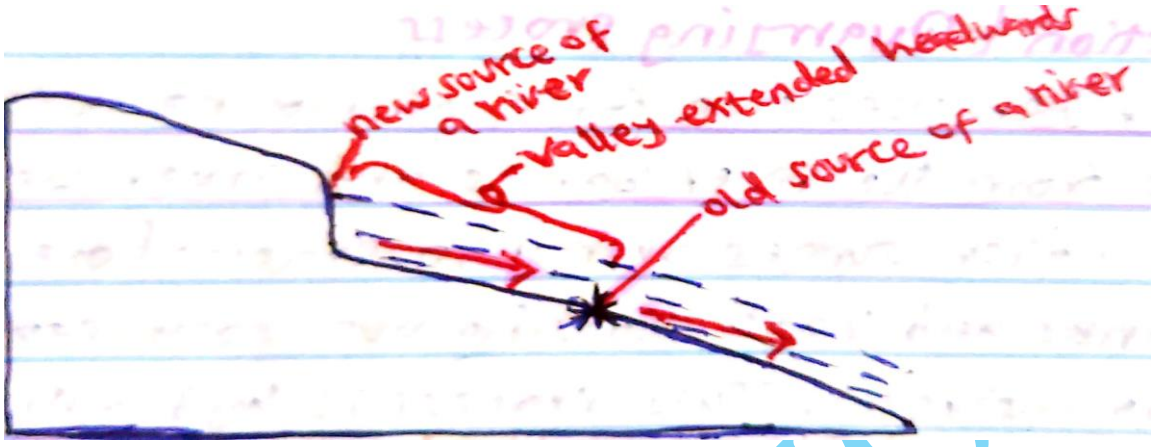
- This is where the running river water dissolves soluble minerals in rocks found in the river banks over which it flows.
    - River water contains both organic and weak inorganic acids.
    - It reacts with some minerals in some rocks in the river bed to form soluble minerals.
    - The soluble minerals are carried downstream in soluble form. This process is **solution/ corrosion.**

## Types of River Erosion.

- These are ways through which a river cuts its channel in its erosive process.
- **Types of river erosion are;** –kcse 2018
    - ✓ Head ward erosion.
    - ✓ Vertical erosion.
    - ✓ Lateral erosion.

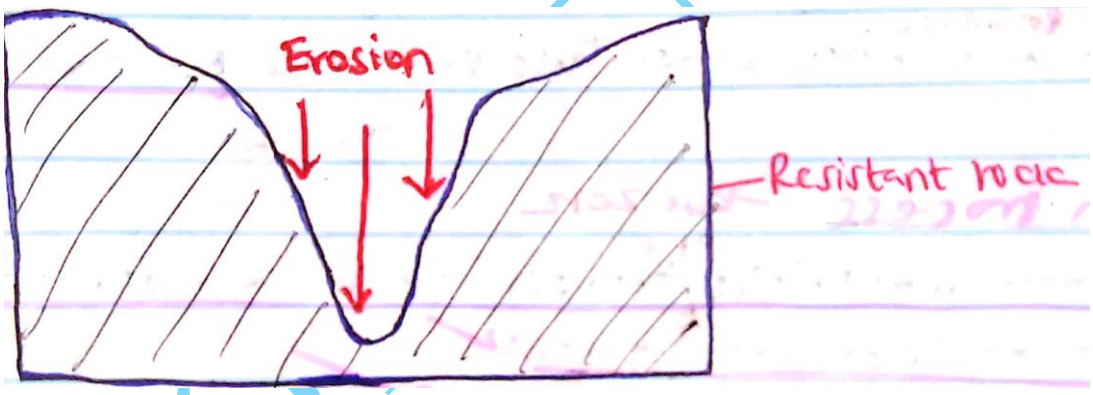
### *a.) Head-ward erosion.*

- This is where **the river increases its length** by cutting back at its source.
- **Caused by** rain wash, gullying, soil creep and spring sapping.



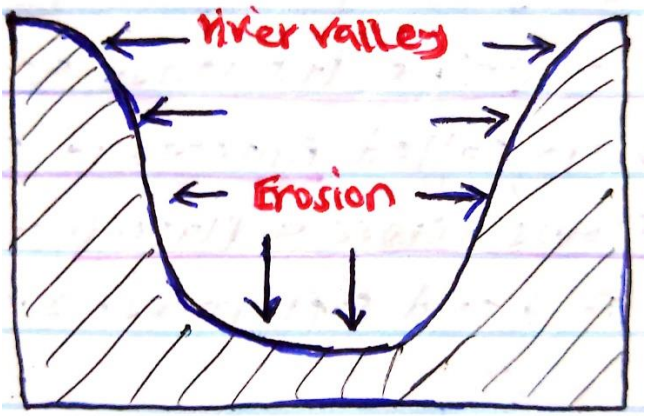

### *b.) Vertical erosion.*

- This is where the **river deepens its channel.**
- **Caused by** hydraulic action, solution and abrasion processes.




### *c.) Lateral erosion.*

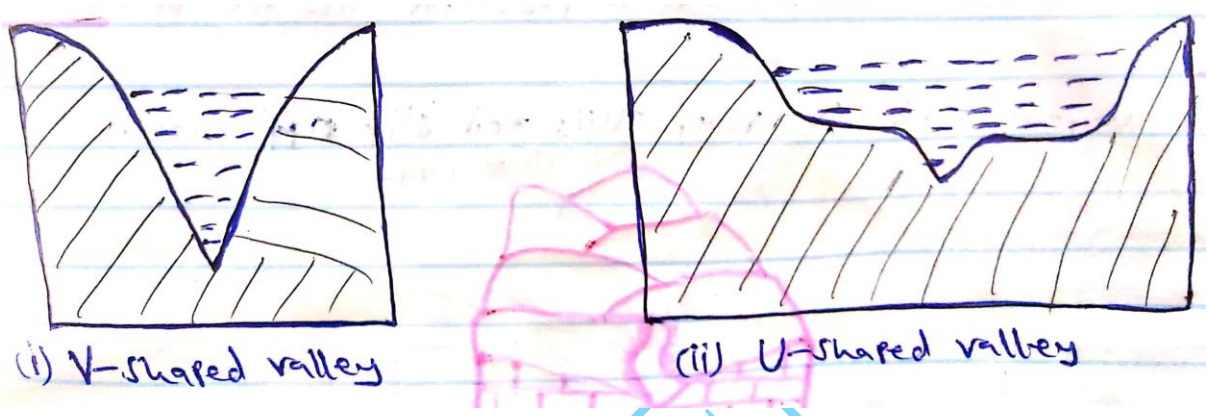
- This is where **the river widen its channel through wearing away of the river banks.**
- **Caused by** abrasion, hydraulic action and solution processes.



## Resultant features of river erosion.

### i.) *Stream cut/V shaped valleys.*

- As river water moves down slope over the earth's surface, it cuts a depression/channel that starts as a gulley.
- With time the gulley widens through lateral erosion and deepens through vertical erosion forming a V shaped valley at the source of a river.
- At the mouth of a river, lateral erosion creates a very wide, shallow channel with a U-shaped cross-section forming U-shaped valley.




### ii.) *Gorges.*

- **Gorges** are deep, narrow and steep-sided river valleys.
- **Gorges are formed in the following ways;**
    - **Gorges are formed where a river flows across a plateau** composed of horizontal and alternate layers of hard and soft rocks. Such gorges are called **Canyons.**
    - **Gorges are formed where a river flows along a line of weakness/ cracks.** The river erodes more vertically along the line of weakness.
    - **Gorges are formed where a river maintains its course across a landscape which is being slowly uplifted**. Such gorges are called **antecedent gorges.**
    - **Gorges are formed where a waterfall retreats upstream.** When water retreats upstream, it leaves a deep valley on the downstream side.
    - **Gorges are formed where there is an abrupt fall in the base level** causing river to renew its erosive activity.
    - **Gorges are formed due to river rejuvenation** forming **rejuvenated gorges.**

### iii.) *Waterfalls.*

- **A waterfall** is a steep fall of river water where a river bed has sudden vertical/ near vertical drop.
- **Cataracts** are series of almost equal short falls of water where the river floor is rough.
- **A cascade** is a small waterfall with a series of falls formed by water in its descent over rocks.
- **Waterfalls are formed in the following ways;**

a.) **Waterfalls formed where a river channel passes over underlying hard rock.**

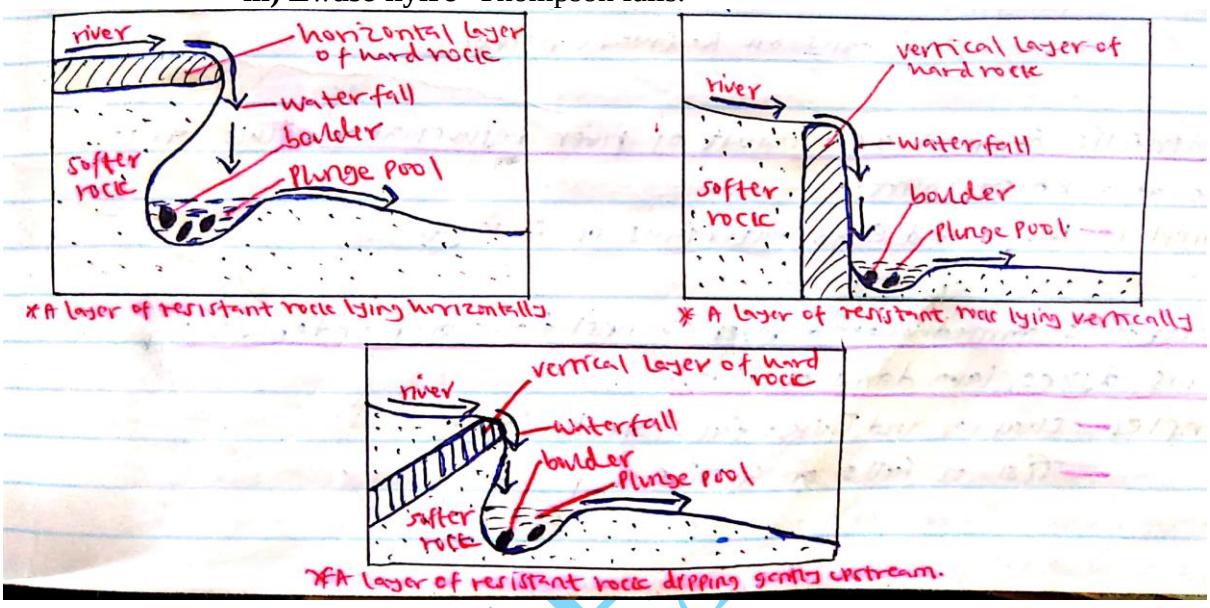
- When a layer of more resistant rock lies across a river bed horizontally, vertically or inclined, the less resistant rock on the downstream is eroded

faster than the more resistant rock upstream leading to a steeper gradient that develops into a waterfall.

- **Examples: i) On River Tana-** Gura falls, Tana falls, Grand falls, Adamson falls.

  **ii) River Athi-** Fourteen falls.

  **iii) Ewaso nyiro-** Thompson falls.




b.) **Waterfall forms when there is a vertical hard rock along the river channel.** Continuous waterfalls can form along its course known as rapids.

c.) **Waterfalls formed where a river course flows over a fault scarp.** The river enters rift valley through a fault scarp forming waterfall.

d.) **Waterfalls formed where a river entres a coastal plain from a plateau.** The river descends a sharp edge of a plateau.

e.) **Waterfalls formed as a result of river rejuvenation.** This takes place at a knick point.

f.) **Waterfalls formed when a river channel flows over underlying volcanic dykes, lava dams or plugs.**

g.) **Waterfalls formed where a river entres the sea through a cliff.** The river water drops into an ocean/ sea above the cliff forming waterfall.

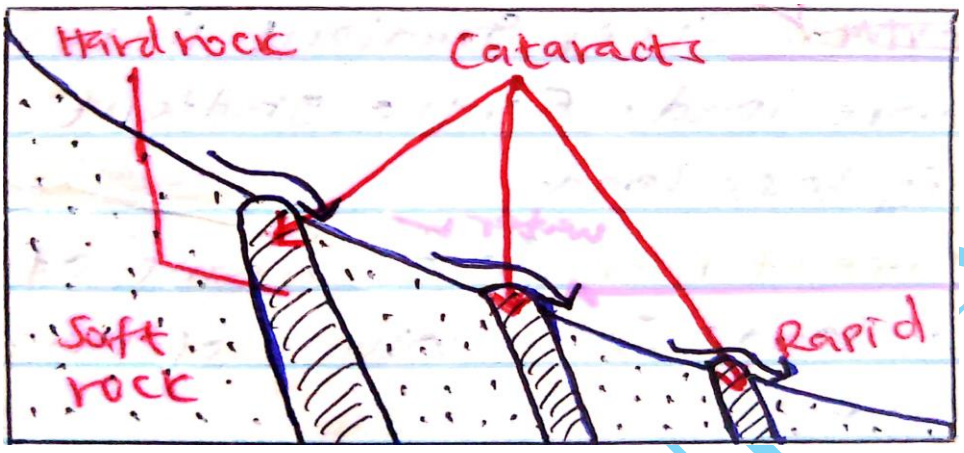
h.) **Waterfalls formed in a glaciated upland.** It occurs where a river descends a hanging valley into a glacial trough forming waterfalls.

### iv.) Rapids.

- This is a section of the river with accelerated current where the stream descends at high speed without a break in the slope of the river bed sufficient enough to form a waterfall.
- **Rapids occur under the following conditions:**
  - Where a layer of resistant rock lies across the river's bed and dips down-stream.

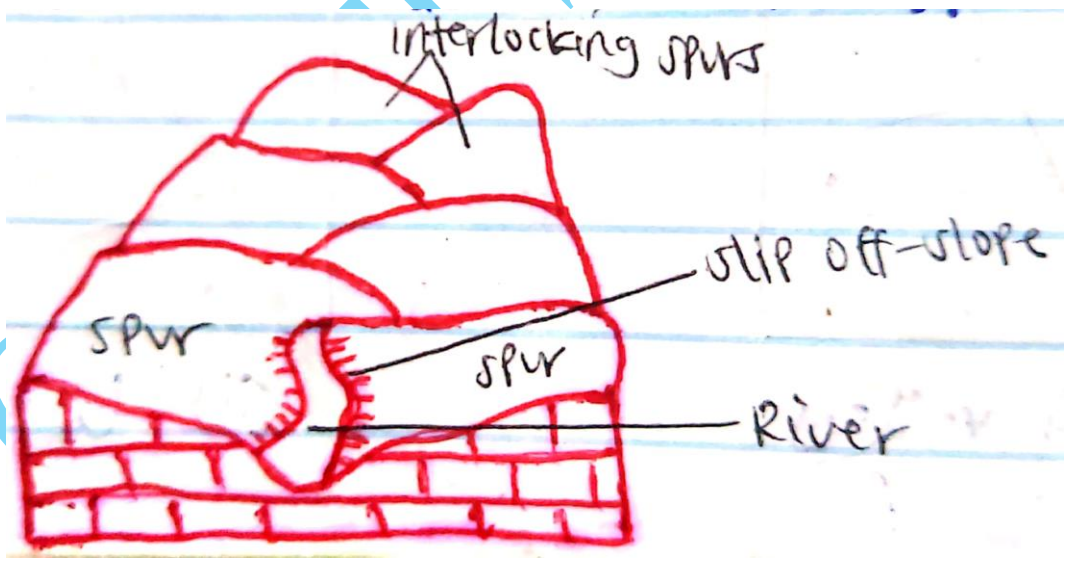
- When waterfalls recede upstream.
- Where a waterfall has been eroded by head ward erosion thus reducing in height.

- If the section of the uneven bed covers an extensive region, it results in formation of a series of rapids known as **cataracts.**



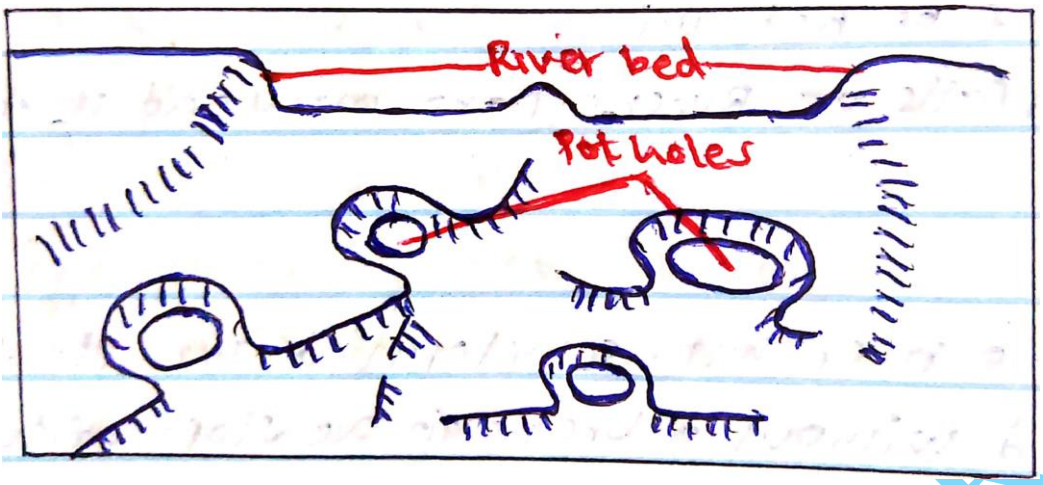

### v.) Interlocking spurs.

- These are projections of land in the upper course of a river that overlaps with each other.
- They form when a river comes across an obstacle/ resistant rock, hence will tend to curve round these rocks, following areas of least resistance, making the river to have a winding course.
- With time the bends are extended and become more pronounced.




### vi.) Potholes.

- These are circular depressions in the river bed.
- When water in a river is flowing rapidly over shallow depressions on the river bed, it develops strong currents called whirlpools that flow in circular manner.
- This also keeps the river load in circular manner too causing the rock fragments to erode the river bed leading to formation of circular depressions called **potholes.**




## 2) River Transportation.

- This is the carrying away of the eroded materials/ load by flowing water downstream.
- **River competence/ stream capacity** is the ability of a river to transport its load.

### Factors influencing river transportation –kcse 2019

- ✓ The volume of water.
- ✓ The gradient of the slope.
- ✓ The nature of the load.
- ✓ The velocity of the river.
- ✓ The amount of the load.

a.) Nature and amount of the load: - small and lighter particles can be transported over longer distances/ larger and heavier particles like boulders are transported over shorter distances.

b.) Gradient and velocity of the river: - steep slope increases river velocity hence transporting more load/ Gentle slope decreases river velocity hence transporting less load.

c.) Volume of river water: - large volume of river water transports a greater quantity of load/ small volume of river water transports small quantity of load.

d.) Presence/absence of obstacles along the river channel e.g. rock outcrops, swamps, vegetation that check the river velocity thus reducing its ability to transport.

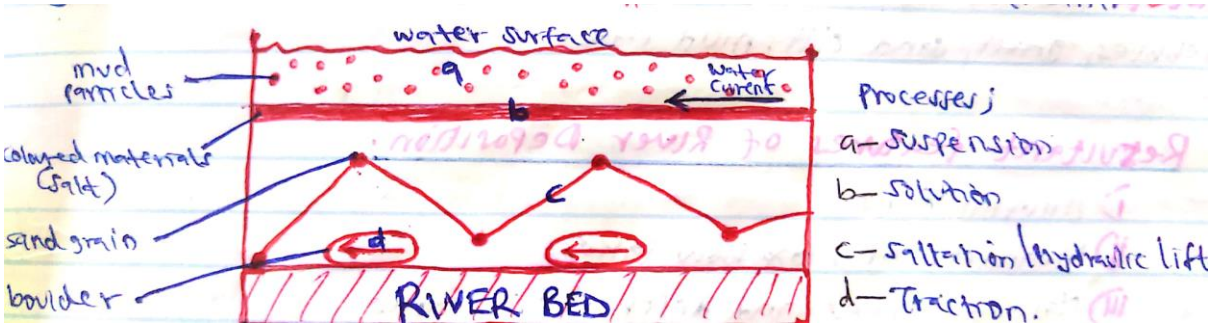
### Processes of river transportation –kcse 2020

***(a) Solution***: - Soluble materials are dissolved in the water and carried down the stream in form of solution.

***(b) Suspension*: -** Light insoluble materials such as silt and sand are carried in suspension and maintained within the turbulence of the water. Some of them float on the surface of the water.

***(c) Traction***: - Large particles/ boulders are pushed and rolled along the river bed by the force of gravity and moving water.

***(d) Saltation/hydraulic lift***: - Some particles/ pebbles which are fairly heavy are moved in a series of short hops and jumps along the river bed.




Note: The load which is carried in solid form is called **clastic load.**

### 3) River Deposition.

- This is the process by which a river lays down the material it is transporting due to reduction in its competency.

**Factors that facilitate river deposition** –kcse 2014

a.) **Reduction in river gradient/ decrease velocity of river water** leads to river deposition.
b.) **Freezing of river water** leads to embedments of the load in the ice leading to deposition.
c.) **River entering a large/ calm waterbody** reduces the speed of the river flow leading to river deposition.
d.) **Presence of obstacles on the river course** which blocks some of the load leading to river deposition.
e.) **Reduction in river volume** which reduces the strength of the river hence deposition.
f.) **Increase in the width of the river channel** makes water to spread over wide area leading to river deposition.
g.) **Increase in the amount/ size of the load** in the river channel leads to collision within leading to deposition.

Note: The deposited materials are called **alluvium** e.g. boulder, pebbles, gravel, sand, silt and mud.

**Resultant features of river deposition.**

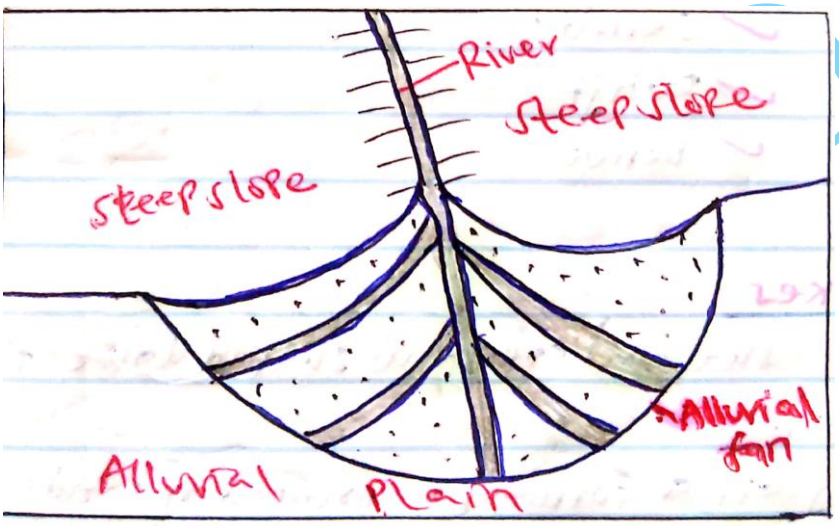
- ✓ Alluvial fans
- ✓ Meanders and ox bow lakes
- ✓ Braided river channels
- ✓ Natural levees and deferred tributaries
- ✓ Flood plains
- ✓ Deltas and distributaries.

### 1. Alluvial fans.

- These are fan-shaped alluvial deposits found at a point where a river enters a plain from higher land.
- **Formation;**
  - A river transport large load.
  - The river flowing through a narrow channel enters a plain from a higher ground.

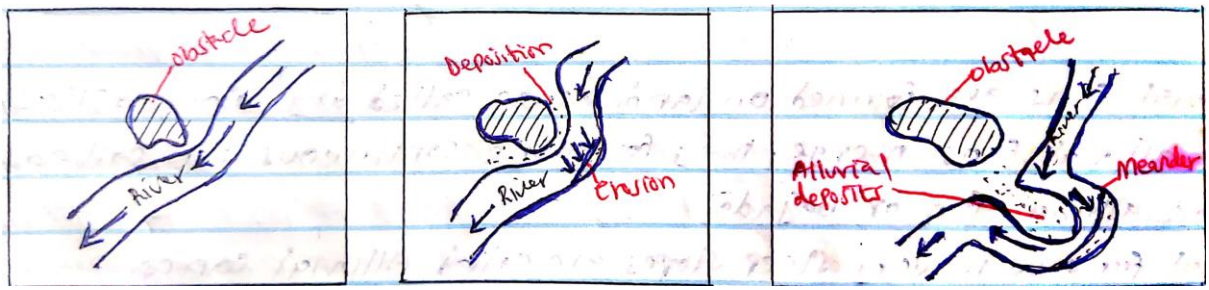
- An increase in channel width leads to decrease in gradient causing abrupt deposition.
- The river scatter alluvium all around to form **an alluvial fan.**

- Alluvial fans are formed on land hence called **dry/ inland deltas.**
- When alluvial fans merge, they form on continuous fan called **piedmont alluvial fan/ Bajada.**
- Alluvial fans with very steep slopes are called **alluvial cones.**
- **Examples**;
  - *Ombei Fan* in Kano plains (Kenya).
  - *On the Ramisi river.*
  - At the confluence of Ewaso Nyiro and Ewaso Narok rivers.
  - Lumeno and Luri alluvial fans on Lumeno and Luri rivers.




## 2. Meanders

- These are curved loop-like bends in the river's course.
- **Formation;**
  - Develops in the old stage of a river where its gradient is very low.
  - The presence of obstacles such as a rock outcrops on the river's course forces the river to flow around them.
  - The flowing of a river around these obstacles results in bends and loops.
  - Erosion occurs on the outside curve resulting in the formation of steep banks called bluffs.
  - Deposition of sediments occurs on the inside part of the meander.
  - Continued erosion on the outer bank and deposition on the inner bank causes the meander to grow outwards.



- **Examples of rivers with meanders are** Yala, Sondu Miriu, Nzoia, Nyando, Tana, Sabaki Galana, Semliki, Rufiji and Benue.

### *3. Ox bow lakes.*

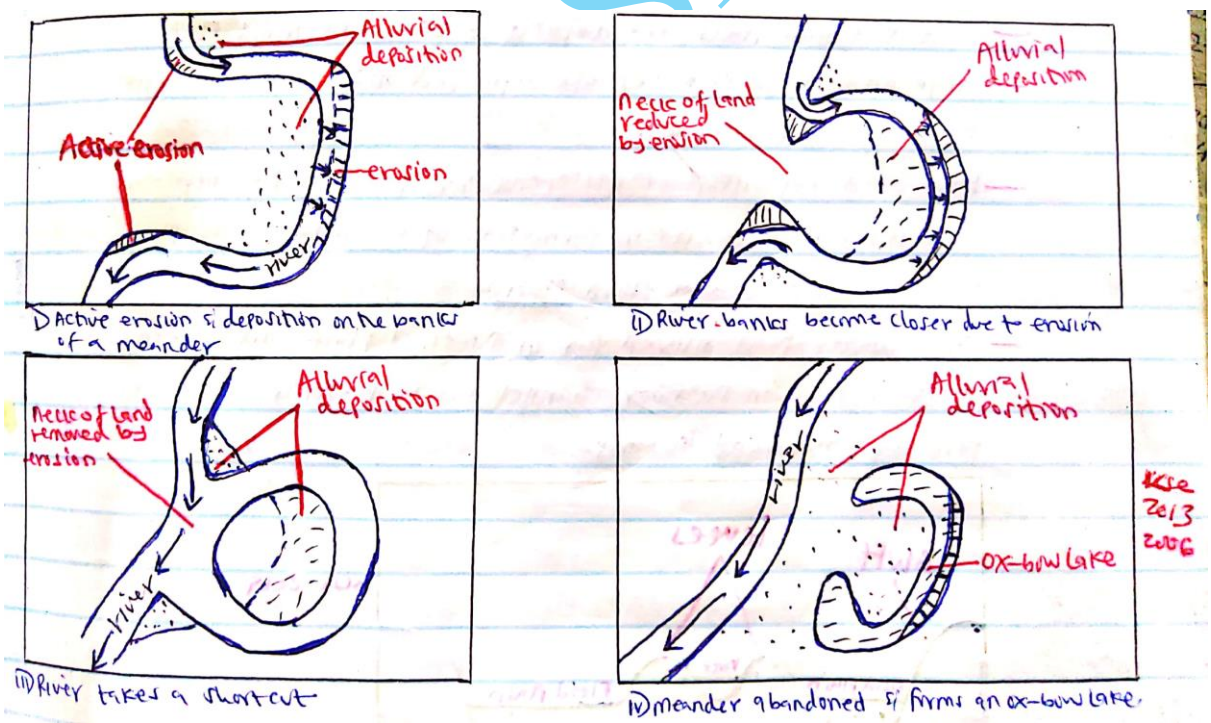
- These are horse-shoe/ crescent shaped lake formed on the flood plain of a river.
- Formed from the cutting off of a formerly pronounced meanders.

**Conditions necessary for the formation of ox-bow lakes** –kcse 2013

- ✓ Presence of **pronounced meanders** in the flood plain.
- ✓ **Heavy load** being carried by the river.
- ✓ **A reduction in the river gradient**/ low river velocity.
- ✓ **Lateral erosion on the outer side** of the river banks.
- ✓ **Deposition on the inner side** of the river banks.
- ✓ **Periodic flooding** to cut off neck of pronounced meanders.

**Formation of an ox-bow lake** –kcse 2006

- An ox-bow lake forms when a river starts to meander on a flood plain.
- Lateral erosion dominates on the outer side of the bend.
- Deposition takes place on the inner bank.
- Lateral erosion results in the reduction of the neck of land between adjacent bends.
- The neck of land is eventually worn away.
- Deposition on the meander side, especially during floods blocks off the meander cut that was the neck of land.
- The abandoned meander with its water forms **an ox-bow lake.**




**Examples of ox-bow lakes.**

- ✓ Lake Kanyaboli on River Yala.
- ✓ Lake Kamnarok in Baringo.
- ✓ On river Nzoia in Bunyala.

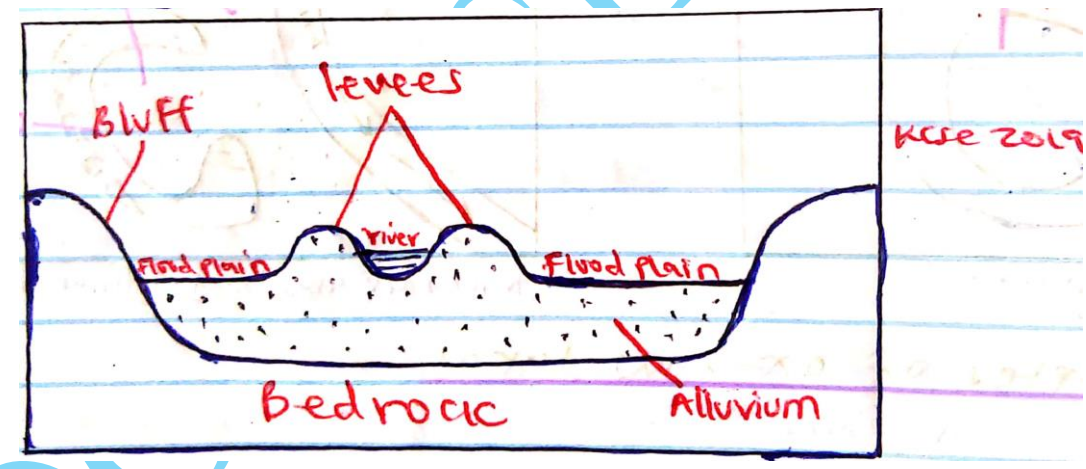
- ✓ Lake Shakababo
- ✓ Lake Gambi
- ✓ Lake Bilisa
- ✓ Lake Mukunguya

} on lower part of R. Tana

Note: When an ox-bow lake fill up with alluvium, it dry out forming **a meander scar.** It also result in the migration of meanders.

## 4. Flood plain.

- This is a wide flat or gentle sloping plain of alluvium which covers the valley floor where rivers commonly flood.
- **Formation;**
  - A river flows through a flood plain in its old stage where gradient is low.
  - Frequent floods occur forcing the river to spill its water over the banks thus depositing various materials such as coarse rocks.
  - Light silt materials are deposited far in the flood plain.
  - Large and rough particles are deposited on the river's banks forming natural levees.
  - Repeated deposition of different materials by the river far from its banks results in formation of a gently sloping plain of alluvium called **a flood plain.**
  - Some water that moved far in the flood plains during floods fail to return in the river channel due to presence of levees forming lakes and swamps.




**Examples of rivers with flood plains.**

- ✓ Nzoia
- ✓ Yala

} forms Nzoia/ Yala flood plain.

- ✓ Nyando
- ✓ Ombeyi

} on Kano plains

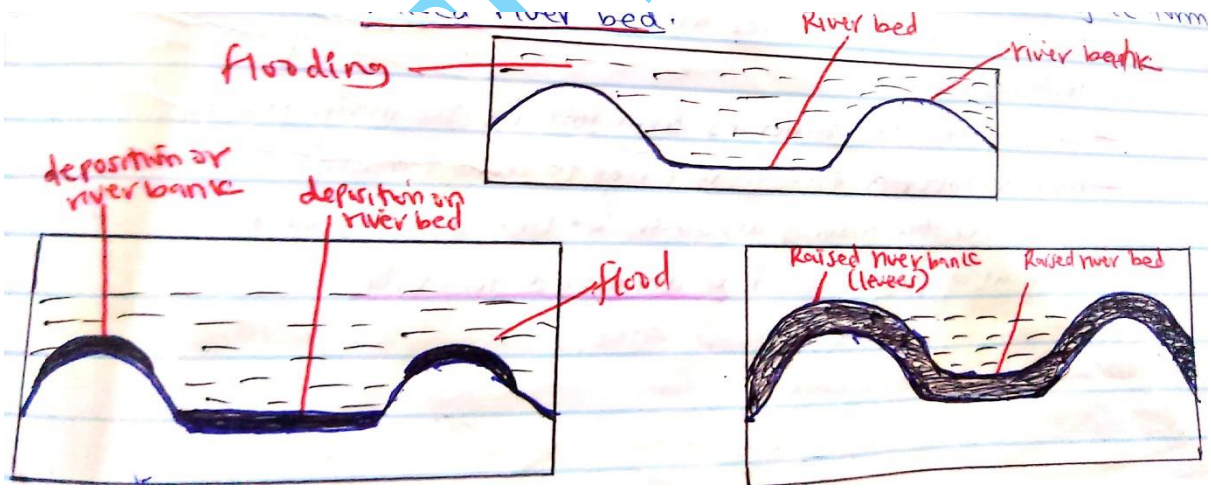
- ✓ Tana
- ✓ Sabaki
- ✓ Rufiji in T.Z
- ✓ Benue in Nigeria
- ✓ Nile in Egypt
- ✓ Chari in Cameroon/ Chad

**Characteristics of a flood plain** –kcse 2006

- ✓ They have a gently sloping gradient/ flat surface.
- ✓ They have thick alluvial deposits/ silt.
- ✓ They have levees on either side of the river banks/ raised river beds.
- ✓ Some flood plains have marshes or swamps.
- ✓ Some flood plains have braided channels.
- ✓ Some have deferred tributaries.
- ✓ Flood plains have river bluffs.
- ✓ They have meanders or bends.
- ✓ Some have ox-bow lakes at their edges.
- ✓ Some have wide river valleys.
- ✓ Some have deltas or distributaries.

## 5. Natural levees and raised river beds.

- **Natural levees** are raised river banks made of alluvial materials –kcse 2001
- **Formation**:
  - They start forming when a river floods.
  - Deposition of alluvial materials takes place when the river spills over its banks.
  - Coarse materials are deposited first followed by finer alluvium that are carried further into the flood plain.
  - The accumulation of alluvial materials raise the river banks to form **natural levees.**
  - During the low season when the river does not flood, deposition takes place on the river bed raising it forming **raised river bed.**




**Factors that lead to flooding of a river with natural levees.**

- ✓ The river bed and channel have been elevated above the general level of the plain.
- ✓ The river channel has become narrower and shallower due to deposition of alluvium.
- ✓ The deferred tributaries created by the deposition may also flood.

**Examples of rivers with natural levees.**

- ✓ Hwang Ho
- ✓ Yang tse-kiang
- ✓ Mississippi- North America

- ✓ Omo- Ethiopia
- ✓ Rivers Nyando, Nzoia and Yala entering lake Victoria.

**Effects of levee formation.**

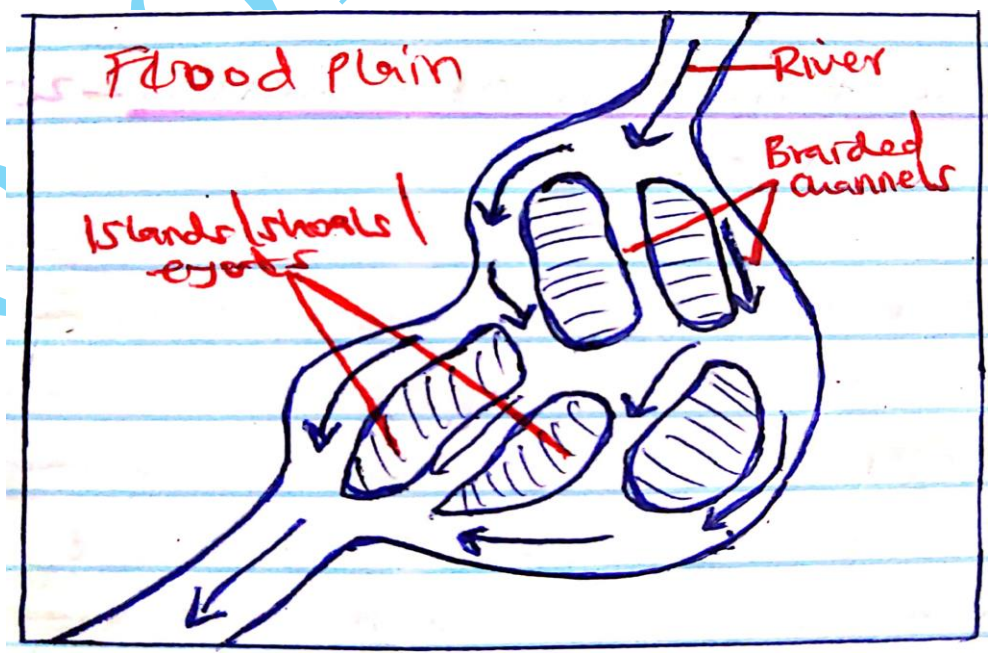
- ✓ Creation of deferred tributaries and deferred confluences.
- ✓ Destructive flooding.

**Deferred tributaries and Deferred confluences.**

- **A deferred tributary** is a stream which is forced to flow parallel to the main river in the flood plain before joining it.
- **Formation;**
  - Frequent floods occur forcing the river to spill its water over the banks, thus depositing materials like coarse rocks and silt.
  - Light silt materials are deposited far in the flood plain.
  - Large and rough particles are deposited on the river's banks forming levees.
  - This blocks the tributary from joining the main river.
  - As a result, a stream is forced to flow parallel to the main river for a long distance before joining the main river at a point called **a deferred junction.**

**6. Braided river channels/ River braids.**

- **A braided channel** is a wide and shallow channel consisting of a tangled network of diverging minor channels separated from each other by low sandbanks and islands of alluvium.
- **Formation;**
  - Forms when a river is carrying very heavy load.
  - The load is deposited in form of ridges.
  - This leads to a subdivision of the river channel and ends up flowing in a targeted network of channels.
  - The sand ridges continue to build up through increased deposition to form alluvial islands called **eyots.**



## Factors that favour the formation of braided channels –kcse 2020

- ✓ The river must be carrying large load.
- ✓ There should be reduction in the stream gradient.
- ✓ There should be presence of obstacles.
- ✓ There should be reduction of volume of water in the river.
- ✓ The river flows at low velocity.
- ✓ Widening of the river channel.

### Rivers with braided channels.

- ➢ Nzoia
- ➢ Yala
- ➢ Sondu
- ➢ Nyando
- ➢ Rufiji
- ➢ Omo
- ➢ Zaire
- ➢ White Nile

## 7. Deltas

- **A delta** is a large, low-lying plain of alluvial deposits at the mouth of a river.
- It is usually triangular in shape and extends beyond the shoreline.
- Deposition at the mouth of a river is caused by a decrease in velocity due to stagnant ocean/ sea/ lake water.
- Heavy loads are deposited first while lighter materials like silt are deposited further seawards.
- A delta formed at the river mouth emptying into a sea/ ocean is called **marine delta.**
- A delta formed at the river mouth emptying into a lake is called **lacustrine delta.**

## Conditions ideal for the formation of deltas –kcse 2002

- ✓ The river must have a larger load of sediments to be deposited at the mouth.
- ✓ The river velocity must be low at its mouth to allow deposition of the load to take place.
- ✓ The river's load should be deposited faster than it can be removed by currents and tides.
- ✓ The river course should not have obstacles like vegetation that would act as filters reducing the quantity of sediments.
- ✓ A shallow continental shelf/ shore around the river mouth hence depositing its load.
- ✓ The area experiencing a low tidal range.

### Formation of Deltas.

- Velocity of a river reduces as it meets sea/ lake water.
- Heavier load is deposited immediately the river enters the sea.
- Lighter materials are carried further into the water.
- Finer particles are deposited when river water mixes with sea water in a process called **coagulation.**
- As the materials accumulate, that part of the sea becomes shallower.
- In some cases, the river bursts its banks and divides up into smaller channels called **distributaries.**
- Distributaries spread river deposits too thus helping to build the delta.

## Types of Deltas.

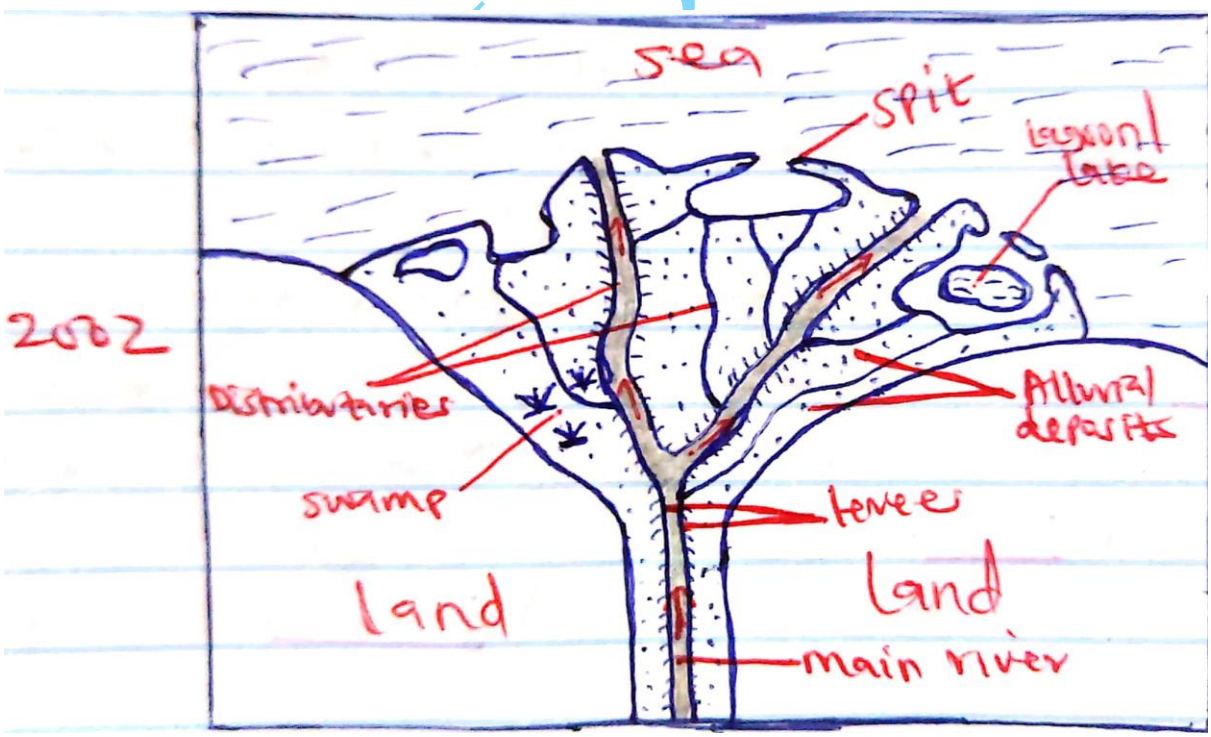
1. Coastal or marine deltas –kcse 2007/ 2009
    a.) Arcuate delta.
    b.) Estuarine delta.
    c.) Bird's foot delta.
    d.) Cuspate delta.

2. Inland deltas/ Lacustrine deltas.

### a.) Arcuate delta.

- It has the shape of letter D/ it is convex in shape in the seaward end.
- It has many distributaries.
- It occurs where;
    - Sediments consists of both fine and coarse materials.
    - Offshore currents are strong enough to enable the convex shape seaward.
    - River has many distributaries to spread materials.

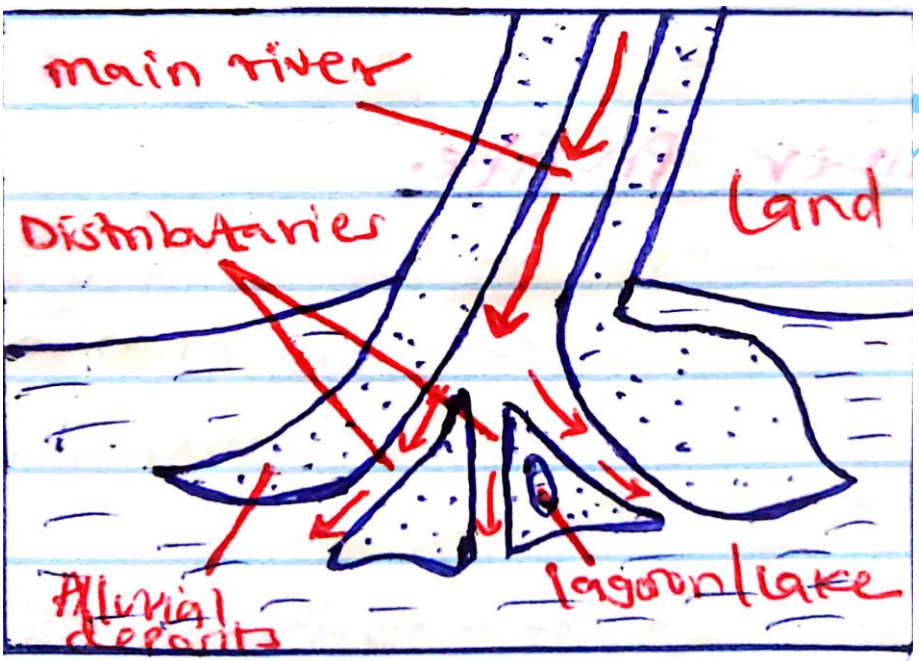
- **Examples of arcuate delta;**
    - Niger delta in Nigeria.
    - Nile delta in Egypt.
    - River Rufiji delta in Tanzania.
    - Irrawady delta in Burma.
    - Indus delta in Bangladesh.
    - Tana, Yala and Sondu river deltas in Kenya.




### b.) Bird's Foot Delta

- Also called digitate/ elongated delta.
- It resembles the foot of a bird.

- **Formation of a bird's foot delta;** –kcse 2009
    - It forms at the river mouth where waves, tides and currents are very weak.
    - Deposition of large amounts of fine sediments occur at the river mouth.
    - The deposits block the channel of the river.
    - The river divides into few distributaries.
    - Each distributaries continues to deposit its load maintaining levees as it extends into the sea.
    - Some distributaries extend further than others creating the shape of a bird's foot.




**Conditions for the formation of Bird's foot delta.**

- ✓ The river must carry large load.
- ✓ There should be no obstacles in the river's course.
- ✓ The gradient should be gentle.
- ✓ The rate of deposition should be higher than the rate of removal of materials.
- ✓ River velocity should be low to ensure more deposition.

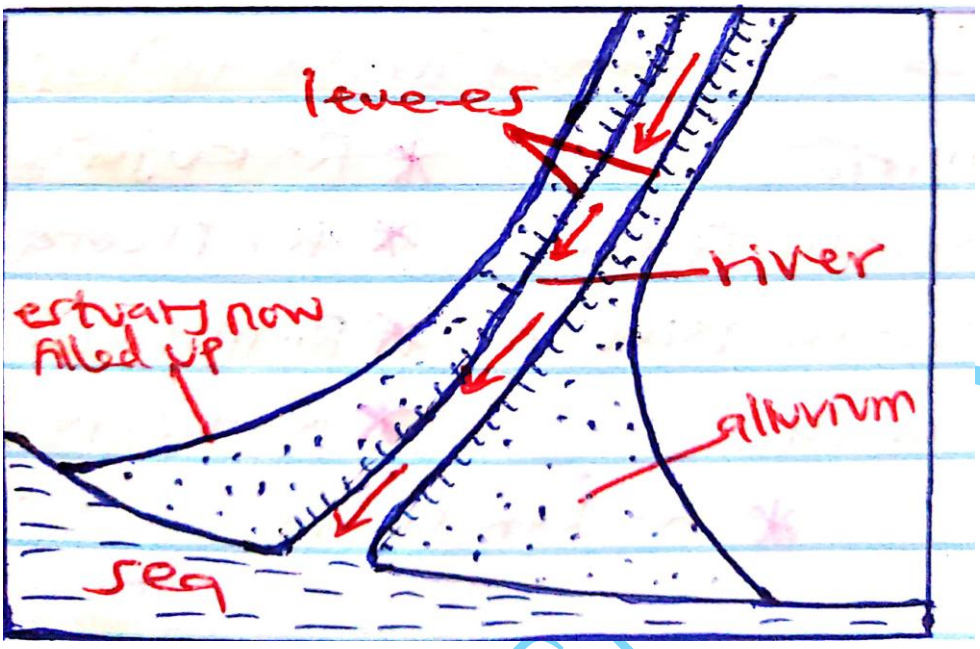
**Examples of bird's foot delta.**

- The following rivers forms bird's foot delta in their mouths: Nyando, Miriu, Kuja, Nzoia, Malewa, Omo, Turkwell, Ombeyi, Kerio, Lokichar, Awach Tende, Awach Kibuon, Nyaidho and Mississippi.

### c.) Estuarine Delta.

- Develops when alluvium is deposited in the submerged mouth of a river (rias).
- When there is an increase in the level of water in the sea or a fall in the level of land, the mouth of the river is drowned.
- This forms an estuary.
- Successive layers of sediments will be deposited, forming islands.
- The river passes through the deposited sediments without splitting into distributaries forming **an estuarine delta.**
- It is characterized by numerous sandbanks and island along the river channel.

- **Examples are deltas on** River Zambezi (Mozambique), River Volta (Ghana) and Betsiboka delta (Malagasy).




**d.) Cuspate delta.**

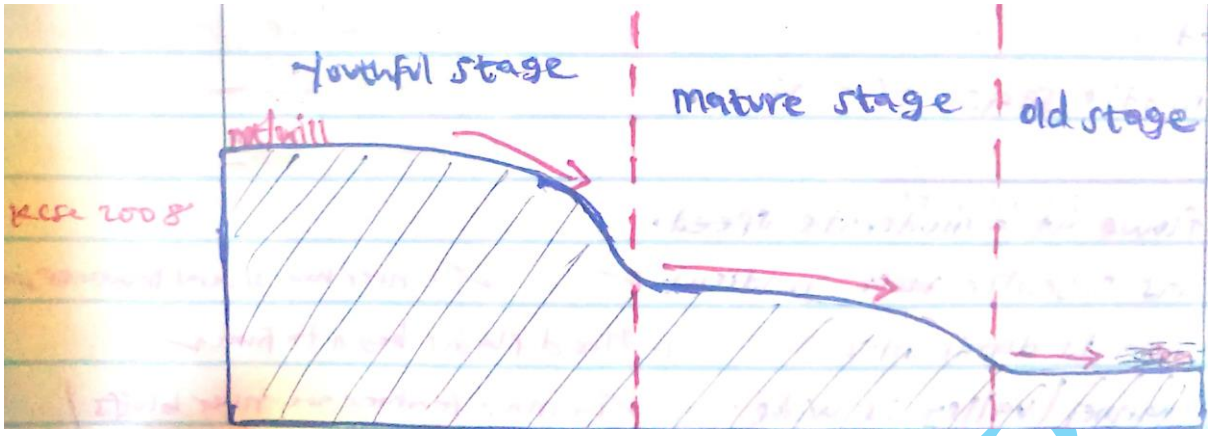
- It is a broad triangular shaped feature formed from deposits projecting seawards.
- It is formed by convergence of two spits growing towards each other.
- The enclosed lagoon is filled with more deposits.
- **Examples**- rivers Congo, Gabon and Sierra leone.

**Inland Deltas**

- Forms along the course of a river before it reaches the mouth; lake/sea.
- Develop when the velocity of the river is reduced on entering a relatively flat land, especially a swampy one.
- During floods, the river builds up levees, which cause distributaries to develop.
- Alluvial deposits are spread over vast area when the river floods.
- **Examples** include Niger Delta (Mali) and Okavango Delta (Botswana).

**The Development of a river profile.**

- **The cross profile of a river** is the appearance of the slope of the river from one bank to the other. This may be V-shaped or U-shaped.
- **The long profile of a river** is a line that joins a river's source to its mouth. It has a concave slope.
- **River profile** is the longitudinal section of a river from source to mouth.
- The river profile is developed through 3 stages namely;
  - (a) Youthful stage.
  - (b) Mature stage.
  - (c) Old stage.




### a) Youthful Stage/ Torrential stage.

- It is the upper stage of a river.

**Characteristics**-kcse 2018

- ✓ The river gradient is steep.
- ✓ The river valley is deep.
- ✓ The river channel is narrow.
- ✓ The cross profile of the valley is V-shaped.
- ✓ The flow of the river is fast.
- ✓ Vertical erosion is dominant.
- ✓ The river has interlocking spurs.
- ✓ Some parts of the river course have rapids/ waterfalls/ cataracts.
- ✓ The river has a small volume of water.

**Resultant features** –kcse 2020

- ✓ Gorges/ canyons.
- ✓ Waterfalls/ rapids/ cataracts/ cascades.
- ✓ Interlocking spurs.
- ✓ Potholes.
- ✓ V shaped valleys.
- ✓ Plunge pools.

### b) Mature stage/ Valley stage.

- It is the middle stage of a river.

**Characteristics** –kcse 2015

- ✓ The river flow is moderate.
- ✓ The river has a gentle gradient.
- ✓ Lateral erosion is dominant.
- ✓ The river has increased volume of water.
- ✓ The river begins to meander.
- ✓ The river has several tributaries.
- ✓ Flood plains begin to form.
- ✓ The main features are river bluffs/ slip off slopes/ open V-shaped valleys.

**Resultant features** –kcse 2008

- ✓ U shaped river valleys/ wide V-shaped valleys.
- ✓ Meanders.
- ✓ River cliffs/ bluffs.
- ✓ Slip off slopes.
- ✓ Alluvial fans.
- ✓ Braids.

### c) Old stage/ Plain stage.

- It is the lower stage of a river.

**Characteristics.**

- ✓ The river flows at a low speed.
- ✓ The river has a very low river gradient.
- ✓ Deposition is dominant.
- ✓ Seasonal floods are common.
- ✓ River valley is shallow, broad and flat.
- ✓ The river has large volume of water and large load.
- ✓ The river has pronounced meanders.
- ✓ The river meanders in the flood plain.

**Resultant features** –kcse 2008

- ✓ Distributaries/ deltas.
- ✓ Natural levees.
- ✓ River terraces.
- ✓ Flood plain.
- ✓ Braided channel.
- ✓ Meanders.
- ✓ Ox bow lakes.
- ✓ Bluffs/ meander scar.

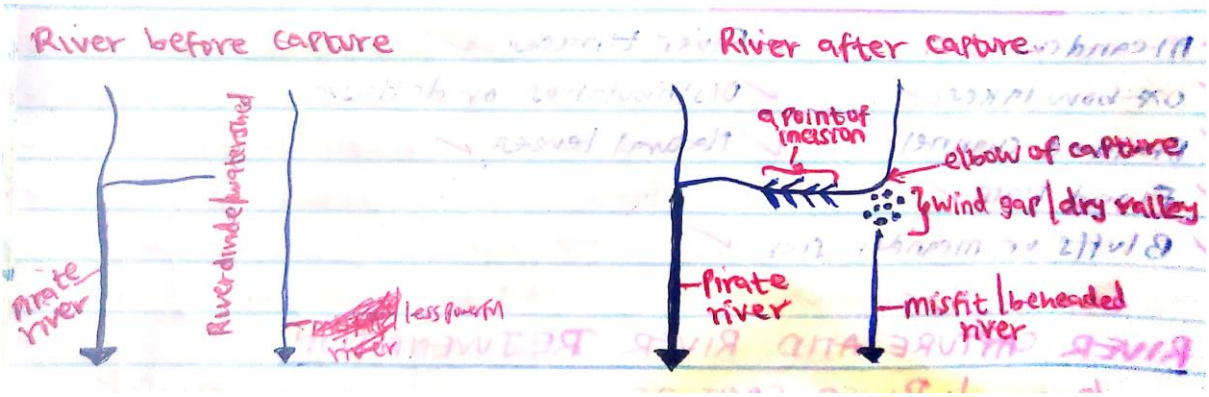
## RIVER CAPTURE AND RIVER REJUVENATION

**River Capture/ River piracy** –kcse 2017

- This is the diversion of the headward waters of one river into the system of an adjacent more powerful river.
- The captured river is called **a victim/ a misfit/ under-fit/ beheaded river** while the one capturing is called **a pirate river/ consequent river.**

**How a river capture occurs** –kcse 2020

- River capture may occur where there are two adjacent rivers/ share a watershed.
- One of the rivers has more erosive power than the other.
- The more powerful river erodes vertically faster than the weaker one thus it flows at a lower level than the other one.
- The more powerful river erodes its valley towards the valley of the other river through headward erosion.
- Eventually the powerful river joins the valley of the weaker river.
- The powerful river diverts the head waters of the weaker river into its channel.
- The diversion of the head water is called **River capture.**




## Conditions necessary for river capture.

- The pirate and Misfit river must flow in adjacent valleys.
- The pirate river should have a wider valley than the misfit river.
- The pirate river must have more active headward erosion than Misfit River.
- The pirate river must be flowing at a lower level than the misfit river.
- The pirate river must be flowing on soft rocks to be eroded more easily.

## Examples of river capture in Africa.

- ✓ R. Miriu captured to form R. Sondu.
- ✓ R. Galana (Athi) captured by River Tiva into River Tana.
- ✓ R. Mwine captured R Mizmui – Tanzania.
- ✓ R. Tano captured by Black Volta River – Ghana.
- ✓ R. Gongola captured by R. Benice – Chad.
- ✓ R. Eyong captured by R. Imo – Nigeria.

## Features associated with river capture –kcse 2020

- ✓ **Elbow of capture-** The point where the waters of a misfit river are diverted into the pirate stream.
- ✓ **Wind gap-** The dry valley remaining at the beheaded point of a former misfit.
- ✓ **Misfit river-** The beheaded stream containing less water causing it to appear too small.
- ✓ **Point of incision-** A point where there is increased vertical erosion.
- ✓ **Pirate stream-** A river capturing a misfit river waters.

## River Rejuvenation –kcse 2018

- It is the renewal of the erosive power of a river.

## Causes of river rejuvenation –kcse 2018

i) **A fall in sea level** increases the velocity of the river thereby increasing the erosive power of the river.

ii) **Regional uplift of land** which increases the gradient along the river to renew its erosive activity.

iii) **Unequal regional subsidence of the land** along the river course increases the erosive power of the river.

iv) **Vertical erosion by the river** may expose resistant rock which creates a knick point thus renewing the river's erosive power.

v) **Increase in a river discharge** due to increased precipitation or river capture causes a river to renew its erosive power.

vi) **Presence of a lake along the river course** leads to deposition of alluvium in the lake and as the river flows out, its erosive power increases.

## Types of river rejuvenation.

I. **Dynamic rejuvenation-** Renewal of the river's erosive activity due to change in the river's base level.

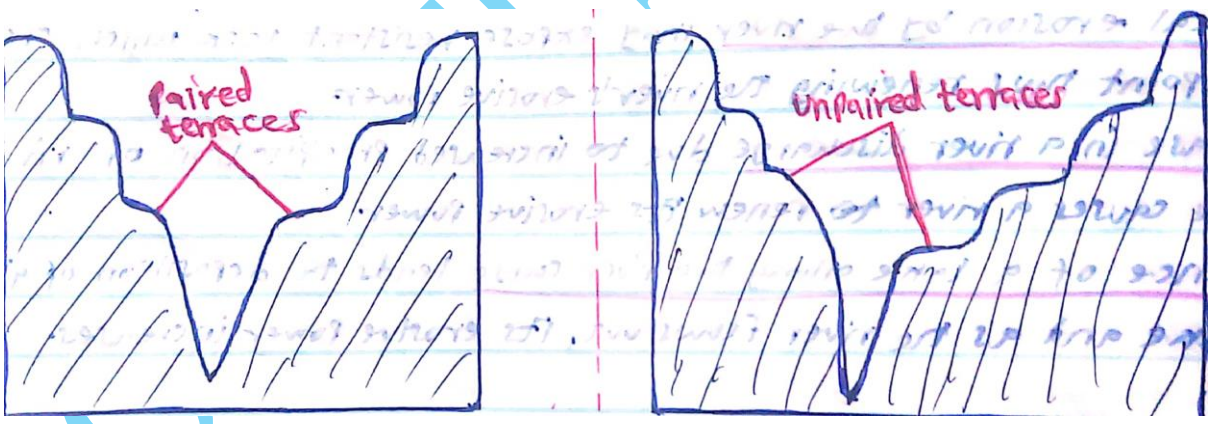
II. **Static rejuvenation-** Renewal of the river's erosive activity due to increased river discharge.

## Features resulting from river rejuvenation –kcse 20018

- ✓ River terraces.
- ✓ Incised meanders.
- ✓ Rejuvenation gorges.
- ✓ Knick points/ waterfall.
- ✓ Valley within a valley.
- ✓ Abandoned/ cut-off meanders.

### (a) River Terraces.

- They are step-like benches develop on the river banks as it increases its erosive power vertically into a flood plain.
- Each time vertical erosion takes place, a new step is formed on the new bed rock that forms the river banks.
- This is usually covered with alluvial deposits.
- River terraces can be either paired or unpaired.
- **Paired terraces** have valley levels on the opposite side with equal elevation.
- **Unpaired terraces** have benches on the opposite sides do not match.




### (b) Incised meanders.

- They are deep river bends formed when a rejuvenated river vertically erodes into its original meander deepening it.
- The river vertically erodes creating a new valley which has the same shape as that of the old meandering valley forming **incised meander.**

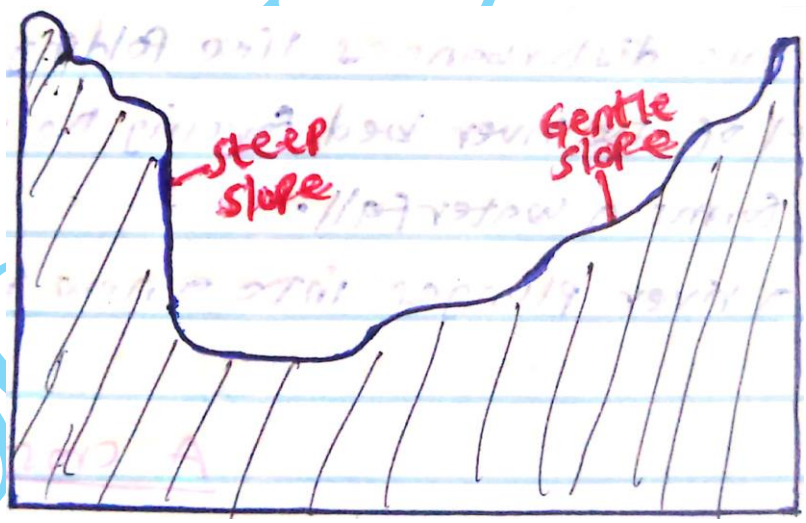
## Types of incised meanders.

### i) Intrenched incised meanders.

- Caused by vertical erosion which makes the cross profile of a river to be symmetrical i.e. steep slopes on both sides on soft rocks.

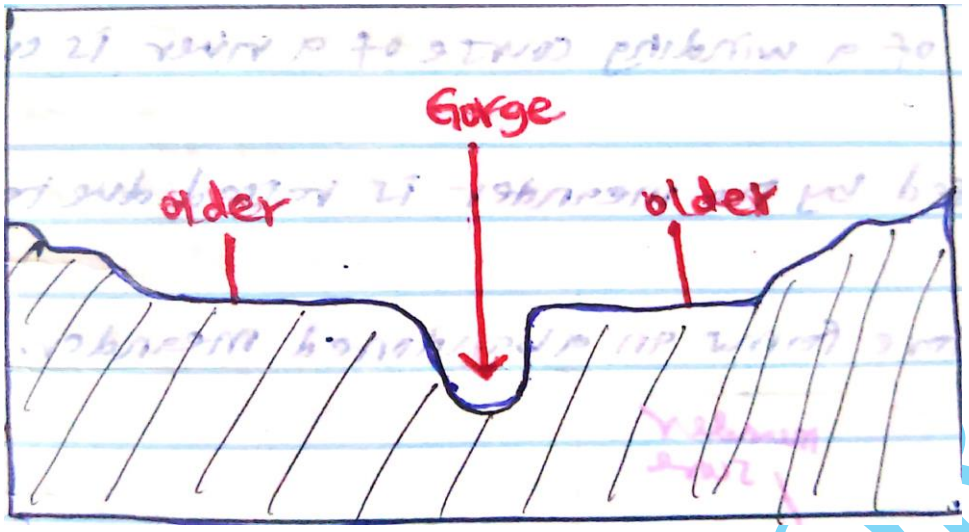

### ii) Ingrown incised meanders.

- Caused by a change in the river base level making the cross profile of a river to be asymmetrical on resistant rocks.




## (c) Rejuvenation gorges.

- **A gorge** is a small incised (down cut) deep and steep valley within a major river valley.
- They develop as a result of intense vertical erosion by the river which makes its valley deeper bounded by steep walls.
- **Example:** Turkwel Gorge on Kerio River in Kenya.

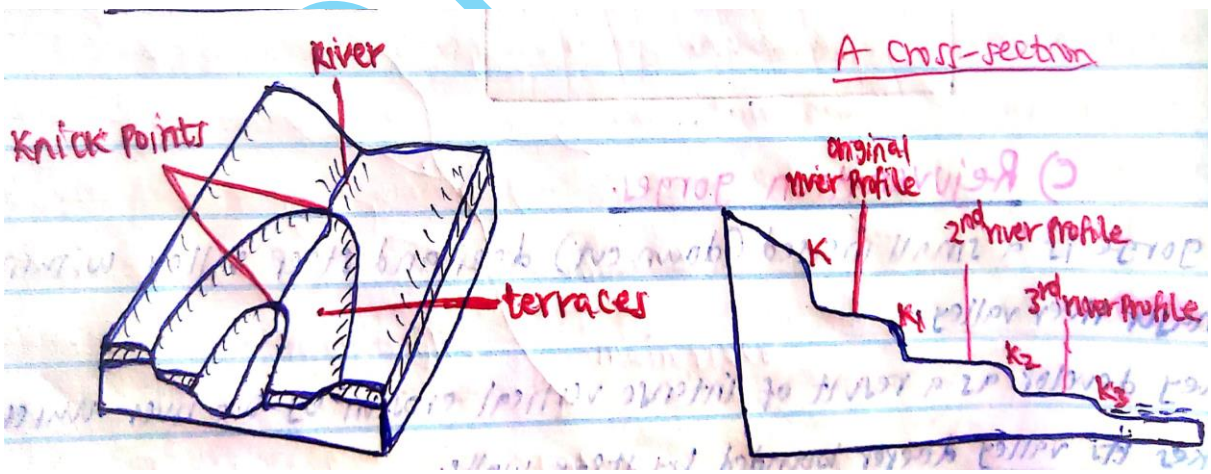



**Causes of Rejuvenantion gorges.**

- ✓ Antecedence where the river maintains its course while the surrounding area is being uplifted.
- ✓ Climatic change where heavy and reliable rainfall increases the river volume which cut down rapidly forming a gorge.
- ✓ An abrupt fall in the river base level causes rejuvenation gorge.

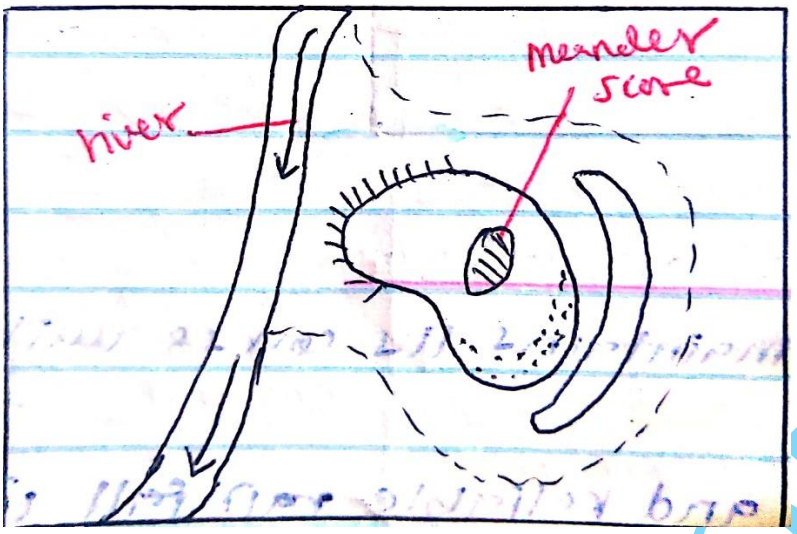
## (d) Knick points.

- They are sharp breaks of the bed on which the river is flowing.
- They occur anywhere along the river course either due to change in rock resistance or due to tectonic disturbances like folding.
- This results in unequal level of the river bed forcing the river to experience a sharp break that forms a waterfall.
- The sharp point at which a river plunges into a new river bed is called **a knick point.**




## *(e)* Abandoned meanders.

- They develop where part of a winding course of a river is cut off as the river flows downstream.
- The land initially enclosed by the meander is raised due to deposition of sediments.
- The meander cut off therefore forms **an abandoned meander.**




*(f)* **Valley within a valley.**

- Rapid rejuvenation due to a fall in a river's base level may produce a steep-sided valley within a former river valley.

**Negative effects of river rejuvenation.**

- ✓ It causes river flooding leading to loss of human life/ displacement of people/ destruction of crops/ property.
- ✓ Wide/ deep rivers are a barrier to transport/ makes it difficult and expensive to construct bridges.
- ✓ River water provide breeding sites for mosquitoes and snails spreading malaria and bilharzia to people.
- ✓ Some rivers are habitat for dangerous animals which may attack people/ destroy crops.

## DRAINAGE PATTERNS.

- Refers to the layout of a river and its tributaries on a landscape.

**Factors influencing the development of a drainage pattern** –kcse 2012

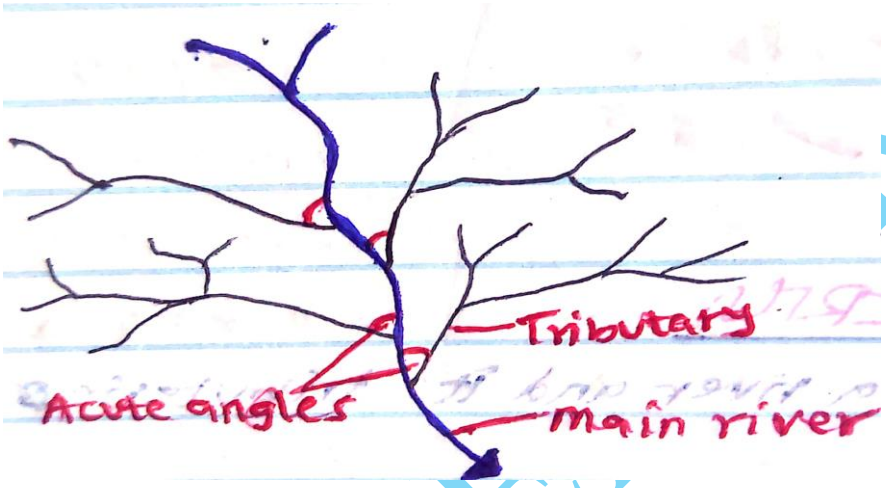
- ✓ **Difference in rock resistance/ hardness** determines how deep and wide a river channel will become.
- ✓ **Direction of the slope of the land** guides the direction of a river flow.
- ✓ **The arrangement of rock layers/ the rock structure** along a river's profile guides the direction of a river flow.
- ✓ **Faulting/ fault guided** guides the direction of a river flow.

**Major drainage patterns**

a. Dendritic drainage pattern.
b. Radial drainage pattern.
c. Centripetal drainage pattern.
d. Parallel drainage pattern.
e. Fault guided drainage pattern.
f. Trellis drainage pattern.

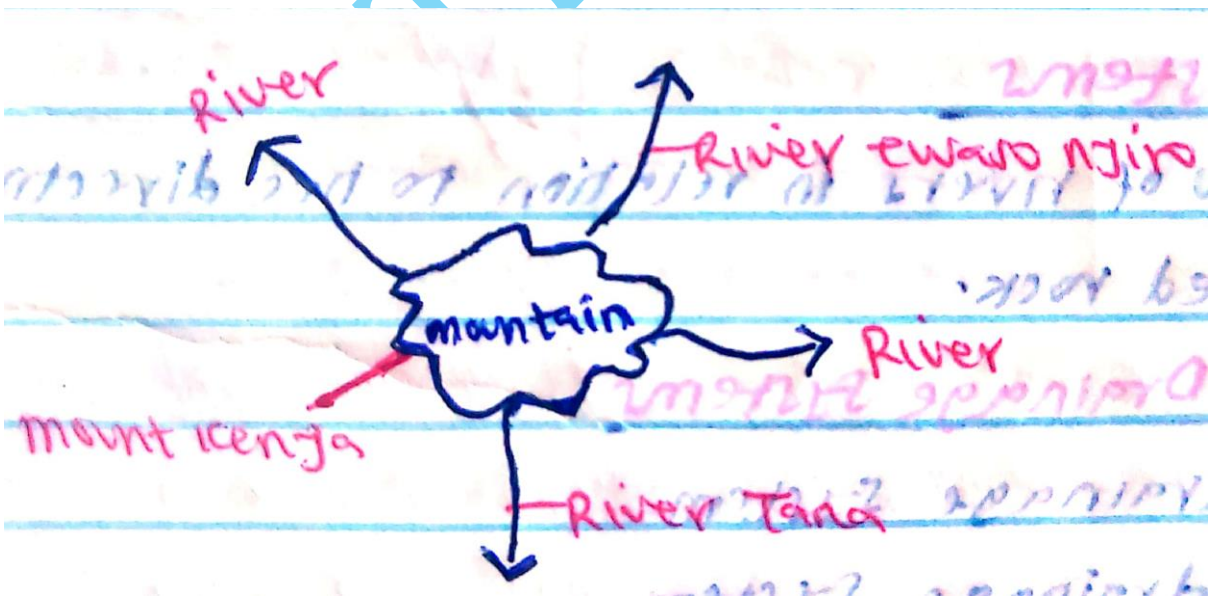
## G. ***Dendritic drainage pattern*** –kcse 2008

- It develops in areas where rocks have uniform structures.
- The direction of flow is influenced by the slope of the land.
- The tributaries join the main river at acute angles.
- The tributaries converge on the main river forming a shape like that of a tree and its branches called **dendritic drainage pattern.**
- **Common on upper courses of rivers** Sondu, Nzoia, Yala, Ewaso Nyiro, Athi and Tana.




## H. ***Radial drainage pattern.***

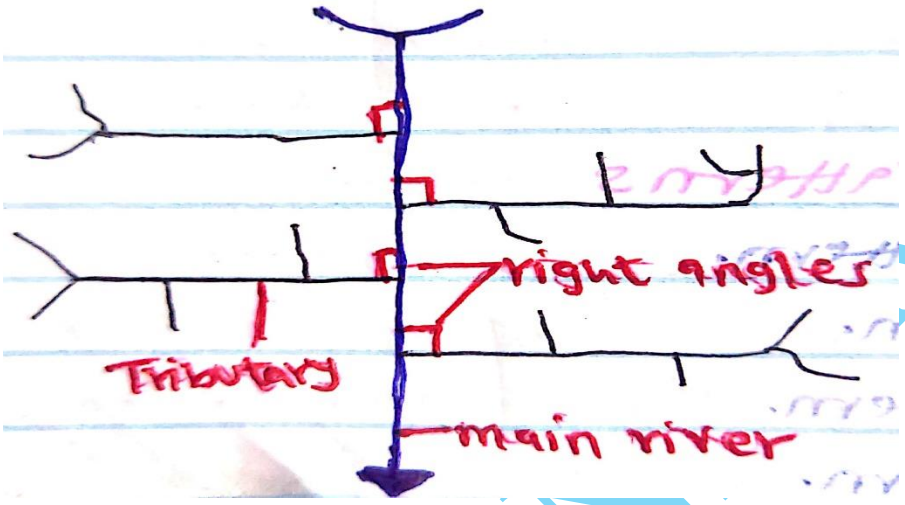
- It develops around a volcanic dome.
- It is controlled by the slope of the mountain.
- Rivers flow outward from a central point like a mountain downstream.
- This resembles the spokes of a bicycle wheel forming **Radial drainage pattern.**




## I. ***Trellis/Rectilinear drainage pattern***–kcse 2008

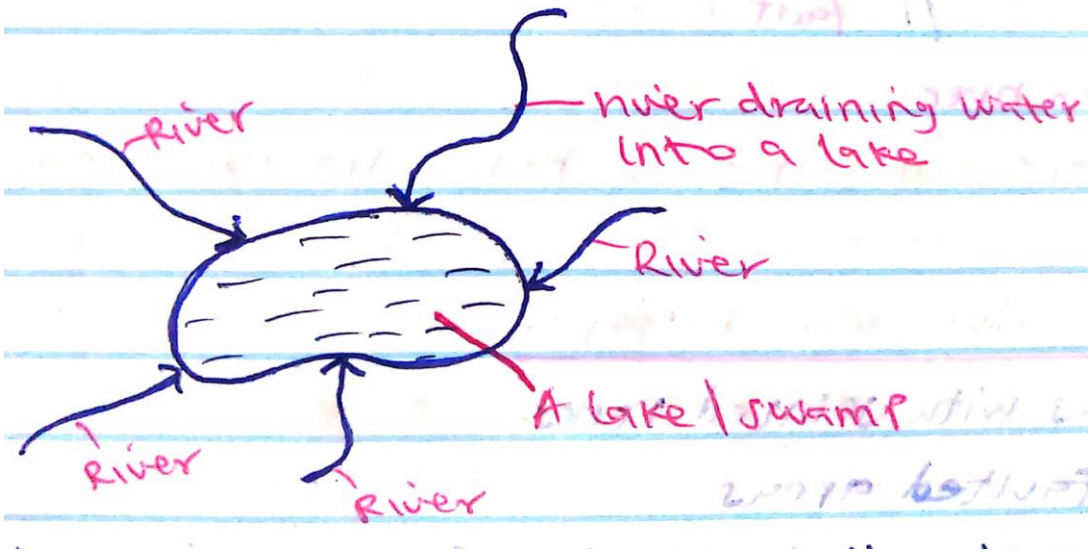
- It develops where soft and hard rocks alternate vertically.
- Tributaries joins the main river at right angles.

- The consequent streams are parallel to the main river.
- Some obsequent streams flow to the opposite direction of the main river.
- The main river and its tributaries form a rectilinear pattern called **Trellis drainage pattern.**
- **Common on rivers** Kerio, Galana and Tana.



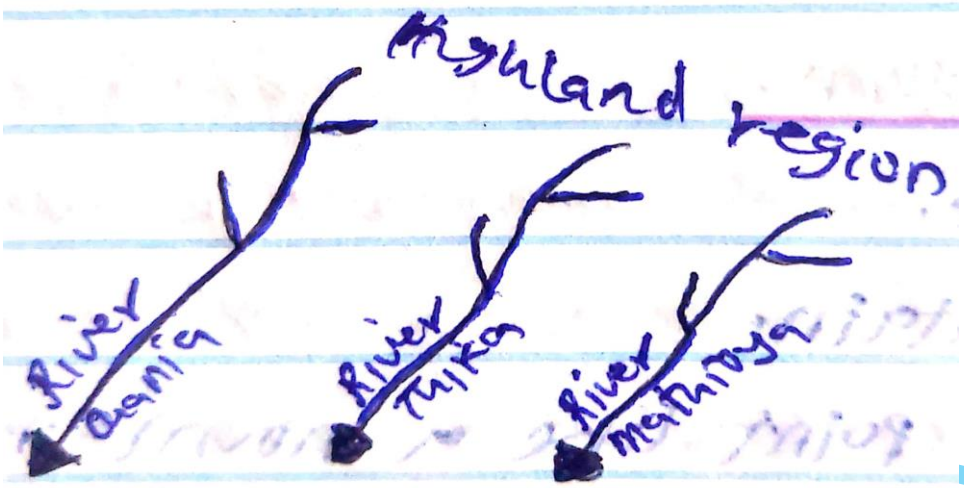

J. ***Centripetal* drainage pattern** –kcse 2004

- It develops where rocks are either homogenous or heterogenous.
- The river is guided by the slope which dips towards the depression.
- Many rivers flowing from different directions discharge their water into an inland basin like a lake/ swamp/ sea forming **centripetal drainage pattern.**



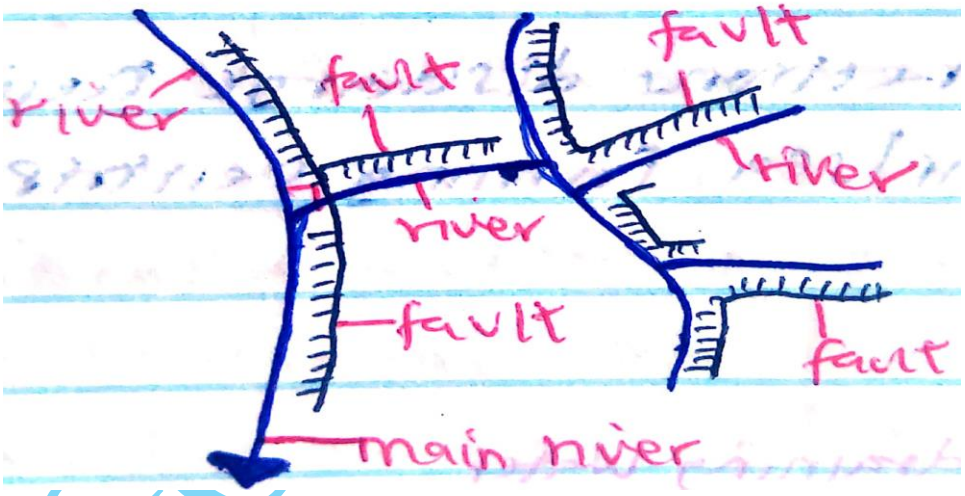

K. ***Parallel drainage pattern.***

- It develops on areas with jointed rocks.
- It also develops in faulted areas.
- Rivers flow along the parallel joints/ faults.
- Rivers run parallel to each other forming **parallel drainage pattern.**
- **Examples are rivers** Tana, Athi, Chania, Thika and Mathioya.




**L. *Fault guided* drainage pattern.**

- Faulting create fault lines on the landscape.
- The fault guides the direction of flow of the river and tributaries.
- Tributaries joins the main river at right angles forming **fault-guided drainage pattern.**




**Drainage System.**

- This refers to the flow of rivers in relation to the direction of the slope and the nature of the bed rock.

**Types of drainage systems**

(a) Accordant
(b) Discordant
(c) Back tilted

} make short notes

## Significance of Rivers and the resultant features.

### 1. Positive effects.

i) Rivers **supply water for domestic and industrial use**.
ii) Some rivers **provide water for irrigation** e.g. Rivers Thiba and Nyamindi to Mwea-Tebere irrigation scheme.
iii) Some rivers **provide port facilities** e.g. Kilindini harbour on river mwachi (Mombasa)
iv) Navigable rivers **provide route-ways for transportation** e.g. river congo, River Rhine.
v) Some rivers **provide sites for generation of H.E.P** e.g. seven forks dams on River Tana and owen falls on river Nile.
vi) Some rivers are **sources of building materials** like sand.
vii) Some rivers are **sources of alluvial minerals** like gold and diamond which are mined and sold earning income.
viii) Some rivers **deposit alluvial soils** along their flood plains hence supporting agriculture.
ix) Some rivers **form natural boundaries** between countries e.g. River Ruvuma between Tanzania and Mozambique.
x) Some rivers **provide rich fishing grounds** which provide fish as a source of protein for people e.g. rivers Tana and Nile.
xi) Some rivers **provide spectacular features** like waterfalls/ rapids **attracting tourists** earning a country foreign exchange e.g. fourteen falls on River Athi.
xii) Rivers **add to the aesthetic value** of the landscape.

### 2. Negative effects of rivers to the human environment- Kcse 2020

(a) Some rivers with almost stagnant water harbour waterborne diseases.
(b) Some rivers flood during rainy seasons causing destruction of property and life.
(c) Some rivers are home to dangerous animals which may attack human beings/ destroy crops.
(d) Rivers which are unnavigable hinder transportation.
(e) River flooding causes displacement of people.



……END……..

# LAKES

## Definition of lakes-kcse 2011/2016

- **A lake** is an extensive body of water in a basin/depression/hollow on the earth's surface.

### Sources of water found in a lake-kcse 2023

- ✓ Rain water.
- ✓ Rivers.
- ✓ Underground water/ magmatic spring.
- ✓ Melting ice.

### Factors determining the size of a lake.

a) Size of depression in which a lake is formed.
b) Amount of water inflow from rainfall, rivers and underground water.
c) Different ways in which water is lost such as evaporation, river outlets, uses by people and amount percolated.
d) Rate of sedimentation in a depression/hollow with water.

### Reasons why some lakes have fresh water-kcse 2017

a) They are fed by rivers/have inflow which dilutes the salts.
b) The bedrock contain minimal saline rocks.
c) They have surface outlets which carries away salts.
d) They have underground outlets which drains accumulated salts.
e) They are situated in areas of high rainfall.
f) They are situated in areas that experience low temperatures therefore minimal evaporation.

### Examples of fresh water lakes

- ✓ Lake Victoria
- ✓ Lake Naivasha
- ✓ lake Baringo

### Reasons why some lakes are saline- kcse 2011/2016/2021

a) They have inadequate fresh water rivers emptying into them.
b) They are fed by rivers/run offs which flows over rocks with higher salt content.
c) They lack outlets.
d) They experience high evaporation rate increasing their salt content.
e) They have underlying salt bearing rock which dissolve into them.
f) They are fed with underground water which contains high concentration of salt.

### Examples of saline water lakes –kcse 2021

- ✓ Lake Magadi
- ✓ Lake Nakuru
- ✓ Lake Turkana
- ✓ Lake Bogoria

- ✓ Lake Elementaita

Ways through which lakes are formed.

- ✓ By erosion
- ✓ By earth movements
- ✓ By vulcanicity/volcanic activity
- ✓ By human activity
- ✓ Mass movements e.g. landslide
- ✓ By weathering e.g. solution
- ✓ By falling of a meteorite e.g. lake Bosumwi

**Processes that lead to formation of lakes**-kcse 2007

- ✓ Crustal warping
- ✓ Vulcanicity
- ✓ Mass wasting
- ✓ Erosion
- ✓ Deposition
- ✓ Human activity

**Formation and classification of lakes.**

a) **Lakes formed as a result of tectonic movements:**
   - ➢ Faulted/Rift valley lakes
   - ➢ Crustal warping (down warped and tilted lakes)

b) **Lakes formed as a result of volcanic activity:**
   - ➢ Crater lakes
   - ➢ Caldera lakes
   - ➢ Lava dammed lakes

c) **Lakes formed by glaciation:**-kcse 2021
   - ➢ Cirque lakes or tarns
   - ➢ Ribbon/finger lake/Rock basin lake
   - ➢ Moraine dammed lake
   - ➢ Kettle lake

d) **Lakes formed by river and wave deposition:**
   - ➢ Ox-bow lakes
   - ➢ Marine or coastal lakes

e) **Lakes formed by wind erosion**

f) **Lakes formed by solution**

g) **Huma-made lakes:**
   - ➢ Dam lakes
   - ➢ Barrages/reservoirs

h) **Lakes dammed by landslides and other waste debris**

i) **Meteorites lakes**

## 1. Lakes formed Tectonic Movements

### a) Faulted or Rift Valley Lakes

- Faulting process leads to fracturing of rocks along lines of weakness/cracks/faults.
- Some parts of the land sink and tilt along the faults.
- This forms deep, narrow, long and steep sided depressions on the earth surface.
- Water from rivers and streams in the surrounding areas may fill these depressions forming **faulted/Rift valley lakes.**

Characteristics of faulted/Rift valley lakes-kcse 2023

- ✓ Most are narrow
- ✓ They are steep-sided
- ✓ Most are deep/ some are shallow
- ✓ Most of them are salty/ some are fresh
- ✓ Most of them are long
- ✓ Most lack outlets

Examples of fresh water lakes in the Rift valley.

- ✓ Lake Baringo
- ✓ Lake Naivasha
- ✓ Lak George
- ✓ Lake Edward
- ✓ Lake Albert
- ✓ Lake Kivu
- ✓ Lake Tanganyika
- ✓ Lake Rukwa
- ✓ Lake Malawi

Examples of salty water lakes in the Rift valley-kcse 2007/2021

- ✓ Lake Magadi
- ✓ Lake Bogoria
- ✓ Lake Nakuru
- ✓ Lake Elementaita
- ✓ Lake Turkana

### b) Lakes formed by crustal warping (Down warping and Tilting) e.g. Lake Victoria- kcse 2007

- Earth movements led to crustal down warping in the region.
- A shallow/basin-like depression was created.
- The areas around the depression underwent uplifting.
- The uplifting reversed the direction of rivers like Kagera, Katonga and Kafu.
- The uplifting also led to cut off rivers like Yala, Nzoia, Mara and Kuja.
- The water from the rivers and rain eventually filled the depression forming **Lake Victoria.**

Examples of lakes formed by downwarping.

- ✓ Lake Victoria
- ✓ Lake Kyoga
- ✓ Lake Koki
- ✓ Lake Wamala

- ✓ Lake Jipe
- ✓ Lake Chad
- ✓ Lake Bangwelu
- ✓ Lake Mweru
- ✓ Lake Amboseli
- ✓ Lake Ol Bolossat
- ✓ Lake Nachu
- ✓ Lake Ngami

**How Lake Victoria influences the climate of the surrounding areas**- kcse 2017/ 2023

- ✓ The lake breezes have a cooling effect on the surrounding land especially in the afternoons.
- ✓ Moisture from evaporation leads to convectional rainfall mainly in the afternoon/ increase amount of rainfall received in these areas.
- ✓ The high rates of evaporation leads to a high relative humidity in the area.
- ✓ Evaporation from the lakes lead to increased cloud cover.
- ✓ Lake and land breezes help to moderate the temperature of the surrounding areas.
- ✓ The lake breezes may strengthen/ divert/ reverse the prevailing winds.
- ✓ The lake influences the occurrence of local winds (land and lake breezes).
- ✓ The lake breezes leads to moderated temperatures hence a low diurnal range of temperature all year round.
- ✓ During cold season, lake breezes may bring warming effect on the land.

Characteristics of lakes formed by down warping.

- ✓ Their basins are very wide.
- ✓ They are shallow.
- ✓ They lie in depressions between raised land masses.
- ✓ Some are tilted.
- ✓ Rivers flow inland from surrounding highland areas.
- ✓ Some have numerous islands which are submerged hills and ridges.
- ✓ Some have several rias which are submerged river mouth.

**2. Lakes formed by Vulcanicity.**

**a) Formation of crater Lakes**

- Magma under intense pressure in the interior of the earth may be forced into cracks or vents violently emptying onto the earth surface.
- This leads to formation of a volcanic mountain.
- Magma in the vent cools and solidify thus contracting.
- This leads to the withdrawal of the magma in the vent thus creating a depression at the top called a crater.
- The depression may be occupied by rain water or melt water forming **a crater lake**.

Examples of crater lakes

i. **In Kenya**-kcse 2011/2016**:** Lakes Simbi, Paradise, Bangale, Mude, Chala, Sonanchi, Nkunga
ii. **In Uganda:** Lakes Katwe, Bunyampaka, Nyamanuka, Nkugutu
iii. **In Ethiopia:** Lake Shala
iv. **In Tanzania:** Lakes Dulutti, Ngozi
v. **In Cameroon:** Lakes Wum, Nyos (Nios) and Oku.

**NOTE:** Crater lakes formed as a result of explosion are called **Maars** e.g. Lake mossoko in T.Z and Lake Nyungu in U.G.

**b) Formation of lava Dammed Lakes**

- During a volcanic eruption, lava may be ejected onto the earth's surface and flow into a river valley.
- Lava cools and solidify forming a lava dam.
- This blocks the passage of water causing the river's water to accumulate alongside the lava barrier forming a narrow, winding lake called **lava dammed lake.**

**Examples of lava dammed lakes.**

- ✓ Lakes Bunyonyi, Mutanda, Kayumba, Kijanebolola in Uganda.
- ✓ Lakes Ruhondo and Bulera at the Rwanda/Uganda border.
- ✓ Lake Kivu in D.R.C
- ✓ Lake Tana in Ethiopia
- ✓ Lake Itasy in Madagascar

**c) Formation of caldera lakes**

- Magma under intense pressure in the interior of the earth flows through cracks/vents towards the earth surface.
- Lava accumulates around the vent on the earth surface forming a volcano with a crater at the top.
- Subsequent volcanic eruptions/subsidence of the volcanic summit cause a large basin/depression called **a caldera.**
- Water from rainfall/melt water occupies the depression leading to the formation of **a caldera lake.**

**Examples of caldera lakes**

- ✓ Lake Magadi in Ngorongoro in T.Z.
- ✓ Lake Shala in Ethiopia.
- ✓ Lake Nyos and Lake Oku in Cameroon.
- ✓ Lake Asosa in Japan.

**3. Lakes resulting from Glaciation.**

- **Glacier** is a moving ice on the earth's surface.
- **Glaciation** leads to the formation of the following lakes;

**a) Formation of Corrie/Tarn Lakes/Cirque lakes**-kcse 2011/2016/2021

- Snow accumulates in a pre-existing depression on the mountain side.
- Snow gets compacted into ice forming a cirque glacier.
- The hollow is enlarged by frost and thaw action.
- It is deepened by ice abrasion.
- The back wall of the hollow is steepened by plucking process.
- Eventually a deep arm-chair depression know as a cirque is formed.
- The cirque is filled with melt water to form **a cirque lake.**

**Examples**

- ✓ Tarns on Mt. Kenya are Teleki tarn, Hidden tarn, Nanyuki tarn
- ✓ Tarns on Mt. Ruwenzoris

### b) Formation of moraine dammed lakes-kcse 2023

- A mass of ice approaches a wide low lying area.
- Ice starts to melt at the edge.
- This leads to deposition of terminal moraine across the valley resulting to a transverse ridge (barrier).
- More deposition of the terminal moraine raises the transverse ridge.
- As the ice melts, the melt waters accumulates behind the ridge.
- The glacier continues to retreat towards the snow field as it is melting.
- The water that accumulates behind the ridge of terminal moraine forms **a moraine dammed lake.**

**Examples**

✓ Lakes Ellice, Tindall and Alice on Mt. Kenya
✓ The Great lakes i.e. Superior, Huron, Michigan, Ontario and Erie.

### c) Formation of Ribbon lakes.

- Moving ice/glacier erodes parts of the landscape.
- Earth materials like rocks are gauged out.
- Long and narrow depressions are formed.
- Depressions are later filled with melt water and rain water forming **a ribbon lake.**

**Examples**

✓ Lake sacred on northern slope of Mt. Kenya in Meru County.

### d) Formation of Kettle lakes.

- Glaciation occurs in an area.
- Large mass of ice erodes the glaciated landscape forming circular hollows.
- Large detached mass of ice melt.
- Melt water accumulates in the circular hollows forming **kettle lakes.**

**Examples**

✓ Lake Muhoma on the Ruwenzoris

## 4. Lakes formed by river and wave deposition.

### a) Formation of ox-bow lakes- kcse 2017

- A meandering river erodes the outer bank of a meander and deposits materials on the inner bank.
- Erosion continues until a narrow piece of land is left separating the two bends.
- This is eventually eroded by floods forcing the river to flow in a straight channel.
- A loop of the meander is abandoned to form **an oxbow lake.**

**Examples of oxbow lakes**

- ❖ Lake Shakababo
- ❖ Lake Gambi
- ❖ Lake Bilisa
- ❖ Lake Mukunguya
- ❖ Lake Kamnarok
- ❖ Lake Kanyaboli

**Characteristics of oxbow lakes.**

- ✓ Most of them are shallow.
- ✓ They are vary greatly in size.
- ✓ They are many in number.
- ✓ Most of them are temporary.
- ✓ Forms at the mature stage/lower course of a river.

**b) Formation of lagoon lake**- kcse 2011/2016/2023

- Sand/shingle are moved by the longshore drift and deposited at the entrance of the bay.
- The deposits gradually accumulate forming a spit/sandbar/ridge.
- The continued deposition elongates the spit, eventually linking the two headlands forming a bay bar.
- The bay bar separates part of the sea water from the open sea.
- The enclosed sea water is the **lagoon.**

**Examples**

- ✓ Lake Sare at the shores of Ugowa Bay in Bondo near Usenge Beach.
- ✓ Lake Nabugabo near Bukakata in Uganda.

**5. Formation of lakes by wind erosion-OASIS**- kcse 2011/2016/2021

- A pre-existing depression is exposed to wind erosion.
- Wind eddies remove unconsolidated materials through deflation.
- Wind abrasion deepens and widens/enlarges the depression.
- Further abrasion and deflation lead to the depression reaching the water table.
- Water oozes out of the ground and collects into the depression to form a lake known as **an oasis.**

**6. Human-made lakes**

- Formed as a result of construction of a dam across a river.
- Behind such dams, water accumulates to form a large human-made reservoir called **human-made lakes.**

**Examples**

- ✓ Lakes behind the seven forks dams in Kenya e.g. Masinga, Gitaru, Kindaruma, Kamburu, Kiambere
- ✓ Lake Nasser on Nile River in Egypt.
- ✓ Lake Kariba on River Zambezi in Zambia/Zimbabwe.
- ✓ Lake Kainji on River in Nigeria
- ✓ Lake Caborra Bassa on River Zambezi in Mozambique.
- ✓ Lake Volta on River Volta in Ghana.

**7. Lakes formed by solution.**

- Formed in limestone or chalk regions.
- Rainwater absorbs carbon (iv) oxide in the atmosphere forming weak carbonic acid.
- On reaching the earth's surface, the rain water percolates through the joints and faults reacting with limestone rock to form calcium carbonate which is soluble.
- This is carried away in solution.
- Continued solution process enlarges the joints/cracks to form sink holes/dolines/uvalas/polje.

- These depressions may be filled with rain water to form **solution lakes.**

**Examples**

- ✓ Lake Ojikoto in Namibia
- ✓ Shotts/Chotts in Morocco
- ✓ Etosha pan in Namibia
- ✓ Makgadikgadi pan in Botswana

### 8. Lakes formed by mass wasting.

- A massive landslide rolls down the hill side into the valley below.
- When it reaches the valley bottom, debris accumulates and blocks the valley.
- If there was a river flowing, it is blocked by a barrier of debris.
- River water accumulates and spread further up the valley.
- If the valley was dry, it may fill with rain water forming **a lake** e.g. lake Funduzi in S. Africa.

### 9. Lakes formed by a faling meteorite.

- Meteorite from space falls on the earth's crust.
- A deep depression (crater) if formed.
- Rainwater fills the depression forming a meteorite crater lake.

**Examples**

- ✓ Lake Bosumtwi near Kumasi in Ghana
- ✓ Lake Lonar
- ✓ Lake Yanisyarvi

## Significance of Lakes

**Positive effects**-kcse 2021

1. Some lakes contain fish which promote fishing/some people earn income through selling fish.
2. Some lakes are sources of valuable minerals which are sold to earn income.
3. Lakes modify climate of the surrounding areas thus encouraging agriculture and settlement.
4. Some lakes are good reservoirs for the production of hydro-electric power which is used in industries and homes.
5. Some lakes provide good scenery which attracts tourists thus earning foreign exchange.
6. Fresh water lakes/man-made lakes provide water for industries/domestic use.
7. Fresh water lakes are used for irrigation which increases agricultural production.
8. Some lakes are sources of rivers which provide water for irrigation/domestic/industrial use.
9. Some lakes provide water transport for people and goods.
10. Some lakes are sources of building materials like sand.

**Negative effects**

1. Some lakes are habitats for disease vectors e.g. mosquitoes and snails which transmit Malaria and bilharzia.
2. Some lakes may cause flooding due to excessive rainfall or when dams break leading to loss of life and property.
3. Some lakes are habitats for dangerous animals like crocodiles, hippos and snakes which kill humans.

4. Some lakes cause drowning accidents to people in time of storms.
5. Some lakes are barriers to road and railway transport.

## TOPICAL QUESTIONS

**1.** Explain how the following factors affect lakes in Kenya**;**-kcse 2011/2016

**a) Deforestation**

- This exposes soil which is eroded and carried into the lake causing siltation.
- It destroys water catchment areas which reduces water fed into the lakes.

**b) Water weeds**

- Emergence of water weeds hinder transportation on the lakes.
- Water weeds like water hyacinth choke the lakes thus hindering effective exploitation of fish.
- When water weeds rot, they affect the habitat of aquatic life.

**c) Industrialization**

- Establishment of industries has led to disposal of waste or pollution or contamination of lakes.
- Establishment of industries has led to increase in water use which has lowered water levels.

**d) Water needs**

- When water is diverted into farms during irrigation, it lowers water levels in the lakes.
- Overuse of water for industrial process leads to lowering of water levels in the lakes.



**……..THE END……..**

# OCEANS, SEAS AND THEIR COASTS

## Definition of Oceans- kcse 2019/2020

- **An ocean** is a large/extensive body of saline water occupying a basin between continents.

**Examples of oceans**

- ✓ Pacific ocean
- ✓ Atlantic ocean
- ✓ Indian ocean
- ✓ Arctic ocean

- **Oceanography** is the study of a large/extensive body of saline water occupying a basin between continents.

## Definition of Seas- kcse 2020

- **A sea** is a large body of saline water along the continental margins.
- **A sea** is a large inland saline water body without a connection with the ocean.
- **A sea** is a large body of saline water joined to or separated from the ocean by straits (a submerged rock).

## Types of seas

### a) Inland/landlocked seas.

- Have no connection with the oceans.
- Examples;
  - ✓ Caspian sea
  - ✓ Aral sea
  - ✓ Dead sea & sea of Galilee
  - ✓ Salton sea

### b) Seas connected to oceans through straits.

- **Examples;**
  - ✓ Mediterranean sea
  - ✓ Red sea
  - ✓ Black sea
  - ✓ Baltic sea

### c) Marginal seas (part of the ocean)

- **Seas on the margin of Atlantic Ocean are** North Sea, Norwegian Sea, Irish Sea, Labrador Sea and Carribean Sea.
- **Seas on the margin of Indian Ocean are** Arabian Sea and Andaman Sea.
- **Seas on the margin of Pacific Ocean are** The Sea of Okhotsk, The Sea of Japan, The Yellow Sea, The East China Sea, the South China Sea, Timor Sea, Tasman Sea and Coral Sea.
- **Seas on the margin of the Arctic Ocean are** The Beaufort Sea and The East Siberian.

### Similarities between Oceans and Seas.

- ✓ Both contain saline waters.
- ✓ Their waters are in constant motion due to waves.

**Differences between Oceans and Seas.**

- Oceans are affected by tides while marginal seas are the only seas affected by tides.
- Oceans have strong ocean currents while Ocean currents only affect the marginal seas like Caribbean Sea the rest have well developed land and sea breezes.
- Oceans have strong winds which cause hurricanes/tornadoes whereas Seas have strong winds cause whirl winds/waterspouts which are less violent.
- Sunlit eastern coasts of oceans lead to coral formations whereas seas have no coral formation.
- Oceans surround continents or vast lands while seas are surrounded by vast lands/continents other than marginal seas.

## The Nature of Ocean Water

- It has five major aspects namely;
  - ✓ Salt water
  - ✓ The temperature of ocean water
  - ✓ The ocean life
  - ✓ The ocean topography
  - ✓ Ocean pollution

### A. Salt water

- Ocean water contains different salts like calcium chloride, magnesium chloride, sodium compounds and potassium compounds.
- Sources of mineral salts in oceans are;
  - ✓ Rivers draining in oceans bring in dissolved minerals.
  - ✓ Most salts were present during the formation of oceans.
  - ✓ Ocean bedrocks contain salts which dissolve in ocean water.
  - ✓ During eruption, volcanic materials released bring in a lot of salts.
- Factors influencing salinity of ocean water;
  - ✓ Latitude- ocean salinity is higher near the tropics due to high temperature causing evaporation. It decreases towards the equator because of heavy rainfall and less evaporation due to high humidity and more cloud cover.
  - ✓ Depth- The surface water is generally more saline than the bottom water.
  - ✓ The position of the inland water- Seas located in regions of high temperatures, with little rainfall and few rivers emptying into them tend to have high salinity and vice versa.
- **Causes of variation in the amount of salt in ocean water;-** kcse 2019
  - ✓ High temperature in ocean water results to high evaporation which leaves behind higher salt concentration.
  - ✓ Fresh water added to the oceans through rainfall and melt ice reduces concentration of salts in the ocean.
  - ✓ Upwelling of water and ocean currents leads to mixing of ocean water causing variation in concentration of salts.

**NOTE: Isohalines** are lines drawn on a map to show places with the same salinity in the ocean.

## B. The temperature of ocean water

- It is not uniform. It varies from the equator poleward as well as from the surface to the bottom.
- It decreases with increase in depth except in the poles where there is temperature inversion due to the cold water caused by melting polar ice.
- An instrument called **bathythermograph** measures temperature with depth.

### Factors influencing the ocean water temperature.

- ✓ Latitude of the ocean.
- ✓ Ocean current.
- ✓ The depth of the ocean.
- ✓ Salinity of the ocean water.
- ✓ Air masses.
- ✓ Upwelling of water.
- ✓ Enclosed and open seas.

## C. The ocean life

- The ocean water by nature forms a habitat of organisms. These include the plankton, nekton and benthos.
- **Planktons** are fish feeds that occupy the surface of the oceans.
- The ocean planktons are called **phytoplankton** e.g. algae like diatoms.
- The animal planktons are called **zooplankton** e.g. eggs and immature fish, lobsters, jellyfish and crabs.
- **Nekton** include all swimming forms of fish from tiny herrings to huge whales.
- **Benthos** are ocean creatures living only at the bottom of sea water e.g. corals, snails, starfish, slams and sea anemones.

## D. Ocean water pollution

- Pollution introduces substances into ocean water that produce a harmful change.
- Ocean water is polluted through;
  - ✓ Industrial waste disposal.
  - ✓ Solid human wastes disposal.
  - ✓ Oil spillage from tankers/ships.
  - ✓ Silt and sediments brought from the hinterland.
  - ✓ Agricultural pesticides and herbicides from the hinterland.

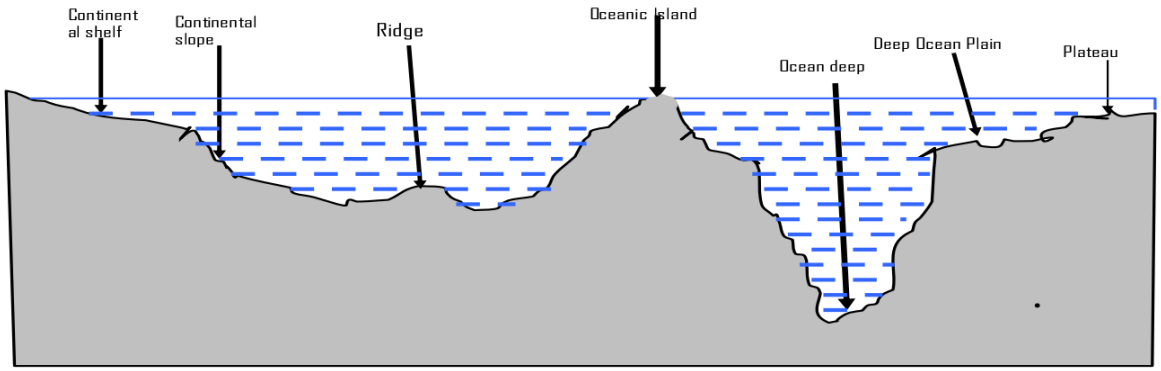
## E. The ocean topography

- Ocean topography is composed of several features like;

a) **Continental shelf-** Relatively flat part of the continent covered by ocean water.
b) **Continental slope-** Steeply dipping surface between continental shelf and the ocean basin proper.
c) **Abbysal plain-** Almost level area of the ocean where sediments are deposited.
d) **Mid ocean ridges-** Range of hills which are submerged formed by volcanic and seismic activities. Those formed through faulting in the seabed are called **sea scarp**.
e) **Sea Islands**- pieces of land surrounded by water.
   i) Continental islands- Ones rising from continental shelf.
   ii) Oceanic islands-Ones rising from the sea floor.
   iii) Coral islands-Ones made of coral.
f) **Deep sea trenches** - narrow steep sided submarine valleys on the ocean floor.
g) **Guyots**- submerged atolls forming an underwater mountain.

h) **Sea mount**- a volcano which doesn't rise above the sea floor.

*Illustration ocean topography.*




## Water movement in oceans.

- Ocean water is in constant motion either on the surface (horizontal movement) or deep in the ocean (vertical movement).
- **The main cause of these movements are;**
  - ✓ The wind
  - ✓ Earthquakes
  - ✓ Submarine volcanic eruption

## Types of water movement in oceans.

### 1. Vertical Movement

- It is the rising of water from the ocean bottom to replace the sinking water from the ocean surface.

**Causes of vertical movement of ocean water**-kcse 2019

- ➢ The difference in density of ocean water.
- ➢ The convergence of different ocean currents.

**How vertical movement of ocean water occur**

- ➢ Cold polar water sinking before moving horizontally towards equator.
- ➢ Ocean currents converge.
- ➢ When ocean water sinks at lower depths after ocean currents converge.
- ➢ When ocean water rises to the surface in a process called upwelling.

**Significance of vertical movement of ocean water**

- ➢ Minerals contents brought to the surface water carry a lot of nutrients for sea animals.
- ➢ The region of upwelling water form major fishing grounds like coast of Namibia.

### 2. Horizontal Movements

- These are movements of water across the oceans.
- They include;
  - ✓ Ocean currents
  - ✓ Tides
  - ✓ Waves

## a) Ocean Currents.

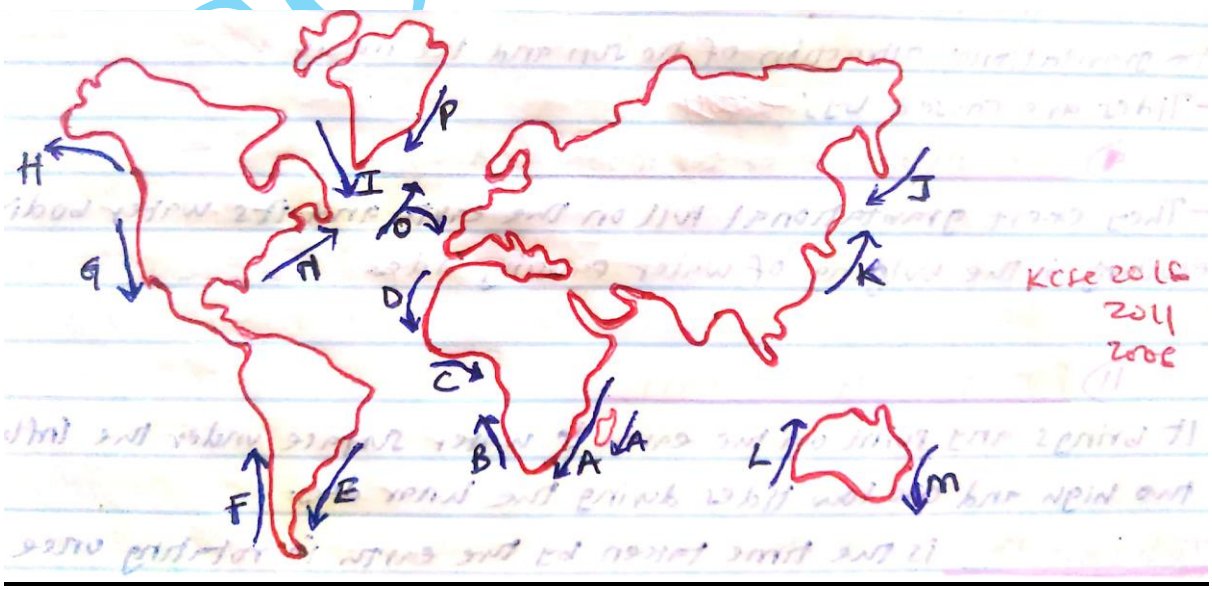
- **An ocean current is a large mass of ocean water flowing in certain direction with uniform temperature** through a slower moving or still water with different temperature.

### Causes of ocean currents-kcse 2011

a) **Winds blowing over the ocean** causing a mass of surface ocean water to move in its direction forming drift currents.
b) **Rotation of the earth** by causing deflection of ocean currents.
c) **Shape of the coastal land mass** by influencing current direction and causing it to flow following the coastal outline.
d) **Differences in ocean water temperature** by causing cold polar water which is dense due to low temp moves towards the equator passing on the ocean floor and warm water of the tropics to move towards the poles passing on the surface.
e) **Difference in ocean water density/salinity.**

### Characteristics of major ocean currents.

a) Generally, the ocean currents flowing from the equator/low latitudes towards the poles are warmer hence called warm ocean currents.
b) Ocean currents flowing from the poles/high latitudes towards the equator are cooler hence called cold ocean currents.
c) Ocean currents flowing in the northern hemisphere generally move clockwise while those in southern hemisphere move anticlockwise.
d) Warm ocean currents tend to be on the eastern coasts of continents while cold ocean currents on the western side.
e) Convergence of ocean currents tend to be on the eastern coasts while divergence on the western coasts.
f) Ocean currents are less developed in the northern part of indian ocean since monsoon winds interferes with the smooth flow.
g) Western coasts experience upwelling of water from depths.
h) Counter-equatorial current separates northern and southern equatorial currents due to trade winds within the equator.



**KEY**

A- Warm Mozambique/Agulhas current
B- Cold Benguela ocean current
C- Warm Guinea ocean current
D- Cold canary ocean current
E- Warm Brazilian ocean current
F- Cold Peruvian ocean current
G- Cold California ocean current
H- Warm Alaskan ocean current
I- Cold Labrador ocean current
J- Cold oya siwo ocean current
K- Warm kuro siwo ocean current
L- Cold west Australian ocean current
M- Warm east Australian ocean current
N- Warm gulf stream
O- Cold north Atlantic drift
P- Cold Greenland ocean current

**Effects of warm ocean currents on the adjacent coastland**- kcse 2006/2016

- ✓ It warms up the adjacent land.
- ✓ It increases humidity of the adjacent land.
- ✓ It may lead to rainfall on the adjacent land.

**Kcse 2011- Name three ocean currents along the western coast of Africa (3mks)**

- ✓ Benguela
- ✓ Guinea
- ✓ Canary

**b) Tides**-kcse 2011

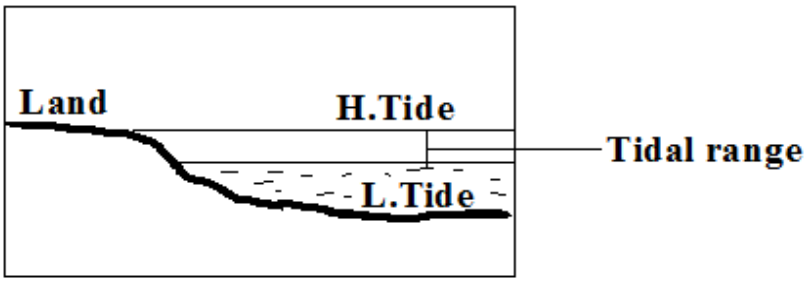
- **Tides** are periodic rise and fall in the level of ocean/sea due to gravitational attraction of the sun and the moon.
- **Tides are caused by;**

i. **The influence of the moon and sun.**

- They exert gravitational pull on the earth and its water bodies resulting in the bulging of water causing tides.

ii. **Rotation of the Earth**

- It brings any point on the earth's water surface under the influence of two high and two low tides during the lunar day.
- **A lunar day** is time taken by the earth to complete one rotation with respect to the moon (24 hrs 52 min)
- **Lunar month** is time taken by the moon to complete one revolution around the earth (27.3 days)
- The moon is always ahead of the earth by 52 minutes due to its revolution e.g. if Nairobi is opposite the moon at 6pm the following day the high tide will be at 6.52pm.
- **Tidal range** is the difference between the highest level reached by high tide and lowest level reached by low tide.




- **High tide** occurs when the level of ocean water moves towards the shore, covering some features like beaches.
- **Low tide** occurs when the level of ocean water moves far from the shore towards the ocean exposing features like wave-cut platforms.
- **Semi-diurnal tide** refers two high and two low tides that attains the same magnitude/ the high tides reach the same height and the low tides reach the same level.
- **Mixed tides** refers to two high and two low tides with a difference in amplitude/ the high tides may be constant while the low tides do not drop to the same level and vice versa.
- **Diurnal tides** refers to only one high and one low tides occurring during a lunar day.

## Types of tides.

- Caused by relative positions of the moon and the sun from the earth.
- Sometimes the moon and the earth are nearer or farther from each other due to their elliptical orbits.
- **Types of tides include;** -kcse 2019
    a) Perigean tides
    b) Apogean tides
    c) Spring tides
    d) Neap tides

### a) Perigean Tides

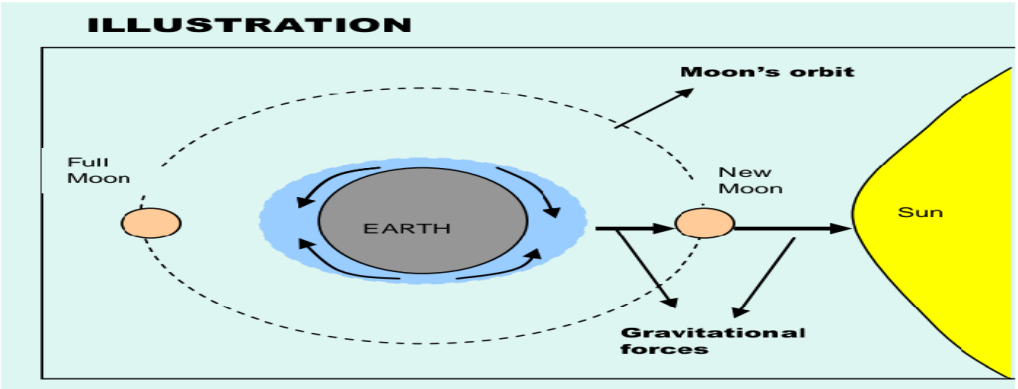
- Occurs when the moon is nearest to the earth **(perigee** position) causing pulling force to be greatest producing high tides higher than normal and so is the tidal range.

### b) Apogean Tides

- Occur when moon is farthest from the earth (**apogee** position) causing pulling force to be weakest producing high tides lower than normal and so is the tidal range.

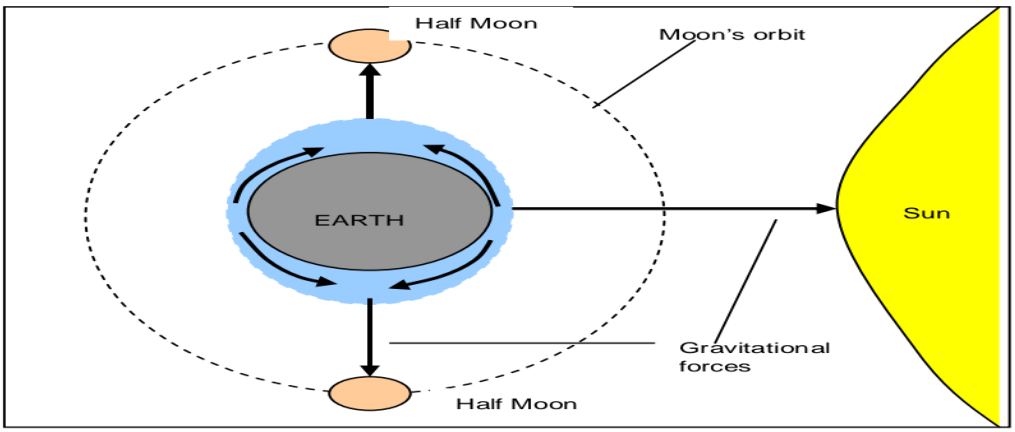
### c) Spring Tides

- Occurs when the sun, moon and the earth are in a straight line (**syzygy** position) and pulling in the same plane causing pulling force to be greatest producing highest high tides and lowest low tides.



### d) Neap Tides

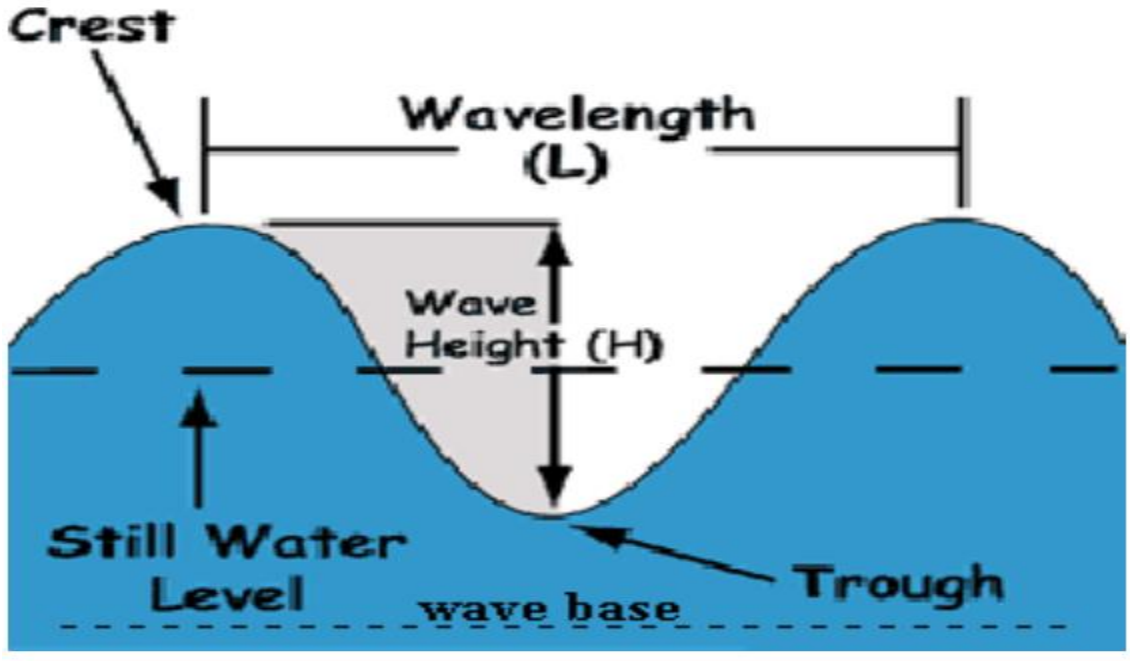
- Occurs when the sun, moon and earth form a right angle(quadrature position) and pulling water to themselves producing high tides being lower than normal and low tides not as low as expected.




### c) Waves

- **A wave** is the oscillation of water particles.
- It is caused by the friction of the wind upon the surface of water.

**Parts of a wave**




- The top of the wave is called a **crest** while the bottom of the wave is called a **trough.**
- The distance between two successive crests on a wave is called **wavelength** or **length of a wave.**
- The difference in height between crest and trough is called **height of a wave.**
- The distance of open water over which the wind blows is called **a fetch.**

**Formation of waves.**

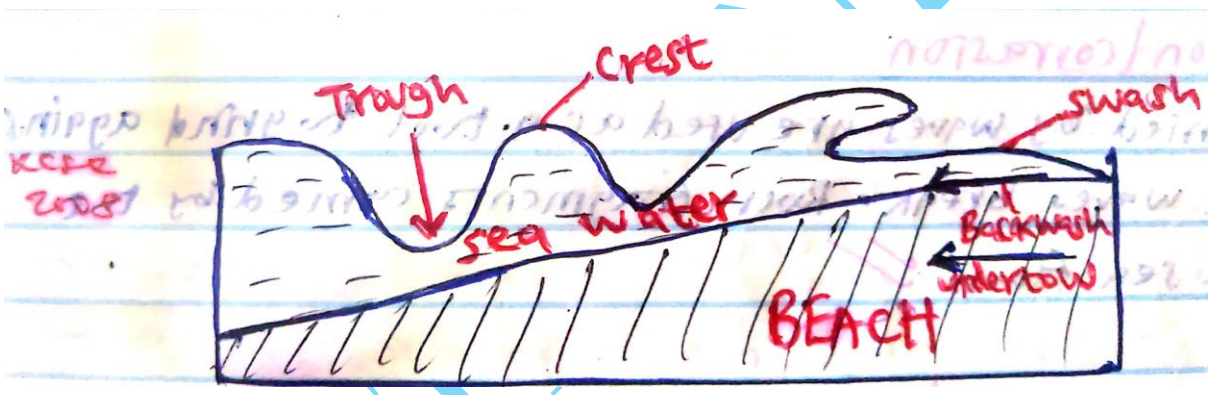
- Air lies over the sea in layers.
- The surface of the sea exerts a frictional drag on the bottom layer of wind.
- The frictional drag is transmitted into layers above moving at different speeds.
- The air tumbles forward in a circular motion causing the water surface to take the form of a wave.

**Factors determining the size of the wave.**

- ✓ Strength of the wind.
- ✓ Regularity of the wind.
- ✓ Distance of open water across which the wind blows.

**Breaking of the waves.**

- The depth of water decreases near the shore.
- The circular motion below the surface is discontinued as water touches the bottom.
- The height of the wave increases but the length reduces.
- The front of the wave does not have enough water. It steepens, becomes hollow and the crest plunges forward and the water breaks.




- The forward movement of water after a wave has broken is called a **swash/send.**
- The return flow of water down the beach to the sea after a wave has broken is called a **backwash**-kcse 2008.
- The water current flowing near the bottom back into the waterbody is called **undertow.**

**Types of waves**

**a) Constructive Waves**

- Formed when swash is more powerful than back wash.
- They are weak and infrequent in an area.
- They deposit materials at the shore forming features like beaches.
- They are common on the shallow gently sloping coasts where the waves break far from the shore.
- They break at a rate of ten times or less per minute.

**b) Destructive Waves**

- Formed when backwash is more powerful than swash.
- They are strong and more frequent in an area.
- They erode materials like pebbles, sands at the shore.
- They are common on the steeply sloping coasts.

- They break at a rate of ten or more times per minute.

## The work of a wave.

- It involves- Erosion
  -Transportation
  -Deposition

### 1. Wave Erosion

**Processes of Wave Erosion**-kcse 2005/2008/2019

a) Abrasion/Corrasion

- Rock fragments carried by waves are used as a tool to grind against the cliff face as the waves break. Rock fragments carried by the backwash erodes the sea floor.

*b)* Solution/Corrosion

- The solvent and chemical action of the sea water dissolves and removes the soluble minerals that are found in the cliff or sea floor especially where there are limestone rocks.

*c)* Attrition

- Rock particles that are carried by waves are constantly colliding against each other and wears them into smaller sizes.

d) Hydraulic Action/Quarrying action

**i) Direct force of the wave**

- The swash or breaking waves hit against the cliffs shattering the rocks.

**ii) Compressed air action**

- The breaking waves compress air into the cracks or joints in the cliff face. This widens the cracks and parts of the rocks may break off.

**Factors determining the rate of coastal/wave erosion**-kcse 2011

a) **The degree of exposure of the coast to wave erosion.** The exposed coasts are eroded more than the sheltered coasts which reduce the rate of erosion.
b) **The duration of exposure of the coast to waves.** The longer the exposure to the coastal waves, the higher the rate of erosion.
c) **Nature or supply of materials.** Heavy materials or boulders have a higher erosive power than fine materials.
d) **Nature or structure of the coastal rocks.** A coast made up of soft rocks or has well jointed/fractured rocks are easily eroded when subjected to sea waves.
e) **Nature or strength of the destructive waves.** Strong waves will cause greater erosion by hydraulic action and abrasion process.

**Features Resulting From Wave Erosion**

a) Cliffs
b) Wave-cut platforms
c) Blow holes
d) Geos
e) Arches
f) Caves
g) Stacks

h) Stumps

### a) Cliff and wave-cut platform

- **Cliff** is a steep rock face along a sea coast where land rises very sharply inland.
- **Wave Cut Platform or Abrasion platform plane** is a fairly flat surface on the shore resulting from the continued wave erosion on the cliff.

**Formation**

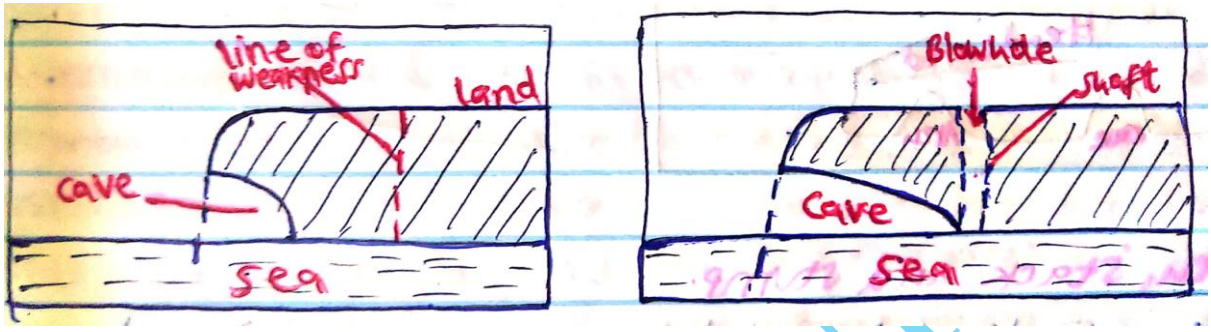
- ❖ Wave erosion attacks a steeply sloping coast at the high tide level mark.
- ❖ As waves erode the coast, a notch is formed into the steep land.
- ❖ Part of the land over the notch becomes overhanging block and eventually collapses forming a vertical rock face called a **cliff.**
- ❖ During high tides, there is undercutting at the base of the cliff by wave erosion forming a notch.
- ❖ Continued wave erosion enlarges the notch to form a cave.
- ❖ Hanging rocks above the caves will weather and collapse.
- ❖ When this process is repeated over time, the cliff will retreat to form a fairly flat surface on the shore called **a wave-cut platform- 2019**

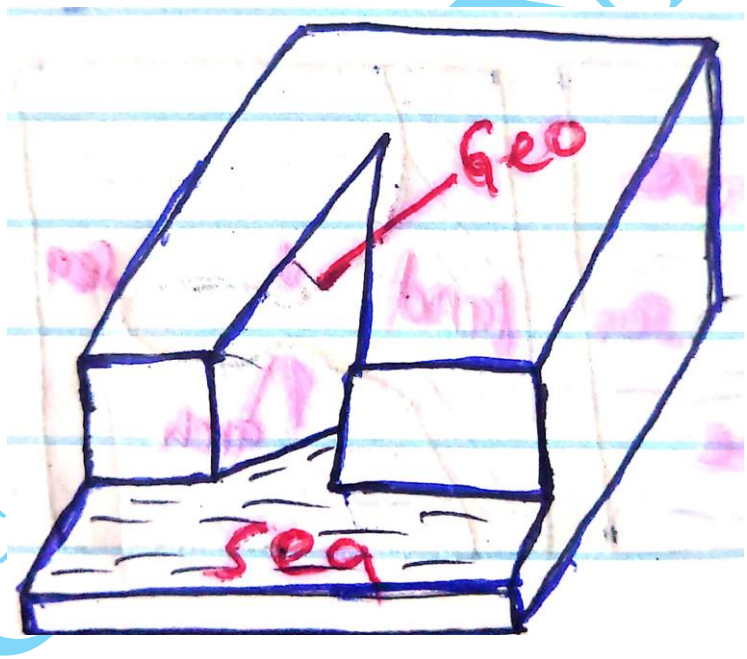

### b) Caves, Blow Hole and Geos

- **Cave** is a natural cylindrical tunnel like chamber extending into the cliff or into the side of a headland.
- **Blow Hole/ Gloup** is a vertical shaft/hole which connects the surface to the cave below.
- **Geo** is a longs narrow sea inlet formed when the roof of a cave between the blow hole and the sea collapses.

**Formation.**

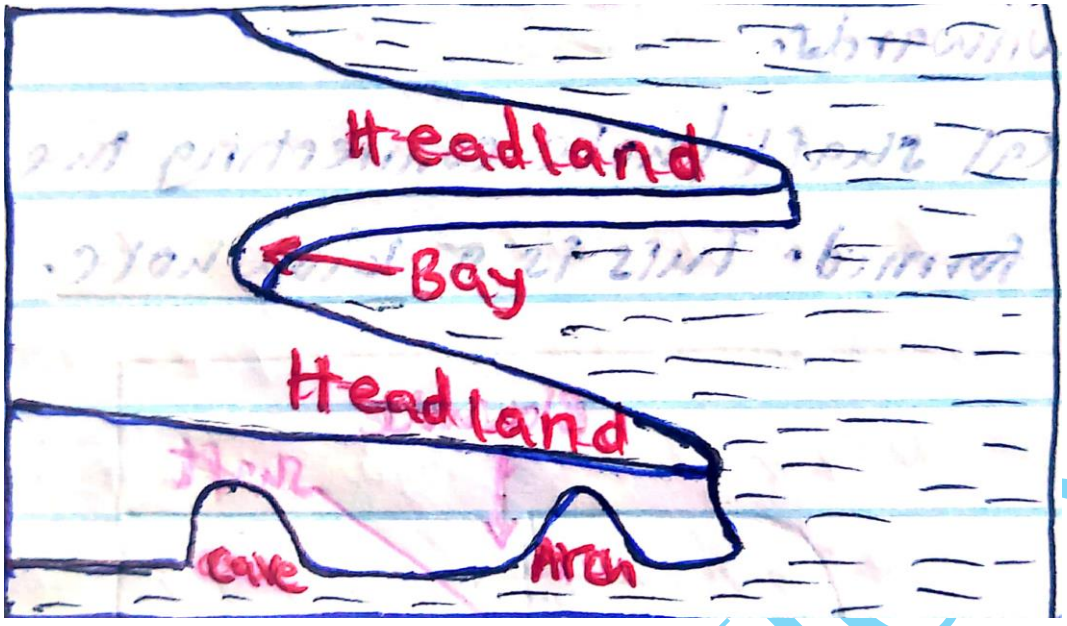
- ❖ Wave erosion through hydraulic action and abrasion attacks the base of a cliff where there are lines of weakness.
- ❖ Small hollow is formed.
- ❖ Continued wave action enlarges the hollow to form a tunnel which extends into the cliff.
- ❖ This results in a natural cylindrical tunnel-like chamber called **a cave.**
- ❖ Weathering especially by solution acts on the line of weakness from the surface downwards.
- ❖ Eventually, a vertical shaft/hole connecting the surface to the cave below is formed. This is **a Blow hole.**
- ❖ During high tide, water is forced through blowhole causing it to widen further.
- ❖ The roof of the cave eventually collapses forming a long narrow inlet called **a Geo.**


### c) Bays and Headlands

- A coast may have alternating layers of hard and soft rocks.
- Wave action may easily erode the soft rock than resistant rock.
- This results in the formation of sea inlet called **bay (**kcse 2008**)** between two resistant rocks.
- The resistant rocks forms finger like projections of land into the sea/ocean called **headlands.**

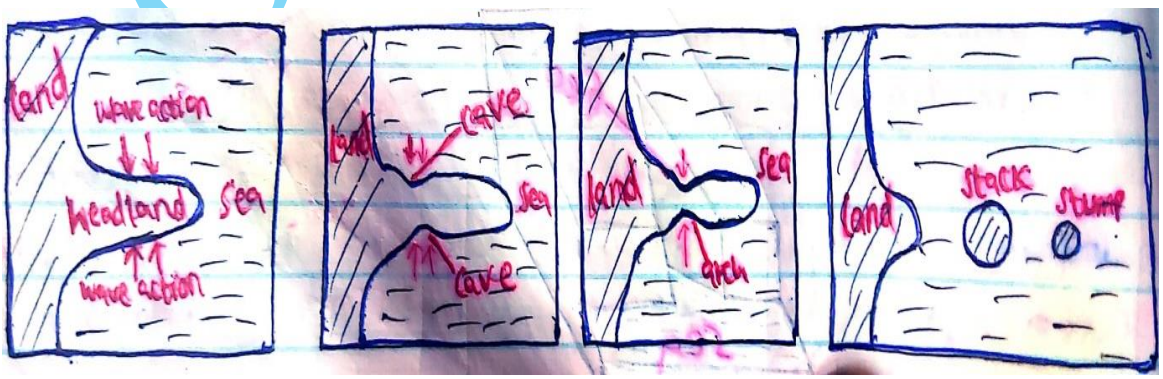


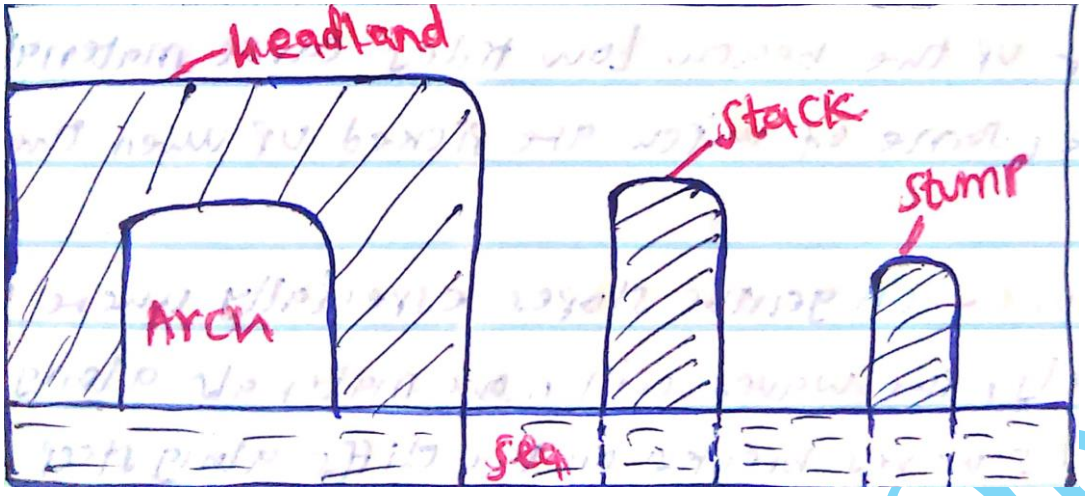

### d) Natural Arch, stack and stump

- **Arch** is an opening from one side of a headland to the other.
- **Stack** a pillar of rock left standing on the seaward side.
- **Stump** is the base of stack left when it collapses as a result of erosion at the base.

#### Formation

- ❖ A coast with a headland is eroded by waves on opposite sides of its side.
- ❖ Waves attack both sides of a headland at right angle forming **a notch**.
- ❖ Waves erode a notch through abrasion and hydraulic action forming **caves** on both sides of the headland.
- ❖ Continued wave erosion and weathering leads to the merging of the caves.
- ❖ The merging of the caves leads to formation of an arch.
- ❖ Continued wave action results in the collapse of the roof of the arch leading to isolation of part of the headland on the seaward side.
- ❖ The isolated headland is called a stack-kcse 2011
- ❖ Farther wave action reduces the size of the stack forming a small rock pillar called a stump which is visible during low tides.






## 2. Wave Transportation

- Examples of load moved by waves are such as shingle, sand, mud and other objects dumped into the sea.

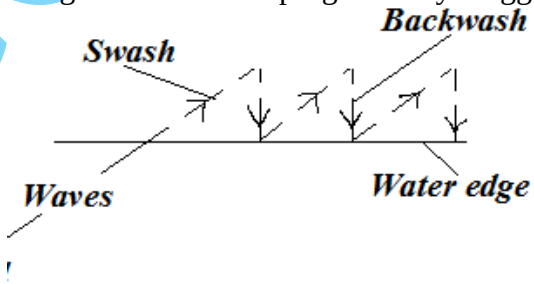
### Sources of materials transported by waves.

- ✓ Rivers draining into the ocean/sea.
- ✓ Mass wasting and weathering along the coast.
- ✓ Wave erosion at the coast.
- ✓ Volcanic eruptions in the sea.
- ✓ Wind deposition in the sea/ocean.

### Waves transportation process.

- Waves transport load by a process called **longshore drift**.
- **Long shore drift** is progressive dragging of materials along the beach as a result of waves breaking at an angle.

- Waves break at an angle.
- Swash pushes materials up the beach at an angle.
- Backwash brings them back at right angle to the edge of water.
- Process is repeated causing materials to be progressively dragged along the beach.




### Factors Influencing Wave Transportation

**a) Strength of waves.**

- Strong waves carry large quantities of load over a long distance while weak waves carry small quantities of load over a short distance.

**b) Tides.**

- Tides cause waves to break farther inland causing materials that were not in contact with breaking waves to be moved about.

**c) Ocean currents.**

- Ocean currents cause movement of materials from one part of the ocean to another e.g. coconut fruits from southern part of Africa to Gulf of Guinea by Benguela current.

**d) Gradient of the shore.**

- On gentle coasts transportation of materials is favoured by longshore drift while on a steep coast they bounce off cliffs and remain floating.

**e) Orientation of coast line/configuration of the coast.**

- Transportation by longshore drift is favoured where coast is aligned obliquely to the direction of breaking waves while on transversely aligned coast swash moves materials back and forth along the same line.

**f) Nature of the load.**

Lighter materials such as sand are carried over long distances while heavy load is transported over a short distance.

## 3. Wave Deposition

- This the process in which materials transported by waves are laid down on the shore.

### Factors Influencing Wave Deposition- kcse 2014/2016/2018

**a) Nature of the materials transported by the waves.** The waves will deposit heavier materials first while lighter materials will be deposited further and closer to the land.

**b) The strength of the waves.** Deposition occurs where the swash is stronger than the backwash. A strong backwash will remove the materials hampering deposition.

**c) Gradient of the shore.** A gentle shore reduces the velocity of backwash causing deposition of materials on the shore-kcse 2008

**d) Depth of the water.** Deposition occurs in shallow waters where waves break, lose energy and drop the materials-kcse 2008

**e) Configuration of the coast.** Deposition occurs more where the coastline does change direction inland since longshore drift is hampered.

### Features Resulting from Wave Deposition-kcse 2019

- ✓ Beaches
- ✓ Spits
- ✓ Mudflats
- ✓ Tombolo
- ✓ Cuspate foreland
- ✓ Dune-belts
- ✓ Bars
- ✓ Salt-marshes

**a) Beaches.**

- **A beach** is gently sloping accumulation materials such as sand, shingle, pebbles and coral fragments along the coast.

## Formation of a beach.

- A beach forms where the shore is gently sloping.
- The breaking waves bring along with them a variety of materials.
- On breaking, the swash sends materials up the shore towards the land.
- The weak backwash spreads the materials along the coast as water withdraws.
- Materials like sand, boulder and coral fragments accumulate on the coast forming a beach.

### Conditions for the formation of a beach-kcse 2009/2010/2016

- ✓ Gently sloping land at the sea shore.
- ✓ Presence of abundant supply of materials to be deposited.
- ✓ Presence of a shallow shore or continental shelf.
- ✓ A relatively weak longshore current.
- ✓ A weak backwash or strong swash or constructive waves.

### Features formed on Beaches.

i) **Beach cusps**

- They are projections of sand and shingles alternating with rounded depressions along the beach.

ii) **Beach Ridges/fills/swales**

- They are low linear heaps of sand, boulders and shingle which are deposited along a regular coast/ at the foreshore of a beach.

iii) **Beach Berms**

- This is a ridge or bench with a steep front.

iv) **Beach Rock Shells**

- Composed of sand, shells and pebbles cemented together by calcium carbonate forming projections above the sand.

### b) Spits

- **A spit** is a low lying narrow ridge of sand, shingle and pebbles with one end attached to the coast and the other end projecting into the sea.

### Formation of a spit-kcse 2014/2016

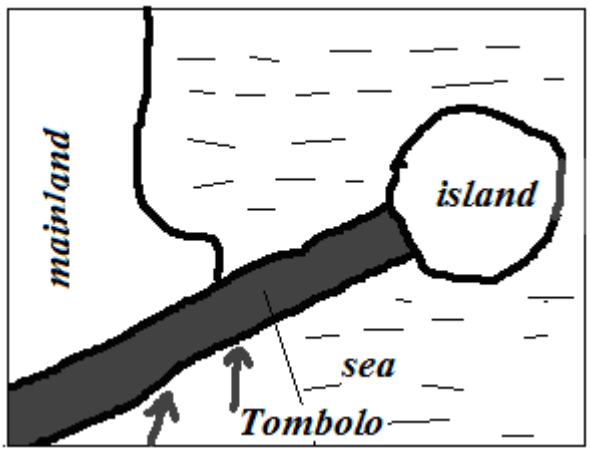
- ❖ A spit forms on a shallow shore at a point where there is a sudden change in the angle of the coastline.
- ❖ The longshore drift deposits materials such as sand, shingles and pebbles at such a point.
- ❖ The deposition continues extending into a bay/mouth of a river with one end attached to the land.
- ❖ Eventually, a low-lying ridge with one end attached to the coast and the other end projecting into the sea is formed. This is a spit.


### c) Tombolo.

- **A tombolo** is a spit extending seawards from the mainland until it is attached to an offshore island.

**Formation of a tombolo**

- ❖ Longshore drift deposits materials like sand and shingle on the mainland.
- ❖ A spit is formed.
- ❖ Longshore drift continues to deposit materials and the spit grows seawards.
- ❖ This elongated ridge of sand and shingle (spit) continues to grow seawards until it links the mainland to an island forming tombolo.




### d) Bars.

- **A bar** is a ridge of sand, shingles and mud deposited in the shallow water which lies almost parallel to the coast.

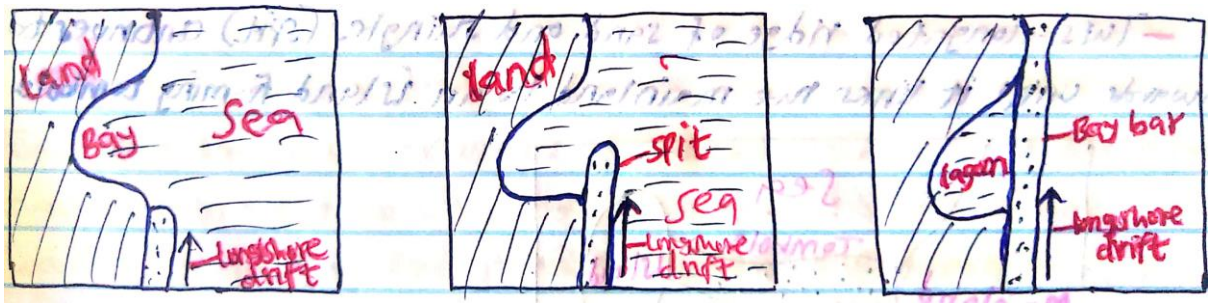
**Types of Bars**

**i) Bay bars**

- **Bay bar** is a ridge of sand, shingles or pebbles joining two adjacent headlands.

**Formation of a bay bar**-kcse 2008

- ❖ Longshore drift deposits materials at the entrance of the bay.
- ❖ The deposits accumulate forming a spit/sand bar/ridge.
- ❖ Continued deposition elongate the spit, eventually blocking the mouth of the bay forming a bay bar.
- ❖ The bay bar separates part of the sea from open sea enclosing sea water as lagoon.

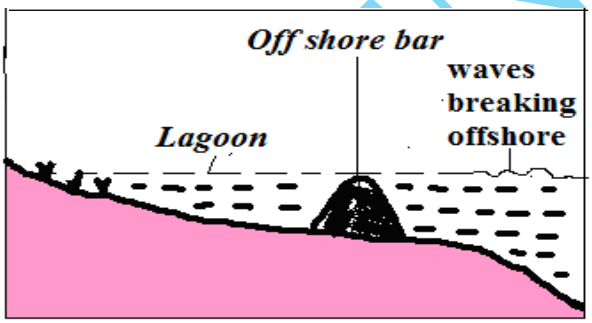



**ii) Offshore bars/barrier beaches**

- They are long, narrow ridges of sand off the shore and parallel to the coast. They are separated from the coast by a shallow lagoon.

**Formation of an offshore bar.**

- ❖ On a very gently sloping shore, the wave start breaking offshore at low tide.
- ❖ A large amount of pebbles, sand and coral fragments are deposited.
- ❖ As the tide drops, waves keep on breaking offshore and deposition continues.
- ❖ The ridge of deposits grows higher almost running parallel to the shoreline forming **offshore bar.**

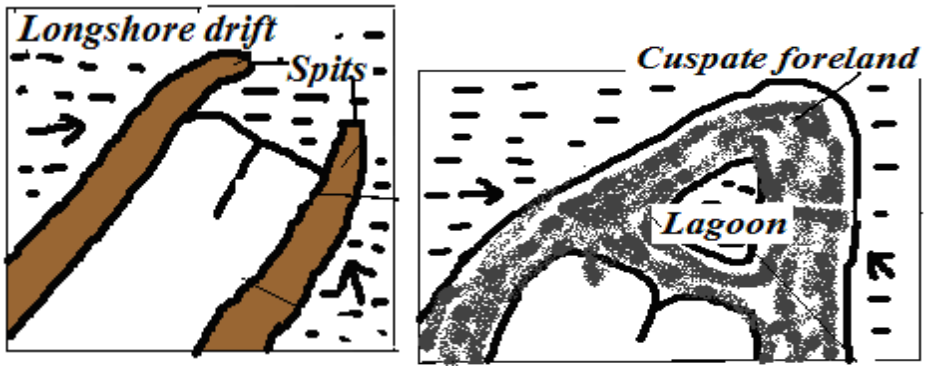



**e) Cuspate forelands.**

- **A cuspate foreland** is a broad triangular shaped deposits of sand or shingle projecting from the mainland into the sea.

**Formation of cuspate forelands.**

- ❖ Formed when two spits growing towards each other join.
- ❖ The longshore drift starts to deposit sand or shingle on two adjacent headlands.
- ❖ These materials accumulate seawards to form spits.
- ❖ The two spits grow towards each other and eventually join forming a triangular shaped feature enclosing a lagoon called a cuspate foreland.



## COAST.

- **A coast** is the zone of contact between land and sea or ocean.
- Coasts can be concordant or discordant.
- **A concordant/regular/longitudinal coast** lies parallel to the great trend line of the land e.g. the coast of Kenya between Malindi and Lamu.
- **A discordant/irregular/traverse coast** lies at right angle to prevailing winds hence receiving more rainfall than concordant coast e.g. coast of Mombasa.

### Terms associated with coasts.

- **Coast-** an inland area next to the coastline.
- **Coastline-** margin of land at the highest water level.
- **Shore-** area at the coast between high tide and low tide level.
- **Shoreline-** the point where the shore and sea water meet.
- **On-shore winds-** blows from the sea to the land.
- **Off-shore winds-** blows towards the sea.

### Factors influencing development of Coasts-kcse 2009

a) **Nature of waves-** Destructive waves makes a coast to have erosion features while constructive waves makes a coast to have depositional features.

b) **Nature of the crustal rocks** will either encourage rapid erosion or reduce the speed of erosion. Hard rocks result in the formation of cliffs and headlands while less resistant rocks result in the formation of inlets or bays.

c) **Alignment of the coast** in relation to the prevailing winds will either cause wave erosion or deposition. Exposed coasts encourages erosion while sheltered coast encourages deposition.

d) **Climate of an area** will determine the growth of coral polyps. Coral coasts develop in tropical regions of the world or fiord coasts were formed as a result of ice erosion in areas experiencing very cold climates.

e) **The gradient or slope of the coast-** steep coast encourage wave erosion resulting in the formation of cliffs and wave-cut platforms. Gently sloping coasts cause increased deposition resulting in the formation of beaches.

f) **Change in the sea level** results in drowning features along the coast to give rise to new features or landforms. The fall in the sea level exposes features that were once covered by the water.

### Basic types of Coasts

1. Submerged coasts
2. Emerged coasts
3. Coral coasts

## 1. Submerged Coasts.

- They refer to a drowned coastline due to change in base level or relative rise in sea level.

**Causes of submerged coasts**-kcse 2000

- ❖ Rise in the sea level.
- ❖ Subsidence of the coastal land.
- ❖ Flooding along the coast.

**Types of submerged coasts**-kcse 2001

**a)** Submerged highland coasts
**b)** Submerged lowland coasts

### a) Submerged Highland Coasts

- Form in areas where a coastal land which is sloping steeply into the sea is drowned due to rise in sea level or subsidence of the coastal land.

**Types of submerged highland coasts**-kcse 2014/2016

- ✓ Ria coasts
- ✓ Fjords(fiords) coasts
- ✓ Dalmatian coasts/longitudinal coasts

- **Ria coasts** are submerged river mouths in the highland coasts e.g. islands of Lamu. Manda, Siyu, Pate, and Kiwaiyu.
- **Fjords(fiords) coasts** are submerged glacial troughs found in highland areas which lie adjacent to the coastline.
- **Dalmatian coasts/longitudinal coasts** are submerged mountains which lie parallel to the coast.

### b) Submerged Lowland Coasts

- Formed when there is a rise in sea level along a lowland coast.

**Types of submerged lowland coasts.**

**i) Estuarine Coast**

- Coast characterised by broad shallow estuaries and mud flats which are visible at low tide.
- Wider and shallower than rias e.g. coastlines of Guinea and Senegal.

**ii) Fjord Coast**

- Coast characterised by numerous inlets formed by submergence of glaciated rocky lowland coasts.
- Have numerous islands and are deeper than rias e.g. S.E. coast of Sweden.

**Characteristics of submerged lowland coasts**-kcse 2011

- ✓ The coasts have broad shallow indentations or estuaries.
- ✓ The coasts have several creeks.
- ✓ The coasts have extensive marshes or mudflats exposed at low tides.
- ✓ The coasts have broad continental shelf.

**Features formed as a result of submergence of the coast**-kcse 2000

- ✓ Fjords/fiords
- ✓ Rias/creeks
- ✓ Islands
- ✓ Estuaries
- ✓ Sounds

- ✓ Broad continental shelf
- ✓ Mudflats

## 2. Emerged Coasts.

- They are exposed from the sea when part of the land which was formerly under water becomes dry.

### Causes of Emerged coasts.

- ❖ A fall in the sea level.
- ❖ An uplift of the coastal land.

### Types of emerged coasts.

**a)** Emerged upland coasts
**b)** Emerged lowland coasts

### a) Emerged Highland Coasts

- Erosional features that have developed along the former shorelines are exposed and appear to be raised from the current shoreline.

### Features in Emerged upland coasts-kcse 2014/2016

- ✓ Raised beaches
- ✓ Raised notches
- ✓ Raised wave-cut platforms
- ✓ Raised cliffs
- ✓ Raised caves
- ✓ Raised geos/blow holes
- ✓ Raised arches/stacks/stumps

### b) Emerged Lowland Coasts

- Develops when the sea level falls exposing part of the continental shelf which then becomes a coastal plain.

### Features in Emerged lowland coasts

- ✓ Abandoned off-shore bars
- ✓ Sand spits
- ✓ Lagoons
- ✓ Mudflats
- ✓ Beaches
- ✓ Fall-line i.e. a point where rivers flowing into the ocean descend through waterfalls and rapids from the edge of the plateau into the emerged lowland coasts.
- ✓ Gentle coastal plains i.e. the original coast is raised to form a gentle or near-flat plain.

## 3. Coral Coasts

- **Coral** is a limestone rock made up of exoskeletons of tiny marine organisms called coral polyps.

## Formation of coral rocks.

- Coral polyps extract lime from sea water to make their shells (exoskeletons) for their protection.
- They live in colonies and when they die, their exoskeletons (made of calcium carbonate) accumulate together with remains of other organisms like crustacean and molluscs forming the ridge-like rock parallel to the shore known as coral limestone rock.
- Successive colonies grow on the solid rock which increase in size forming coral reefs (large masses of coral rocks).

## Conditions favourable for the growth of coral polyps-kcse 2007

- ✓ The water should be warm about 20°c- 30°c
- ✓ The water should be clear from silt/sand.
- ✓ The water should be shallow to allow sunlight to penetrate.
- ✓ The water should be saline.
- ✓ There should be plentiful supply of plankton/microscopic plant food.
- ✓ The water should be well oxygenated.
- ✓ There should be extensive submarine platforms for the formation of colonies by the coral polyps.

## CORAL REEFS

- **A coral reef** is a narrow ridge of coral rocks found at or near sea surface and run parallel to the shoreline.

## Types of coral reefs

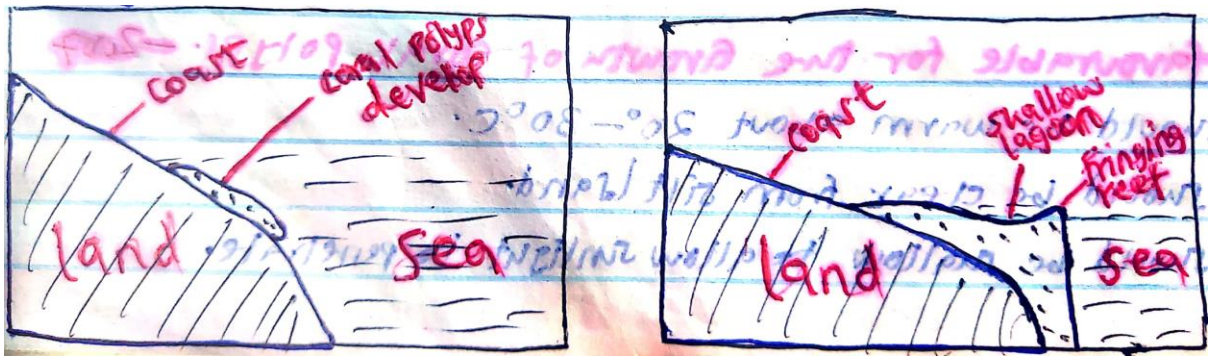
**a.** Fringing reef
**b.** Barrier reef
**c.** Atoll

### a) Fringing Reef-kcse 2009

- It is a coral platform formed closer to the shore and is separated from the shore by a shallow lagoon.

## Formation of fringing reefs-kcse 2016

- It is formed when coral polyps start building a reef near the shore /island extending seawards.
- The rate of accumulation is faster seawards than towards the shore.
- The reef therefore becomes steeper seawards than towards the shore, exposing a narrow and shallow lagoon.
- The accumulated coral materials form a fringing reef.

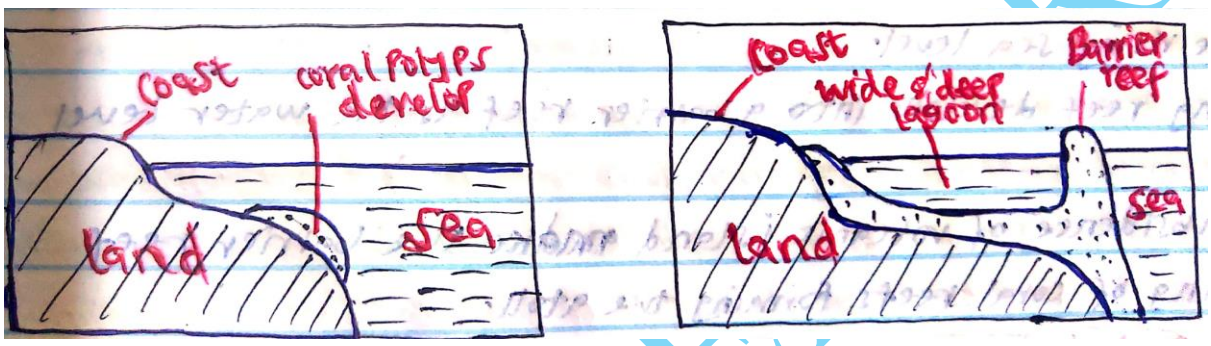


## b) Barrier Reefs-kcse 2009

- It is a coral platform formed a long distance away from the shore and is separated from the shore by a wide deep lagoon.

### Formation of barrier reef

- It is formed when coral polyps start building a reef near the shore /island extending seawards.
- The rate of accumulation is faster seawards than towards the shore.
- The coral reef builds for a long distance from the shore.
- The reef therefore becomes higher seawards than towards the shore, exposing a wide and deep lagoon.
- The accumulated coral materials form a barrier reef.

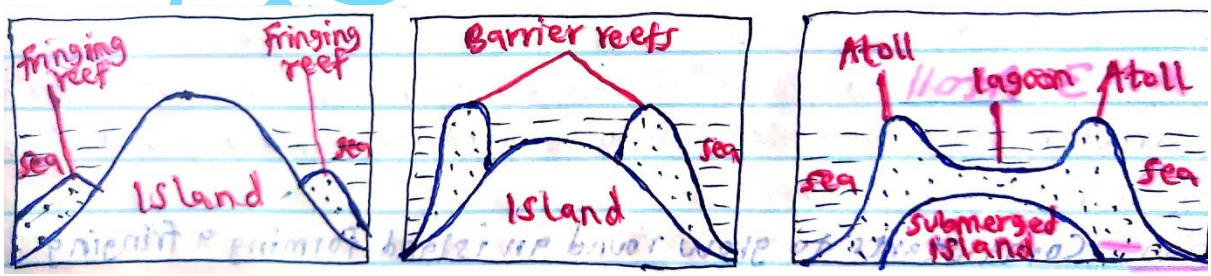



## c) Atoll Reef.

- **Atoll** is a circular, elliptical or horse shoe shaped coral reef enclosed by a deep lagoon.

### Formation of Atoll

- Coral starts to grow round an island forming a fringing reef.
- The island begins to sink or subsides as the level of sea rises.
- Coral continues to grow at a faster rate than the rate at which the sea is rising forming barrier reefs around the island.
- The sea level rises submerging the island.
- The coral reefs forms a ring around a deep lagoon forming **an atoll.**

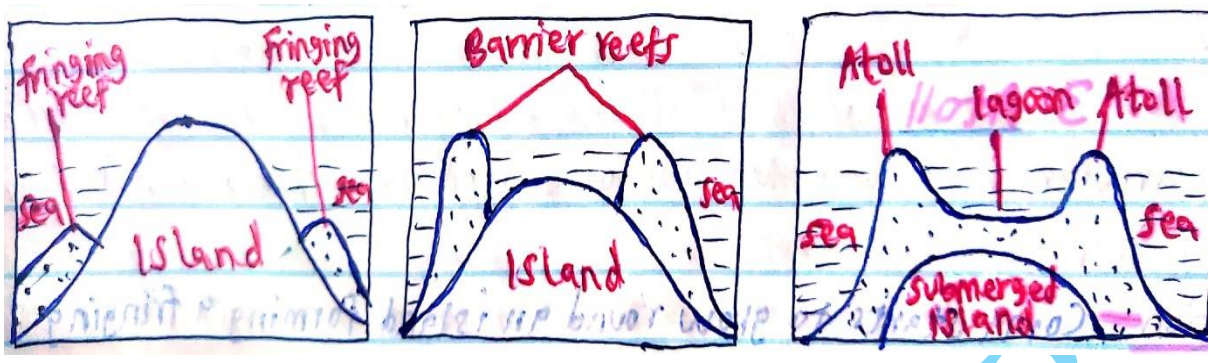



## Theories explaining the origin/formation of Barrier reef and Atolls.

### 1. Darwin's Theory.

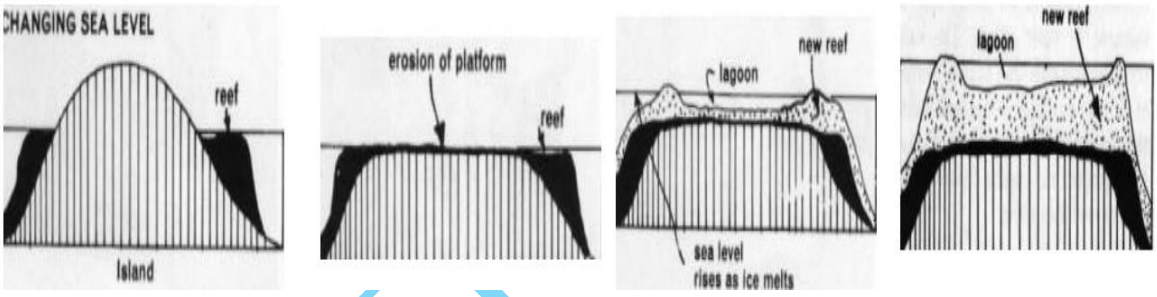
- Fringing reef develops around an island.
- The island starts to sink.
- Coral continues to grow upwards to keep pace with rising sea level and seawards because there is more food and water is clear.
- The reef extends great distance away from the land to become barrier reef.
- The island continues to sink becoming completely submerged.

- The barrier reef forms a ring of coral called atolls.



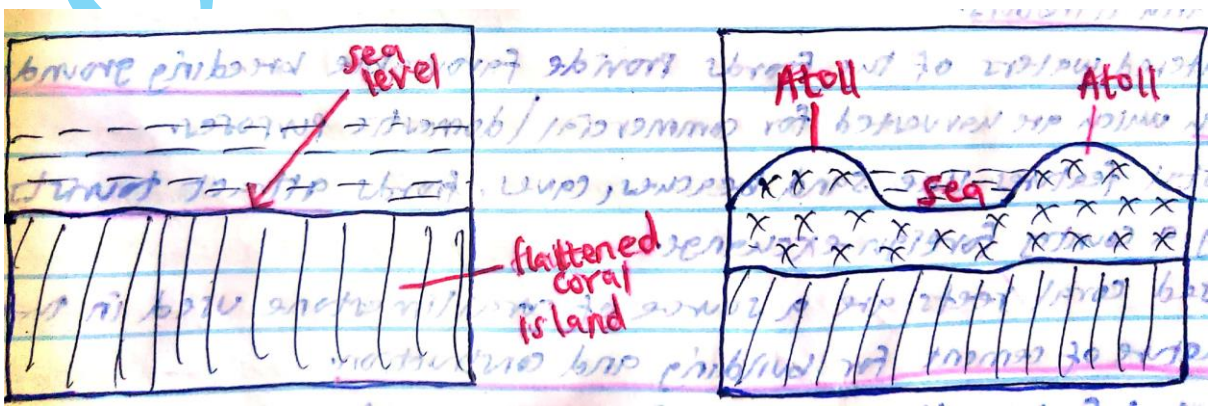

## 2. Murray's Theory.

- Fringing reef grows on a submarine hill.
- It disintegrates due to wave attack.
- Coral fragments accumulate on the seaward end.
- Polyps start building on it upwards where there is more food and clear water to form barrier reef.
- The barrier reef forms a ring of coral called atolls.




## 3. Daly's Theory.

- During ice age there was withdrawal of water causing global fall in sea level.
- Coral growth was retarded by low temperatures.
- Waves pounded coral reefs and islands and flattened them to the same level as the sea.
- At the end of ice age temperatures began to rise again favouring the growth of coral once again.
- More water was added to oceans causing polyps to continue to grow upwards to keep pace with the rising sea level.
- They were permanently exposed on the surface to form atolls.



## Significance of Oceans-kcse 2014/2016

**a.** Oceans provides building materials e.g. sand, coral rocks
**b.** Oceans modify the climate of the adjacent lands thus enhancing agricultural activities.
**c.** Oceans are used by water vessels thereby enhancing transport/communication.
**d.** Oceans provide sites for recreational activities thus promoting tourism.
**e.** Oceans are habitats for aquatic life hence encouraging fishing.
**f.** Oceans contain minerals which are extracted for economic development.
**g.** Ocean waves/tides are harnessed to generate electric power for industrial/domestic use.
**h.** Oceans provide water for cooling industrial plants.
**i.** Oceans encourage education and research.
**j.** Oceans provide ideal grounds for testing military weapons.

## Significance of Coasts and Coastal Features.

a) Submerged coasts like fiords and rias favour the development of ports and harbours.
b) Sheltered waters of the fiords provide favourable breeding grounds for fish which are harvested for commercial/domestic purposes.
c) Coastal features like sand beaches, caves, fiords attract tourists earning a country foreign exchange.
d) Raised coral reefs are a source of coral limestone used in the manufacture of cement for building and construction.
e) Coastal features like lagoons, fiords, coral reefs, continental shelf provide suitable grounds for marine life breeding e.g. Malindi marine national park.
f) Mudflats support the growth of mangrove trees which provide strong building poles. Mangrove trees also provide sites for research purposes in biogeography.
g) Coasts form good sites for development of urban centres like New York, Tokyo, Mumbai, Sao Paulo and Rio de Jeneiro.
h) Depositional features like sand dunes/coral reefs inhibits water transport and development of ports. Tankers will hit coral reefs causing oil spills.
i) Emerged coasts have poor sandy soils unsuitable for growing of a variety of crops.

## TOPICAL QUESTIONS

1. **Explain three ways in which coral reefs contributes to the economic development of Kenya. (6mks)- 2001**
   - ✓ Coral reefs attract tourists who earns Kenya foreign exchange used in developing other sectors of the economy.
   - ✓ Coral reefs provide breeding grounds for fish hence promoting fishing industry along Kenyan coast.
   - ✓ Coral reefs provide limestone coral used in manufacturing of cement for building and construction.
   - ✓ Many local people use coral rocks directly as building stones for houses thus when sold generates income.
   - ✓ Some coral stones are extracted and sold as ornaments.

2. **Give four characteristics of continental shelf. (4mks)**
   - ✓ It is shallow and gently sloping.
   - ✓ Its width varies 120-160km between places.
   - ✓ Some have islands formed by marine erosion and coral reefs.
   - ✓ Contain depositional materials brought in by rivers and spread out by currents.

3. **Give three reasons why corals do not grow in polar areas. (3mks)**
   - ✓ Low water temperatures.
   - ✓ Sea water of low salinity
   - ✓ Presence of cold ocean currents
   - ✓ Presence of deep submerged upland coasts.

4. **Outline the distinctive characteristics of a fiord. (3mks)- 2008**
   - ✓ It is narrow sea inlet
   - ✓ It has a U-shaped cross section
   - ✓ It has steep walls
   - ✓ It has hanging valleys
   - ✓ It is shallower seaward and deeper landwards
   - ✓ It has deep waters

5. **State three conditions necessary for the formation of a spit. (3mks)- 1999**



……THE END……

# ACTION OF WIND AND WATER IN ARID AREAS.

## Introduction.

- **Aridity** is the state of insufficient moisture in an area leading to scanty vegetation and deficiency in soil fertility.
- **Arid lands** are areas that receive insufficient rainfall (less than 250mm per annum) with scanty vegetation cover.
- **Desertification** is the slow but steady encroachment of arid-like conditions onto agricultural productive land.
- **Desert** is an arid area with scarcity of rainfall (below 250mm p.a.) and with scanty vegetation.

## Types/ kinds of desert landscape/ surfaces.

**(a) Sandy desert surface (erg or koum).**
- It is covered by extensive deposit of sand.

**(b) Stony desert surface (Reg or Serir).**
- It is covered by angular pebbles, gravels and boulders.

***(c)* Rocky desert surface (hamada).**
- It is a bare rock surface.

**(d) Badland.**
- It is covered by deep, steep sided gullies and ridges.

## Types/ categories of Deserts based on their location.

(a) **The hot continental interior deserts** e.g. Sahara and Arabian Desert.
(b) **The coastal deserts of western margins of continents** e.g. Atacama in South America, Namib Desert in Namibia and Arizona desert in U.S.A.
(c) **The mid-latitude desert of continental interior** e.g. Gobi Desert in Central Asia.
(d) **The ice and snow deserts of polar lands** e.g. Greenland and Antarctica Deserts.

### Major deserts in Africa –kcse 2021

- ✓ Sahara
- ✓ Kalahari
- ✓ Namib

### Major deserts in Kenya.

- ✓ Chalbi
- ✓ Kaisut
- ✓ Karoli

## Factors for the development of deserts.

i. High temperatures leading to high evaporation rate.
ii. Prolonged drought/ insufficient rainfall.
iii. Presence of cold ocean currents on the path of rain bearing winds hence drop moisture.
iv. Rain shadow effect caused by relief barriers.
v. Continentality/ long distance from the sea.
vi. Human activities like deforestation/ overgrazing/ overstocking.

vii. Location of an area in a region of anticyclones where winds are descending and diverging.

**Reasons why wind action is distinct in hot deserts** –kcse 2021

- ✓ There are a lot of loose/ unconsolidated dry materials which are easily eroded.
- ✓ Hot deserts experience strong, tropical storms which facilitate wind erosion.
- ✓ Hot desert surfaces are bare/ have scanty vegetation cover leaving most of the surface exposed to wind erosion.

## ACTION OF WIND IN ARID AREAS.

- The major processes resulting from wind action are;
  - Wind Erosion
  - Wind Transportation
  - Wind Deposition

### 1. Wind Erosion

- It involves the wearing off of the desert surface by the action of wind.

**Ways/ processes of wind erosion** –kcse 2003

**(a) Abrasion-** The materials carried by wind scour, grind and polish desert rock surface eroding them.

**(b) Deflation-** The dry/ loose unconsolidated materials are scooped and lifted to the air by wind currents hence rock eroded.

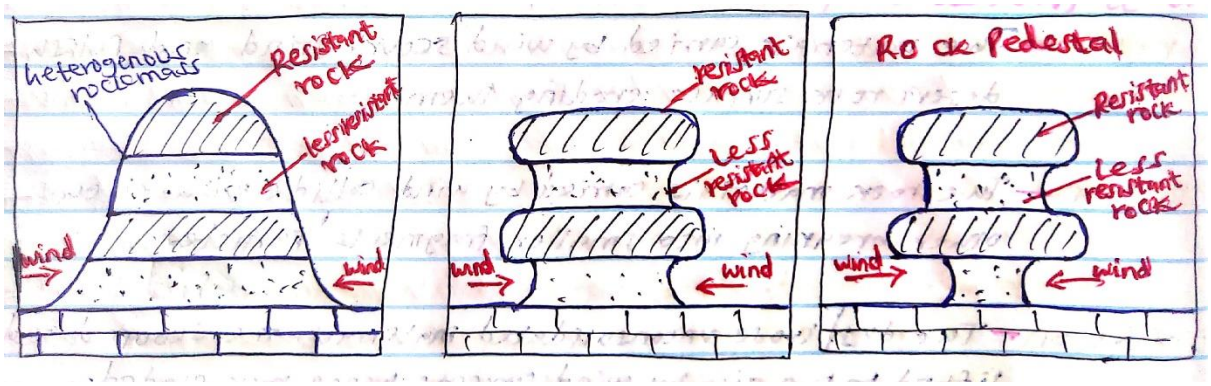
**(C) Attrition-** The rock materials carried by wind collide with each other breaking into smaller fragments/ particles.

**Resultant features of wind erosion in arid areas** –kcse 2011

- ✓ Rock pedestals.
- ✓ Mushroom blocks.
- ✓ Zeugen.
- ✓ Yardangs.
- ✓ Depression/ Deflation hollows.
- ✓ Millet seed/ sand grains.
- ✓ Ventifacts and dreikanters.

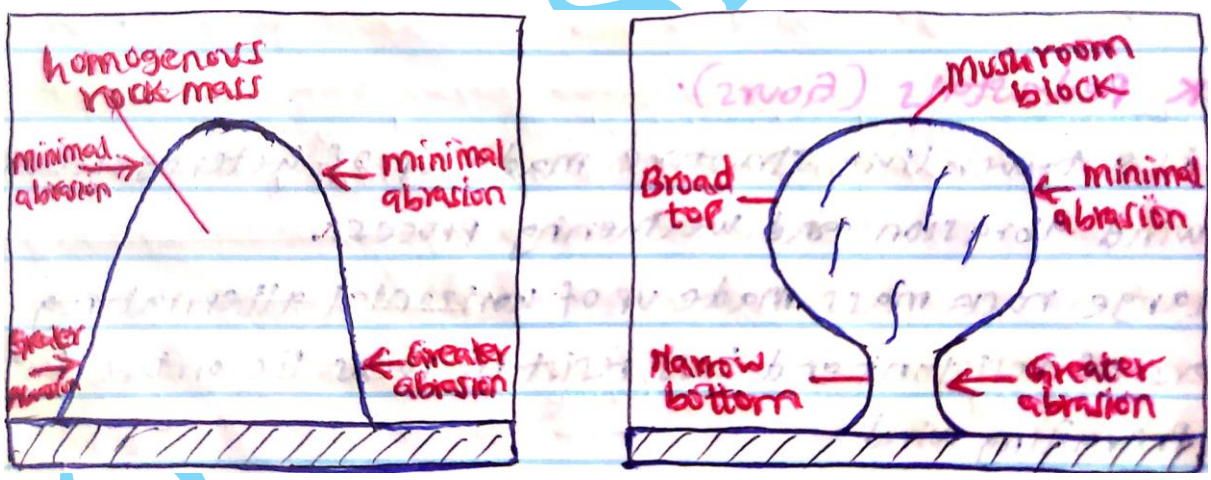
#### *a) Rock pedestals/ Gours.*

- **Rock pedestal** is a tower like structure made up of heterogenous rocks shaped by wind abrasion and weathering process.
- **Formation;**
  - A large rock mass made up of horizontal alternating layers of resistant and less resistant rocks lie on the path of prevailing wind.
  - The rock mass undergoes erosion by abrasion.
  - The less resistant layers are eroded more than the resistant layer of rocks.
  - The base undergoes more erosion by abrasion since the wind is carrying more load near the ground.
  - This results in a rock pillar that has protruding resistant layer of rocks with narrow less resistant layers of rock called **a rock pedestal/ Gour.**




**b) Mushroom block.**

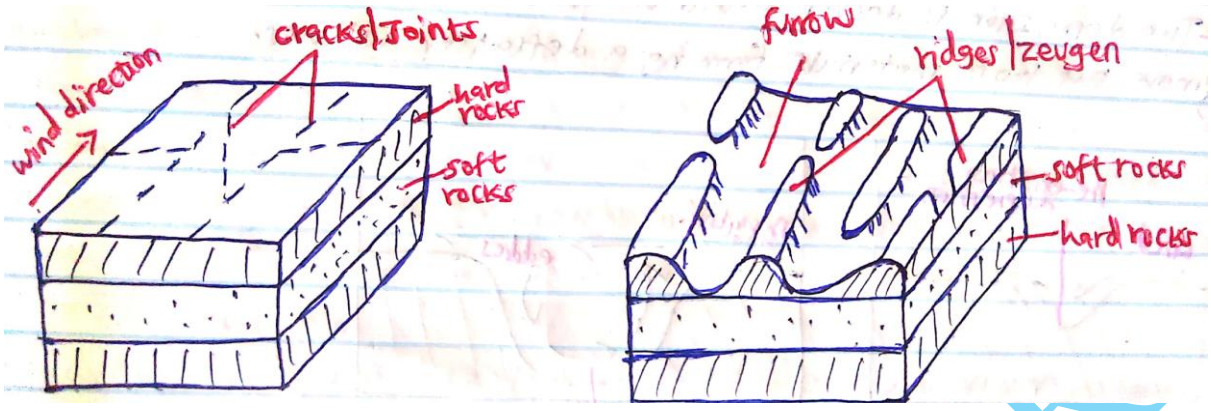
- This is a massive block of homogenous rock with a smoothened and rounded top and narrow intensively eroded bottom due to wind abrasion.
- **Formation;** –kcse 2023
    - It is formed from a homogenous rock which lies vertically on the path of the prevailing wind.
    - There is wind abrasion by heavier materials near the ground resulting into intensive undercutting of the rock.
    - The top of the rock undergoes polishing and smoothening by fine airborne materials.
    - This results into a feature with a broad rounded top and a very narrow base/ bottom known as ***mushroom block.***




c) **Zeugen**–kcse 2003

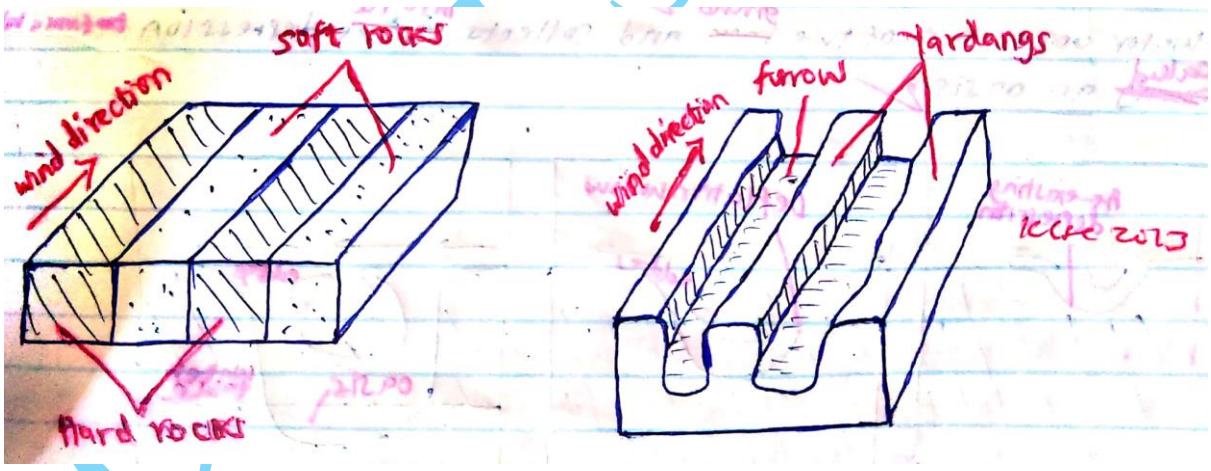
- It is a ridge and furrow landscape formed from a massive rock with alternating layers of hard and soft rocks lying horizontally.
- **Formation;**
    - It is formed in desert area where alternating horizontal layers of hard and soft rocks occur.
    - The top layer of hard rock is jointed and has cracks.
    - Weathering opens up the joints deepening them to reach the soft layer of rocks.
    - Wind abrasion deepens and widens the cracks into the softer rocks.
    - The softer rocks are eroded faster than the hard rocks forming furrows.
    - The hard rock forms ridges separating the furrows.

- This results into a ridge-furrow landscape. This ridge is called ***zeugen***



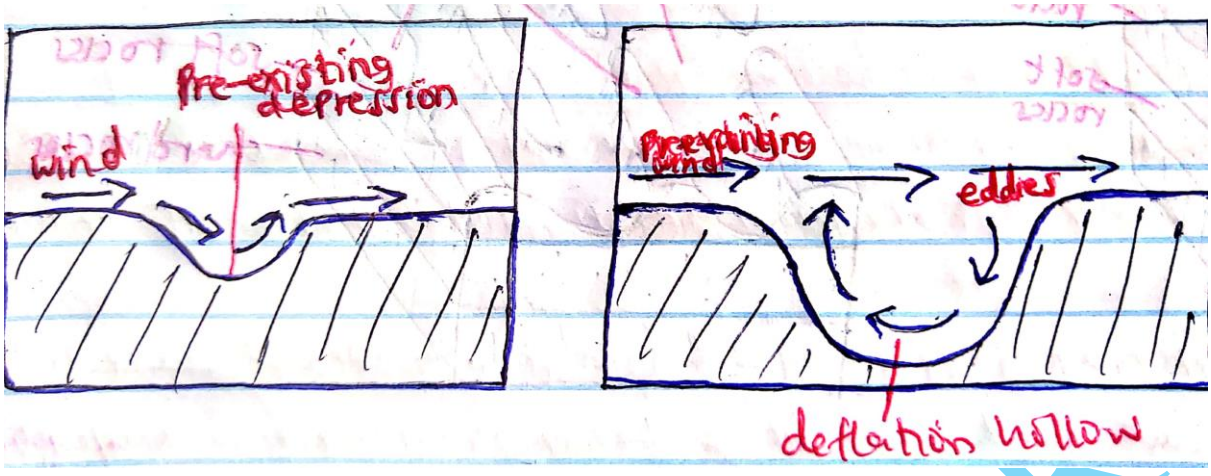

d) **Yardangs.**

- They are elongated rock ridges which are vertically laid down separated by shallow furrows/ grooves.
- **Formation;** –kcse 2023
  - They are formed by massive alternating layers of hard and soft rocks which are vertical/ near vertical.
  - The rocks lie parallel to the direction of prevailing wind.
  - Wind abrasion acts on the soft layers.
  - The worn out materials are removed and transported by deflation.
  - The hard layers are left standing out as small ridges separated by furrows forming features known as ***yardangs***



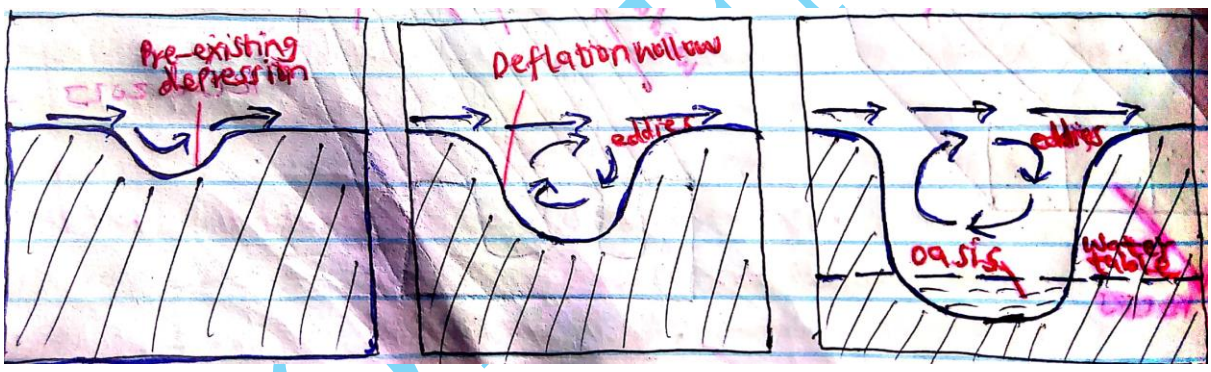

e) **Formation of Depression/ Deflation hollows.**

- A pre-existing depression or localized fault is exposed to wind erosion.
- Wind eddies removes unconsolidated materials by wind deflation.
- Weathering aids in the breaking down of the exposed rock.
- Wind abrasion excavates the depression by eroding the rock along the weak lines.
- The depression is deepened and widened as deflation continues to remove the loose materials forming ***deflation hollows.***




**Formation of an oasis** –kcse 2021

- A pre-existing depression is exposed to wind erosion.
- Wind eddies remove unconsolidated materials through deflation.
- Wind abrasion deepens and widens/ enlarges the depression.
- Further, abrasion and deflation lead to the depression reaching the water table.
- Water oozes out of the ground and collects into the depression to form a lake known as ***Oasis*.**




### f) Millet seed or Sand Grains.

- They are rounded sand grains produced by attrition.
- The wind borne materials knock against each other reducing in size to the size of the **millet seeds.**
- They are common in extensive sandy deserts.

### g) Ventifacts and Dreikanter.

- When boulders, stones or pebbles are polished and faceted through abrasion by wind-blown sand in the desert, they form **ventifact,**
- When wind changes its direction, the lighter stones may be forced to lter their positions resulting into a three faceted feature called **dreikanter.**

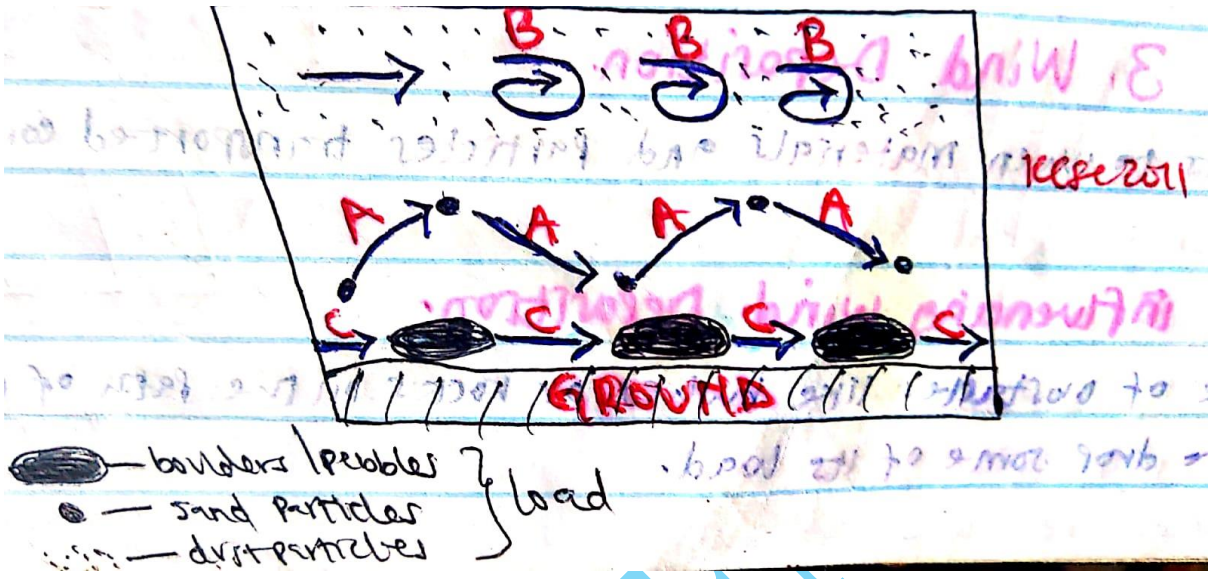
## 2. Wind Transportation.

- **Wind transports its load in three ways/ processes namely**; –kcse 2021

(a) ***Suspension***: - It is where fine materials are picked by wind raised high and blown over long distances.

(b) ***Saltation*: -** It is where coarse grained sand particles are transported through a series of bouncing/ jumps along the surface.

(c) ***Surface Creep*: -** It is where large/ heavy materials are rolled/ pushed forward by the use of wind along the surface.




Note: The process labelled A is Saltation, B is Suspension and C is Surface creep/ traction/ rolling.

**Factors influencing wind transportation.**

i. *Strength and speed of wind* – strong winds transport more and heavier materials compared to a weak wind.
ii. *Obstacles* – Intervening obstacles e.g. rock outcrops/desert vegetation on the path of a prevailing wind reduces its speed causing the wind to drop some of its load.
iii. *Nature of load* – Light particles such as fine dust are easily picked up by wind and blown to far distances.
iv. *Vegetation cover/water mass* – areas where the surface is covered by vegetation/ a water mass, the sand particles are bound together. This reduces the ability of wind to pick and transport these particles.
v. *Periodic changes in weather* – e.g. sudden short rains may interfere with transportation.

### 3. Wind Deposition.

- It refers to when materials and particles transported come to rest.

**Factors influencing wind deposition.**

i. **Presence of intervening obstacles** – checks the speed of wind forcing it to drop some load.
ii. **Nature of the desert surface** – moist grounds impedes the transportation of materials close to the ground due to friction. The materials are dropped.
iii. **Strength and direction of wind** – When the wind slackens, it begins to drop some of its load. Similarly when winds blowing from different directions meet, collision occurs resulting in some of the load being dropped.
iv. **Amount of load carried** – Materials carried by overloaded wind constantly collide among themselves causing some of them to be dropped.

v. **Variation in weather conditions –** Moist conditions/showers lead to deposition of the load suspended in the air.

**Resultant features of wind deposition** –kcse 2014

- ✓ Dunes
- ✓ Draas
- ✓ Loess

### *a. Sand dunes*

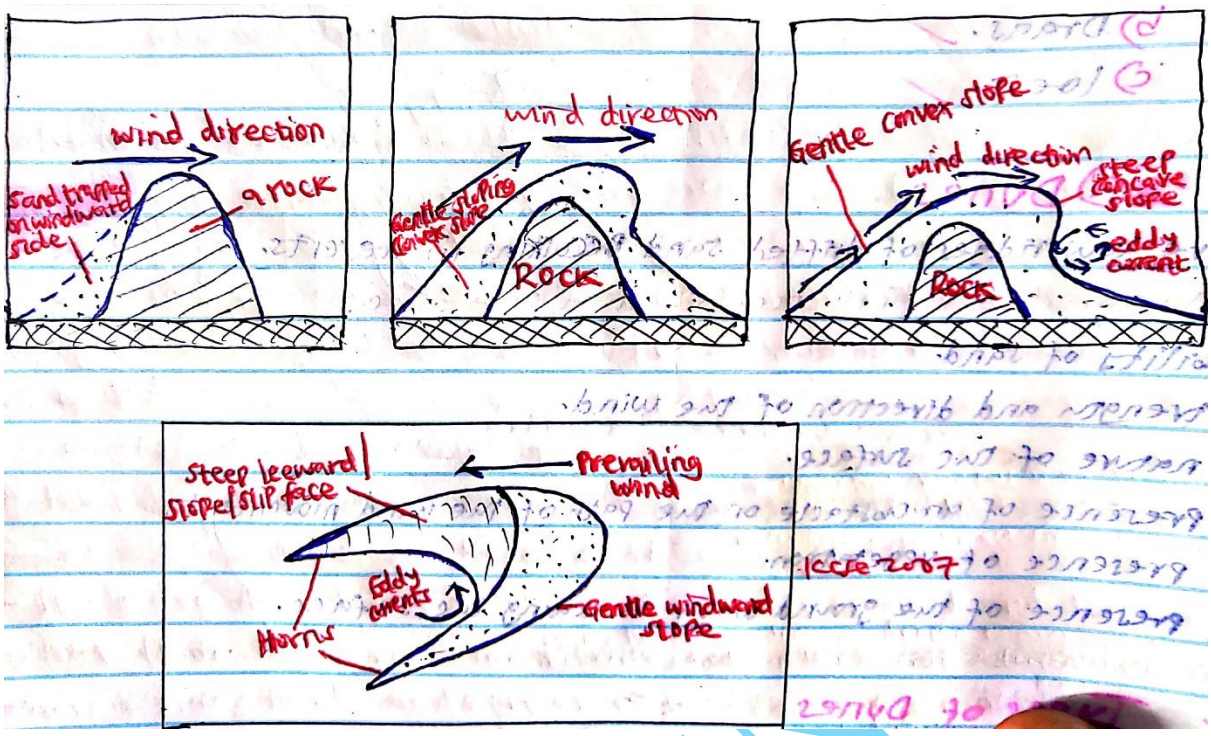
- They are low ridges of drifted sand occurring in deserts.
- **The following factors influence formation of a dune;**
  - Availability of sand.
  - The strength and direction of the wind.
  - The nature of the surface.
  - The presence of an obstacle on the path of the wind movement.
  - The presence of vegetation.
  - The presence of the ground water reaching the surface.

**Types of dunes** –kcse 2018/ 2023

i. Barchans
ii. Seif dunes
iii. Transverse dunes/ wave dunes
iv. Wake dunes
v. Star dunes
vi. Draas dunes
vii. Linear/ longitudinal dunes/ lateral dunes
viii. Parabolicdunes

#### i. Barchans

- They are crescent shaped sand dunes which lie transversely to the direction of the wind.
- **Formation;** –kcse 2013
  - It develops in arid areas when sand accumulates around an obstacle that lies in the path of the wind.
  - The gradual accumulation of sand forms a hill.
  - Eddy currents on the leeward side of the dune causes the formation of a shallow depression or concave/ steep slope.
  - With time the prevailing wind forces the sand at the edge of the dune to move forward forming the horns.
  - The continuous extension of the horns lead to a crescent shaped feature called **barchans.**

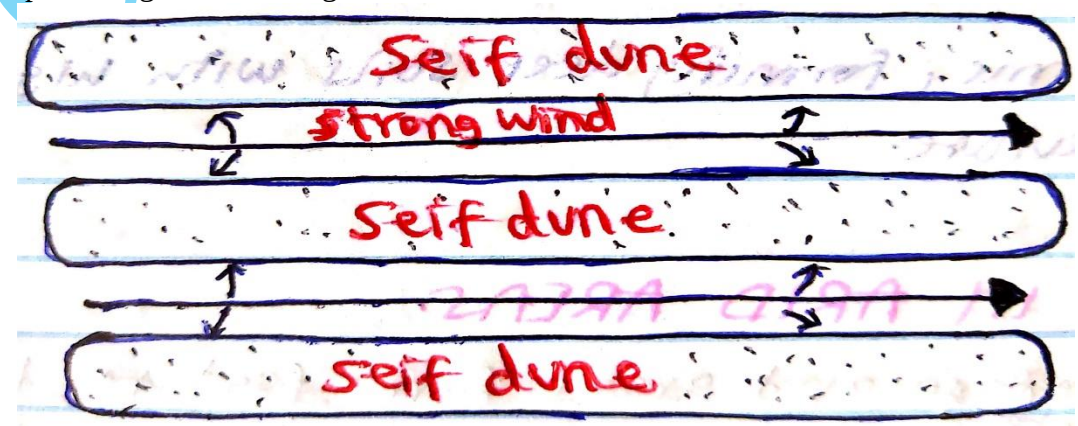



**Characteristics of Barchans.**

- ✓ Crescent shaped.
- ✓ Lie at right angle to prevailing winds.
- ✓ Have horns pointing downwards.
- ✓ Develop in places of steady winds.
- ✓ Formed where has been an obstruction in the path of wind.
- ✓ Steep leeward slope.
- ✓ Gentle windward slope.

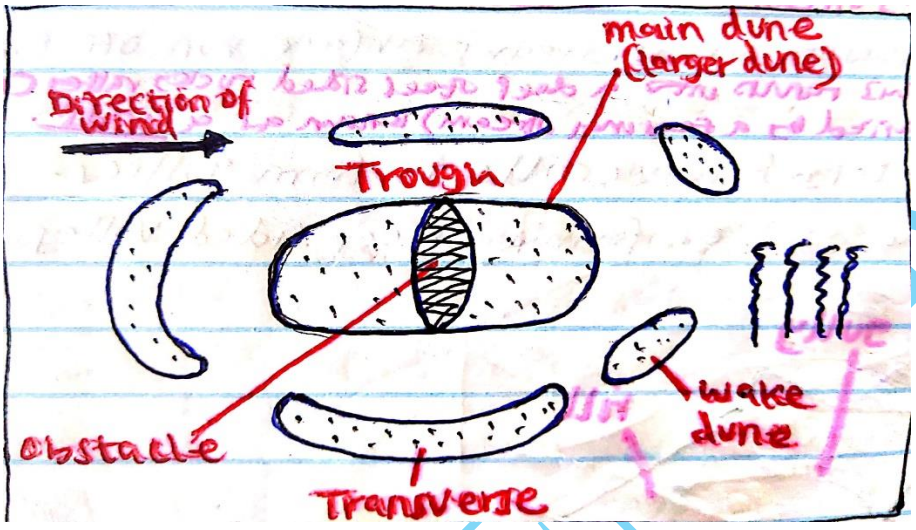
**ii. Seif Dunes.**

- They occur as long ridges of sand extending many kilometres and lie parallel to the path of the prevailing wind.
- Formed when barchans are stretched and straightened by wind action to form ridges of sand.
- Cross winds interrupt the prevailing winds to drive sand from side to side.
- This breaks the crescent shape of barchans into longitudinal ridges.
- They extend to a length of over 100km and are parallel to each other to the path of prevailing wind forming **seif dunes.**



### iii. Transverse and wake dunes.

- They are long wave-like sand dune ridges separated from each other by troughs.
- They form when less strong winds blow from one direction, depositing huge dune fields called **transverse dunes/ lateral dunes.**
- If a sand dune forms on the leeward side of the larger dune trailling away in the direction of the wind movement forming **a wake dune.**




**(b) Draas.**

- They are formed from seifs or transverse dunes that attain very high heights.
- They are sometimes flat at the top thereby influencing formation of small barchans and seif dunes due to their massive extent.
- They can accumulate to form high ridges or hills rising up to about 200m.

**(c) Loess.**

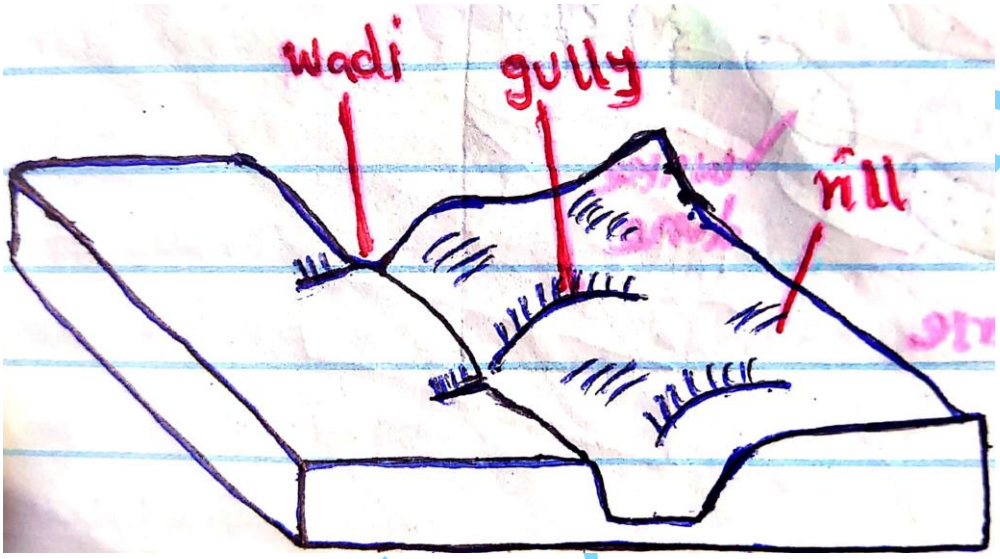
- These are fine particles of dust that are blown out of the deserts and deposited in other areas.
- They accumulate over time, forming deep soils with high mineral content suitable for agriculture.

## ACTION OF WATER IN ARID AREAS.

- **Action of running water in arid areas forms features like;**
  - ✓ Wadis
  - ✓ Inselberg
  - ✓ Pediments and peneplains
  - ✓ Pediplains
  - ✓ Playa and Salinas
  - ✓ Mesas and buttes
  - ✓ Dry river valley
  - ✓ Alluvial fan
  - ✓ Bajada

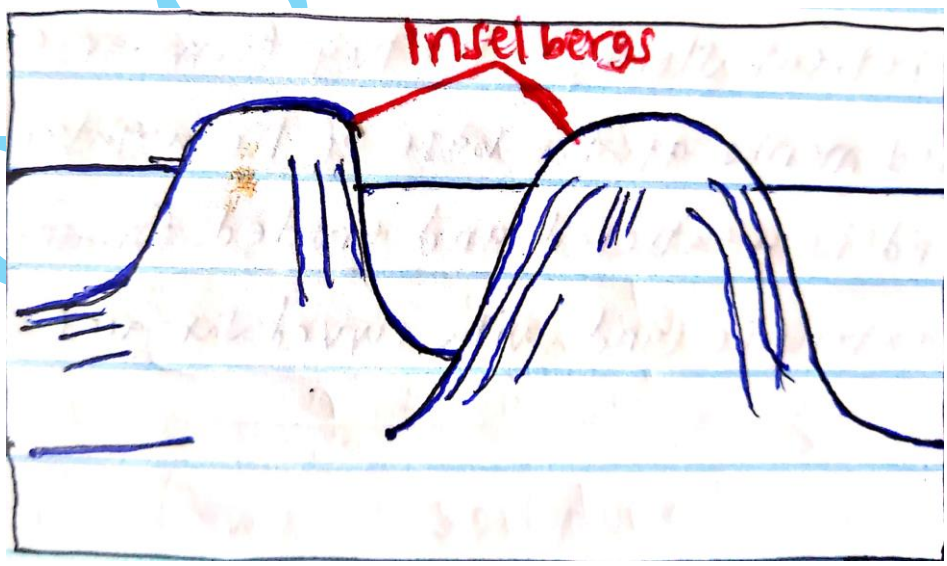
a. ***Wadis***

- They are deep desert valleys which are steep sided and rise from a flat floor.
- **Formation;** –kcse 2021
    - Torrential rainfall in the desert causes flash floods.
    - The flash floods cut small channels known as rills.
    - With increased rain, the rills widen and deepen to form gullies.
    - Temporary streams occupy and rapidly enlarge and deepen the gullies.
    - This results into a deep steep sided rocky valley (occasionally occupied by a seasonal stream) known as a **wadi.**




***b. Inselberg***

- It is a prominent residual rock mass in a desert.
- Wind erosion attacks the soft part of the rock or cracks formed due to weathering.
- Water may remove weathered materials thereby exposing the rock in an extensive flat area, leaving a mass of hard rock standing as residual hills called ***inselbergs.***

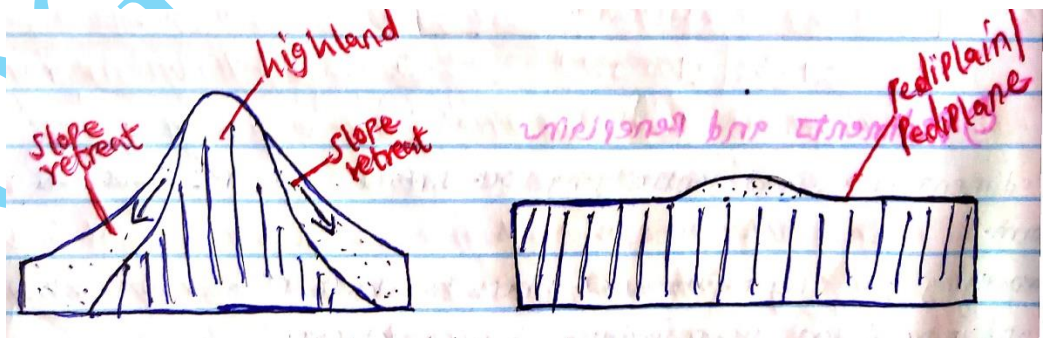


### c. ***Pediment and peneplains.***

- A pediment is a broad gentle lying rock surface which resembles a platform.
- Weathering and erosion processes attack the base of a slope on a highland in the desert areas resulting in slope retreat.
- During sudden rainstorms, flash floods water falls from the highlands into the lower surfaces enhancing erosion.
- The slope of a highland retreats slowly forming a gentle sloping surface called **pediment** at the base of the highland.
- The low level plain is called **peneplain.**

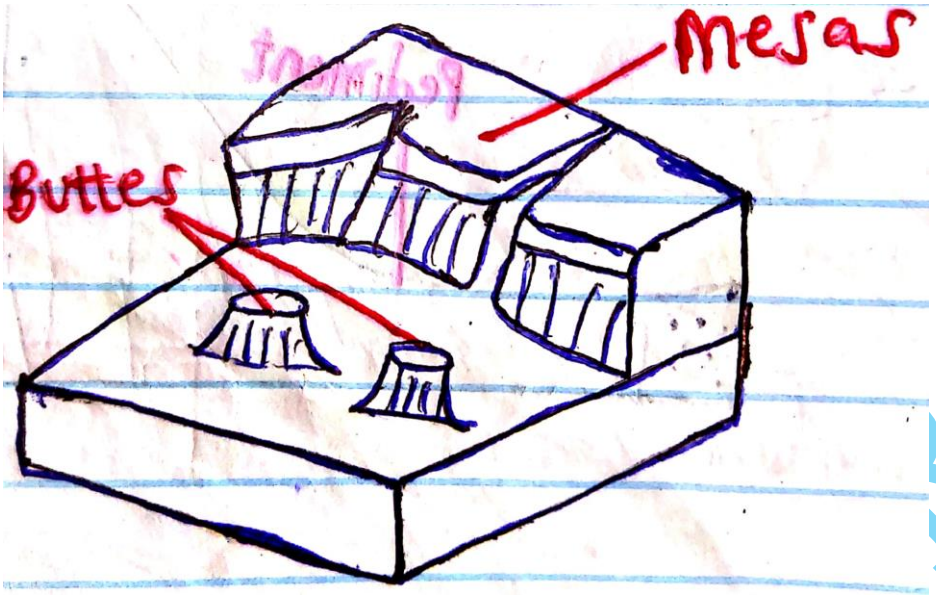

### d. ***Pediplains/Pediplanes.***

- They are multi-concave or steep surface features which result from the coalescence of several large scale adjacent pediments.
- Pediplains develop when pediments form around highland areas in deserts.
- During sudden rainstorms, flood water falls from the highlands into the lower surfaces enhancing erosion.
- Both slopes of a highland retreat slowly until they form an extended gentle sloping surfaces called pediments at the base of the highland.
- Eventually, the main highland is weathered and eroded forming residual hills which are reduced to an extensive land with curved surfaces forming ***pediplanes /pediplains.***




### e. ***Mesas and Buttes***

- They develop on sedimentary rocks that are capped with hard rocks.
- The soft surface is eroded until the horizontal hard rocks are exposed.
- These resistant rocks form residual hills which have a table-like shape called **mesas.**
- Continued erosion by wind and water reduces mesas thus forming **buttes.**




### *f. Dry river valleys.*

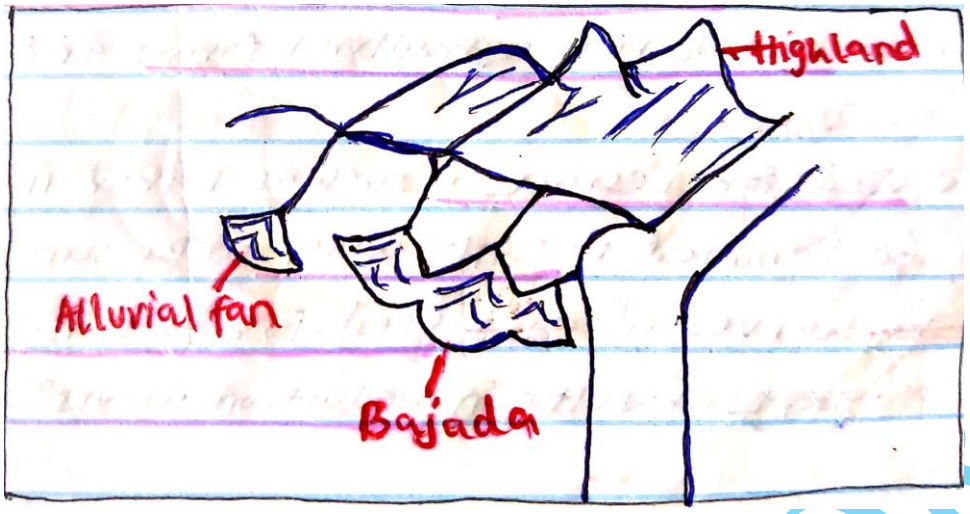
- Sheet floods and flash floods collect in river valleys during the short wet season to form fast flowing streams.
- The streams deepen the valleys through vertical erosion and widens the banks through lateral erosion.
- During dry season, these river beds remain dry forming **dry river valleys.**

### *g. Alluvial fans.*

- Streams from hills/ uplands flow to the lowlands.
- At the foot of these uplands, the speed of the running water is reduced leading to deposition of large amounts of sediments.
- Overtime these deposits accumulate spreading outwards to form a feature made up of coarse material called **alluvial fan/ alluvial cone.**

### *h. Bajada/ Bahada.*

- Temporary streams emerge from the highlands in desert areas during sudden rainstorms and flow into the lowland.
- The speed of such stream reduces as they reach the base of highlands depositing large amounts of sediments.
- These materials are deposited at the point where the temporary streams join a wadi.
- Continued deposition results in an accumulation of cone-shaped features called alluvial cones/ alluvial fans.
- When several alluvial cones/ fans along the wadi join, they form a continuous gentle feature called **bajada** with coarse sand.




### *i. Playas and Salinas.*

- A playa is a temporary lake in the desert in an inland drainage basin.
- Wind erosion by deflation processes erodes the surface forming shallow depressions called deflation hollows.
- Surface run-off from sudden rainstrorms flow into the deflation hollows or other existing basins to form temporary lakes called **playas.**
- Water in these playas is salty due to high temperatures experienced in desert areas.
- The high temperatures cause salinization in desert areas.
- Eventually, such playas may dry up and leave salty crystals called ***salina/ salar.***

**Significance of the resultant features of action of wind and water in arid areas** –kcse 2021

i. The unique desert features like barchans/ zeugen are tourist attraction that earns the country foreign exchange.
ii. Loess form deep soils that promote agriculture.
iii. The extensive desert landscape form appropriate site for military training/ nuclear testing.
iv. The extensive desert landscape is ideal for film making.
v. Salt flats are economically used for salt production.
vi. Wind deflation hollows/ oasis are sources of water for agriculture/ domestic use/ attract settlement.
vii. Sand harvested is used for building and construction.
viii. Shifting sand dunes hinder transport activities which hinder settlement.
ix. Extensive desert landscape form appropriate site for testing car and jet engines.

……END……

# ACTION OF WATER IN LIMESTONE AREAS.

## Surface water.

- This is water found on the earth surface.
- **Surface water include** rain water falling directly, Run-off water, River water, lake water, sea water and ocean water.
- **Sources of surface water;**
    - Precipitation
    - Springs
    - Melting ice

## Underground/ Ground water.

- This is water found below the earth surface.
- Sources of underground water/ Ground water include;
    - ✓ Precipitation/ Rainwater.
    - ✓ Melting glacier/ Melt water.
    - ✓ Water bodies like sea/ ocean/ lake water.
    - ✓ Magmatic water- water tapped in the rocks underground during volcanicity (plutonic water).

### Ways in which underground water may reach the surface of the earth.

a) Through wells drilled into artesian basin.
b) Capillary action i.e. upward movement of water through the rocks.
c) Springs – occur in areas where saturated rock layer is exposed to the surface.
d) Through streams.

### Factors influencing the occurrence of underground/ Ground water.

**i.) Precipitation/ Rainfall** –kcse 2015

- When rains last for long hours it enhances infiltration thereby replenishing the underground water sources.
- Heavy rains saturate the surface blocking air spaces thus reducing the rate of infiltration leading to low amount of underground water.
- High rainfall leads to high rate of infiltration hence high amount of underground water.
- Little rainfall/ no rainfall leads to low rate/ no infiltration hence low amount of underground water.

**ii.) Gradient of the slope.**

- The more gentle a slope is the greater the percolation of water into the ground than steep slope which allow fast surface runoff.

**iii.) Amount of Vegetation cover** –kcse 2015

- Presence of vegetation cover reduces the speed of surface run-off hence increasing the rate of infiltration leading to high amount of underground water.
- Presence of vegetation cover breaks the force of rain drops giving water more time to infiltrate hence increasing the amount of underground water.
- In areas of scanty vegetation/ on bare ground the surface run-off is high hence reducing rate of infiltration leading to low amount of underground water.

**iv.)** **Nature of the rocks.**

- Rocks with large spaces have high ability of allowing water to percolate through them thus availing underground water.
- Permeable rocks allow easy water infiltration than impermeable rocks thus availing underground water.

**v.)** **Level of saturation of the ground.**

- The drier the ground, the higher the rate of infiltration. Pore spaces of wet ground are blocked hence reducing water infiltration.

**vi.)** **Level of saturation of the atmosphere.**

- When the atmosphere has a low moisture content, there is increased evapo-transpiration due to high temperatures reducing water infiltration into the ground.

## The water table.

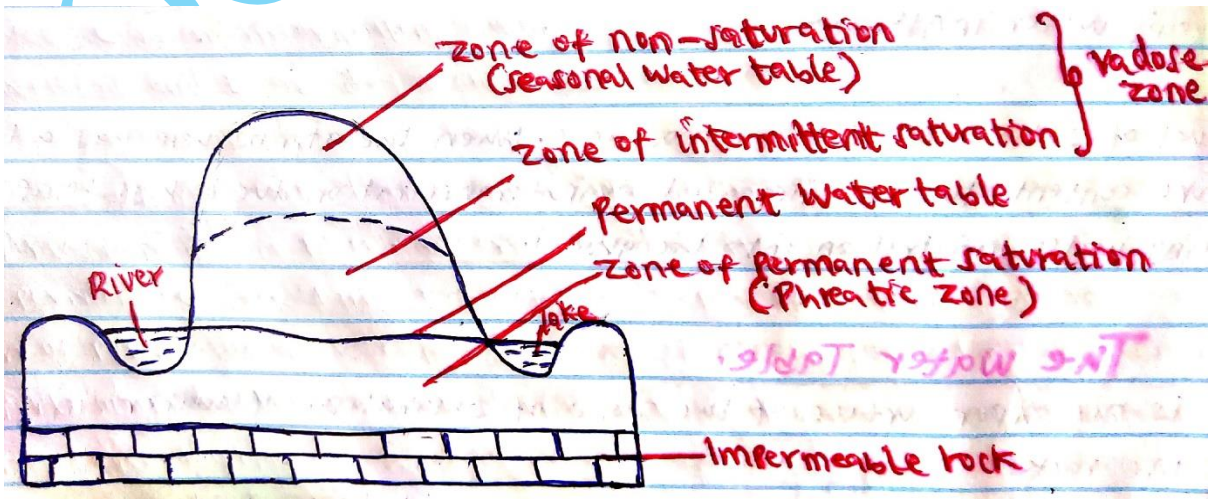
- This is the upper surface of the zone of saturation of water in permeable rocks.
- The highest level nearer to the surface reached during the rainy season is called **temporary water table.**
- The lower level reached during the dry season and is permanently saturated is called **permanent water table.**
- The stratum of a permeable rock which hold water in its mass and allows it to pass through is called **Aquifer (aquafer).**

## Layers/ Zones of saturation/ ground water

a) **Zone of non-saturation**: - This is found immediately below the earth's surface (permeable layer). It allows water infiltration.The top part of this zone is called the *soil water belt.*

b) **Zone of intermittent saturation**: - This is located below the zone of non-saturation. Its water content fluctuates according to season i.e. contains water during rainy seasons but unsaturated during dry season.

c) **Zone of permanent saturation**: - This is the region where all the rock pores/air spaces are permanently filled with water. It contains water in both wet and dry seasons. The upper level of this zone is called **permanent water table.** It is also called **phreatic zone.**



NOTE: **Phreatic zone** is a zone of saturation while **vadose zone** is a zone of intermittent and non-saturation.

**Features formed by underground water.**

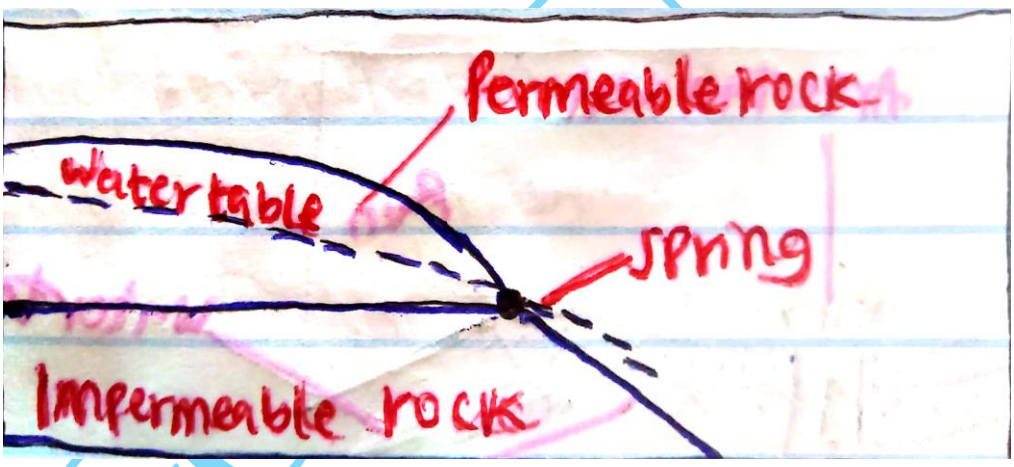
a) Springs
b) Wells
c) Boreholes
d) Artesian basin
e) Artesian well

### i. Springs.

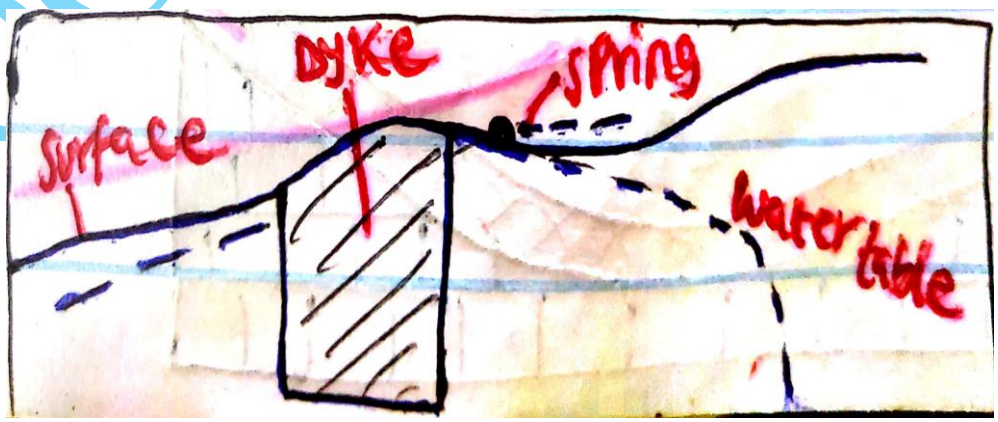
- **A spring** is a natural outflow of water from the rocks.
- The natural outflow of water from the ground all year round is called **permanent springs.**
- The natural outflow of water from the ground after a period of heavy rainfall is called **intermittent springs.**

**Ways in which springs occur.**

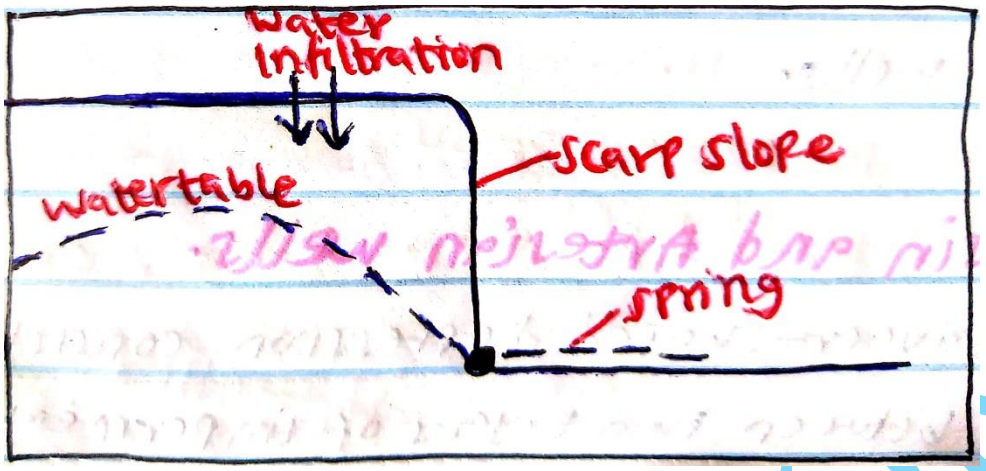
a) Where a permeable rock overlies an impermeable rock. A spring occurs where the two rock layers meet the earth's surface.



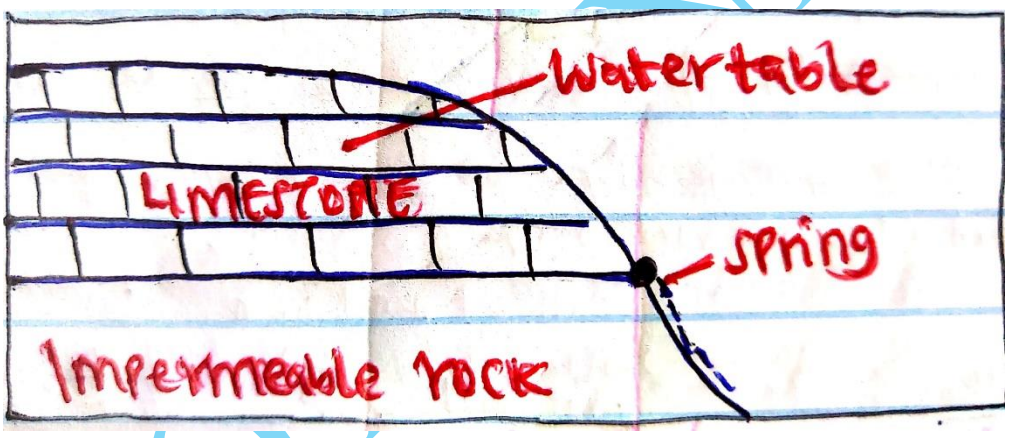

b) Where an igneous dyke cut across a layer of permeable rock.



c) At the foot of a steep scarp slope underlain by impermeable rock layers.

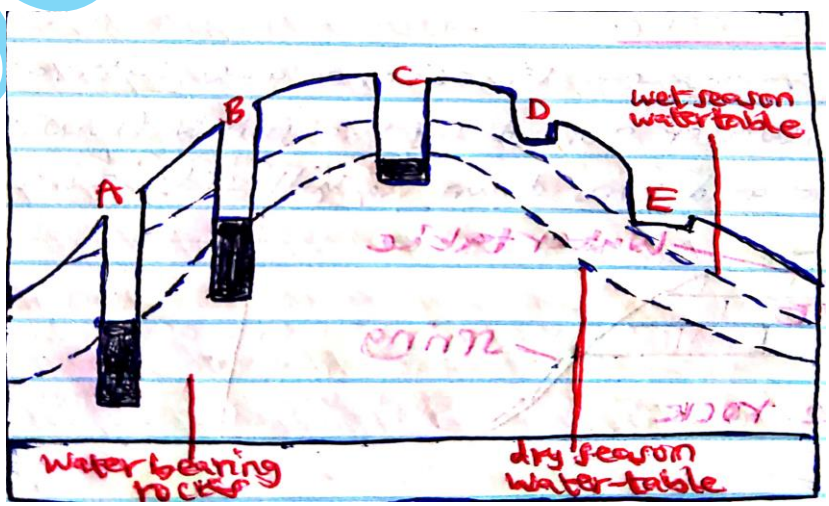



d) Where there is well jointed rocks e.g. limestone are saturated to the level of the water table. The water guided by the joints flow out of the junction with impermeable rock and runs down the hill side as a spring.




**ii. Wells and boreholes.**

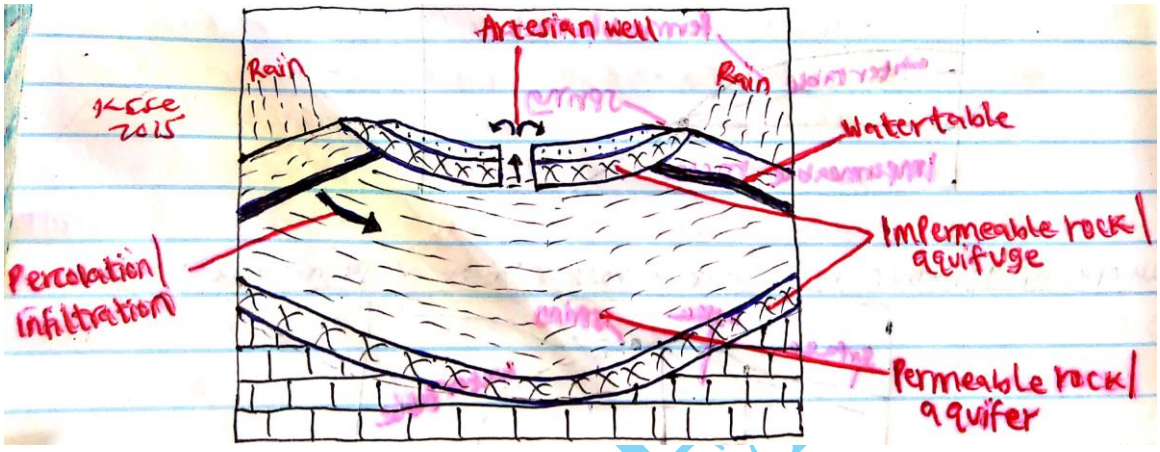
- These are holes sunk/dug into a permeable rock to reach the water table.
- Water from the underground seeps out of the water table into the well.
- Permanent wells are sunk below the water table hence they don't dry.



- Wells A and B are permanent.
- Well C is an intermittent well.
- Wells D and E are dry wells.

### iii. Artesian Basin and Artesian wells.

- **Artesian basin** is a **saucer-shaped depression consisting of a layer of permeable rock lying between two layers of impermeable rocks** with part of permeable rock exposed to the surface along the edges of basin- kcse 2009
- ***Artesian well*** is a hole sunk into a permeable rock in an artesian basin.




- **Aquifer** is a permanently saturated permeable rock that lies in between two layers of impermeable rocks.
- **Aquifuge** are impermeable rock layers that sandwich an aquifer/ permeable rock.

**Conditions that favour the formation of an artesian basin** –kcse 2023

a. **The aquifer must be exposed in an area of sufficient precipitation/ water source** to provide more water into the well preventing it from drying.
b. **The aquifer must be sandwiched/ lie between two impermeable rock layers** so that it can retain *water*.
c. **The mouth of the well must be lower than the intake area** to ensure water has sufficient pressure to flow out naturally.
d. **The rock structure must form a shallow syncline** such that the mouth of the well is at a lower level to ensure sufficient pressure to naturally force out water.
e. **The margins of the aquifer must be exposed** to allow water to infiltrate.
f. **There must be a partial or total blockage of exit for the water** to be replaced under pressure.
g. **The aquifer must be of the same permeable materials** so as to retain water.

Problems of/ Dangers that face artesian wells.

- ✓ Water from the wells may come in contact with salt bearing rocks hence becoming salty reducing its use.
- ✓ Excessive use of water from the wells with less intake to refill them may eventually lead to its drying up.
- ✓ Percolation of surface run-off from polluted land and rain water result in pollution of the water in the artesian well.

## Importance of underground water.

**a.)** Underground water provides sites for settlement e.g. spring line settlement.
**b.)** It can be sued for irrigating land increasing agricultural production.
**c.)** Springs form major sources of water for both domestic and industrial use.
**d.)** Springs form major sources of various rivers that provide water for industrial and domestic use.
**e.)** Underground springs helps to keep lakes fresh e.g. Lake Naivasha.
**f.)** Hot springs, geysers and steamjets can be harvested to produce geothermal energy.
**g.)** Hot springs and geysers attract tourists earning a country foreign exchange.
**h.)** Some hot springs are health spas.
**i.)** Hot water from the ground is pumped into houses to heat them during winter.
**j.)** Hot springs deposit some minerals like salt particles which are useful to man.

## Carbonation process –kcse 2004

- Rain water absorbs carbon (iv) oxide in the atmosphere to form a weak carbonic acid.

**Rain water + carbonic (iv) oxide ⟶ carbonic acid**

- The rain falls on jointed limestone rocks.

- The percolating rain water reacts with limestone rock (calcium carbonate) to form a soluble calcium bicarbonate.

**Limestone rock + carbonic acid ⟶ calcium bicarbonate**

NOTE: Carbonation solution process above leads to the development of various features in Karst or limestone regions.

## Karst landscape.

- It is an area of limestone chalk or dolomite with uniquely developed features/ scenery.
- It is a limestone region with unique features resulting from chemical weathering of rocks.

### Characteristics of karst landscape.

a. It has thin soils.
b. It has deep steep sided dry valleys.
c. It lacks surface drainage.
d. Its surface is rocky and rugged.
e. It exhibits numerous residual hills and solution hollows.
f. It has a subterranean network of underground drainage, caves and caverns.
g. It has poor/ scrub vegetation as well as some shrubs and grasses with stunted growth.
h. It has many solution depressions.

## Karst scenery –kcse 2021

- **Karst scenery** is a limestone/ dolomite/ chalk area/ region where water action has created unique rugged features on the surface and underground.

**Conditions necessary for the development of karst scenery** –kcse 2021

- ✓ The rainfall should be moderate to high/ humid conditions.
- ✓ The temperatures should be high/ hot conditions.
- ✓ Presence of hard/ well jointed rocks.
- ✓ The water-table should be deep below the surface.
- ✓ The area should have thick limestone/ chalk/ dolomite on the surface and beneath.

**Reasons why there are few settlements on the karst landscape** –kcse 2021

- ✓ The landscape is rocky/ rugged thus discourages settlement.
- ✓ The region experiences inadequate water supply both on the surface and underground discouraging settlement.
- ✓ The surface in most places has thin soils which discourages crop farming.
- ✓ There is scarcity of vegetation in most places limiting rearing of livestock.
- ✓ The landscape is rugged hindering development of transport network.

***Quiz; State three ways in which limestone landscape influences human activities.***

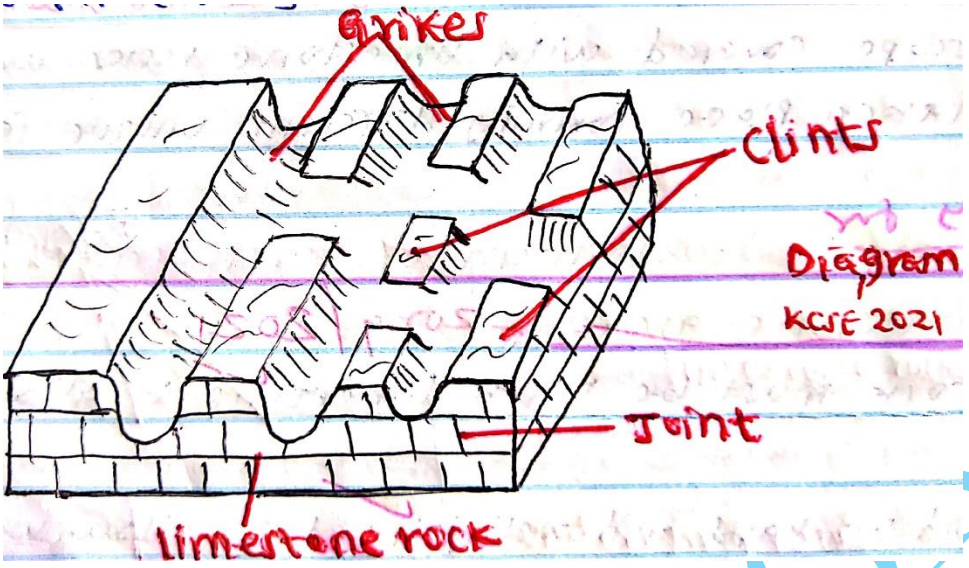
- ✓ Features like caves attract tourists earning a country foreign exchange.
- ✓ Limestone rocks are used for cement manufacture promoting industrial growth.
- ✓ Limestone rocks are used in building and construction.
- ✓ Limestone areas are used for grazing sheep as soils are thin and dry and has poor vegetation like scrub, shrubs and grasses.
- ✓ Limestone regions are rugged with grikes and clints making development of infrastructure difficult discouraging settlement.
- ✓ Limestone regions have intermittent surface drainage hence shortage of water thus discouraging settlement.

**Surface features in limestone regions.**

- ✓ Grikes and clints.
- ✓ Shallow/ sink holes.
- ✓ Dolines
- ✓ Uvala
- ✓ Polje
- ✓ Limestone gorge
- ✓ Dry valleys
- ✓ Blind valleys

**(a) Grikes and Clints.**

- Rain water reacts with carbon (iv) oxide in the atmosphere forming a weak carbonic acid.
- When acidic rain falls, it reacts with limestone rocks forming a soluble calcium bicarbonate.
- Water infiltrating the rocks through the joints enlarges them through solution process.
- The joints are enlarged to become gullies called **grikes.**
- The grikes are separated by ridges/ blocks of limestone called **clints.**

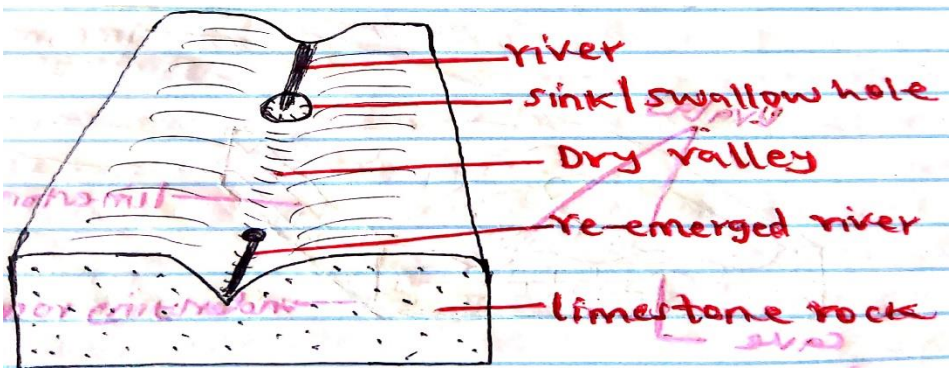



**(b) Swallow/sink holes.**

- Rain water reacts with carbon (iv) oxide in the atmosphere forming a weak carbonic acid.
- When acidic rain falls, it reacts with limestone rocks forming a soluble calcium bicarbonate.
- The calcium bicarbonate is easily carried away by water in solution form where the joints converge.
- As a result, deep oval-shaped vertical holes called **sink holes** are formed.
- If a river disappears through an enlarged sink hole, the hole will be called **a swallow hole.**

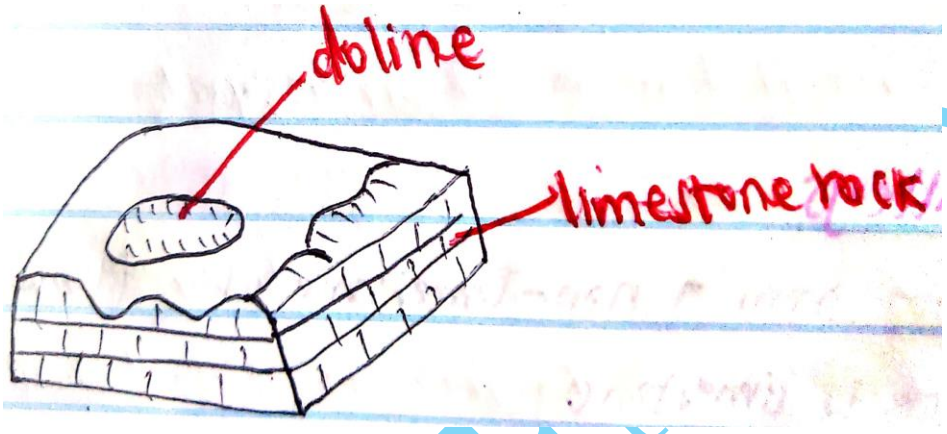
**(c) Dry Valleys**

- A river originating from a non-limestone area flows into a region where the surface rock is limestone.
- The river cuts a deep steep-sided valley as it flows down hill.
- Weathering by solution process occurs along vertical joints where the joints converge forming a swallow hole.
- Eventually, the river disappears into the swallow hole and continues flowing underground.
- The river re-emerges at a point further downhill where the limestone and impermeable rock meet at the earth surface.
- A section of the river valley between the swallow hole and the point where the river re-emerges on the surface is called **dry valley.**



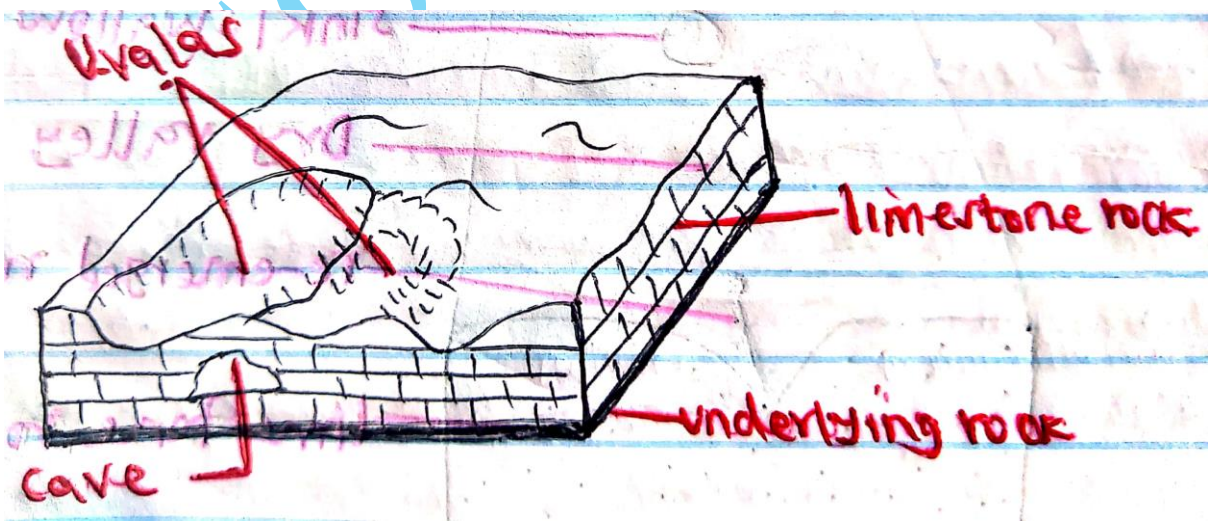
### (d) Dolines.

- Rain water reacts with carbon (iv) oxide in the atmosphere forming a weak carbonic acid.
- When acidic rain falls, it reacts with limestone rocks forming a soluble calcium bicarbonate.
- Calcium bicarbonate is carried by water in solution form along the joints forming sink/ swallow holes.
- Continued solution enlarges the sink/ swallow holes forming a large shallow elliptical shaped-depression called **a doline.**



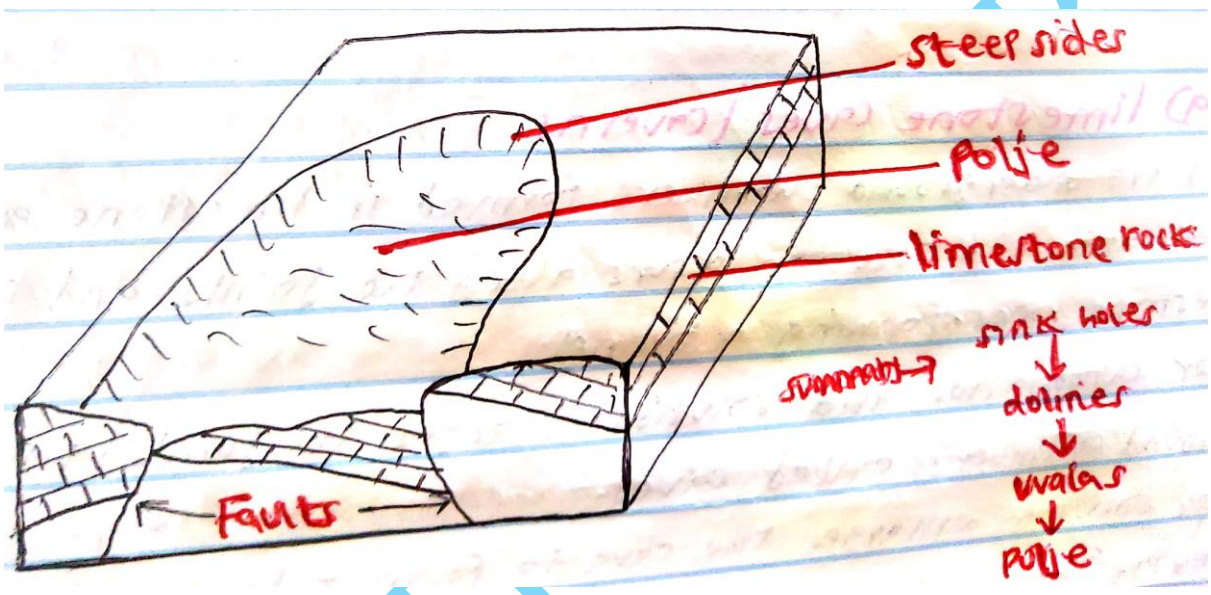

### (e) Uvalas

- Rain water reacts with carbon (iv) oxide in the atmosphere forming a weak carbonic acid.
- When acidic rain falls, it reacts with limestone rocks forming a soluble calcium bicarbonate.
- Calcium bicarbonate is carried by water in solution form along the joints of limestone rocks enlarging them forming swallow holes which are later enlarged forming dolines.
- Further carbonation and solution results in the merging of several dolines forming a large depression called **uvalas.**



(f) **Poljes** –kcse 2021

- Rain water absorbs carbon (iv) oxide from the atmosphere to form weak carbonic acid.
- When acidic rain falls, it reacts with limestone rocks forming a soluble calcium bicarbonate.
- The solution reacts with joints of limestone rocks forming a deep vertical hole called sink hole.
- Further solution on two or more adjacent sink holes leads to the formation of dolines.
- Continued solution on the walls of adjacent dolines leads to the formation of a large depression called uvala.
- Several uvala join/ collapse to form a very large steep sided depression called **polje.**




**(g) Limestone gorge.**

- It is a deep, steep sided valley.
- Gorges in limestone areas can be formed by permanent rivers whose origin is a non-limestone area.
- The larger river flows through the limestone area where it erodes and deepens its valley.
- There is more vertical erosion and minimal lateral erosion leading to a deep steep-sided river valley called **a limestone gorge.**

**(h) Blind valley.**

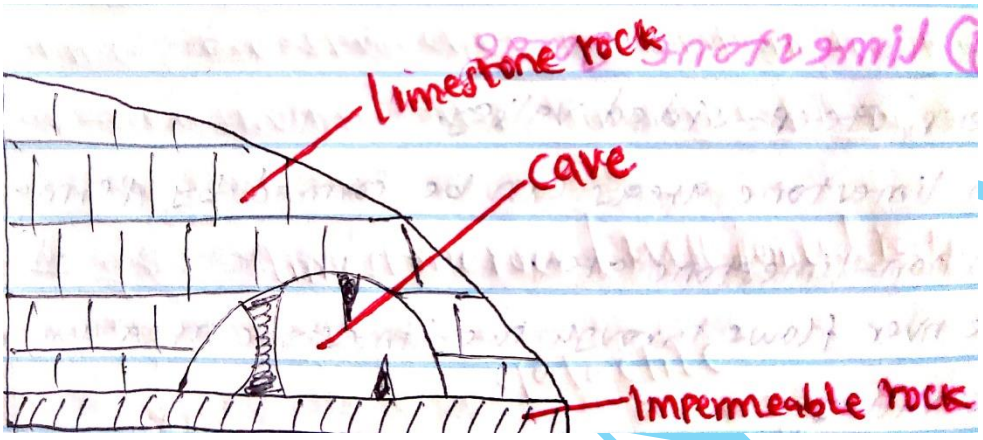
- It is a valley closed at the lower end by a rock wall and its base is a shallow hole through which the surface stream disappears underground.

**Underground features in limestone regions.**

- ✓ Limestone caves/ caverns
- ✓ Stalactites
- ✓ Stalagmites
- ✓ Limestone pillar
- ✓ Underground streams
- ✓ Karst windows, karst bridge and Hums.

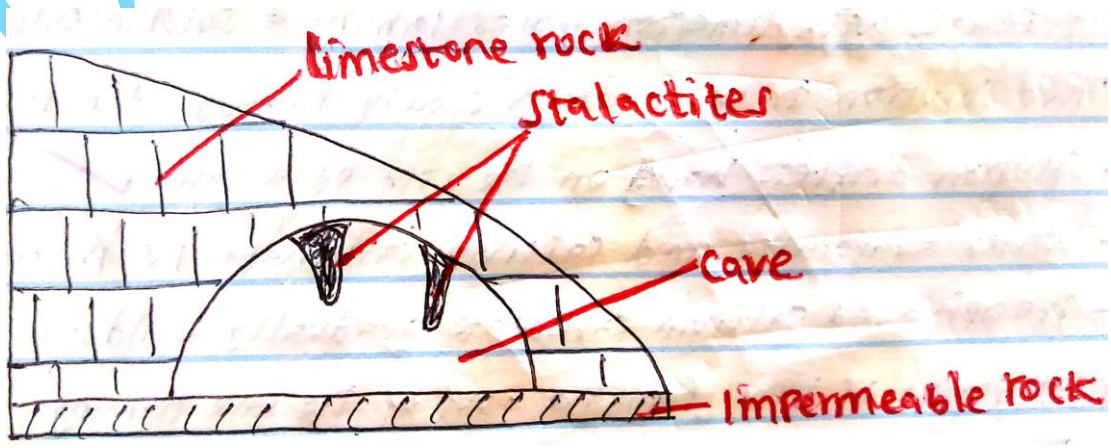
**(a) Limestone caves/ caverns.**

- They are underground chambers formed in limestone areas.
- Carbonation and solution occurs along the joints and bedding planes of limestone rocks forming a tunnel.
- Further carbonation and solution enlarges the joints/ tunnel to form underground chambers called **caves.**
- Further solution enlarges the cave to form a larger chamber called **a cavern.**



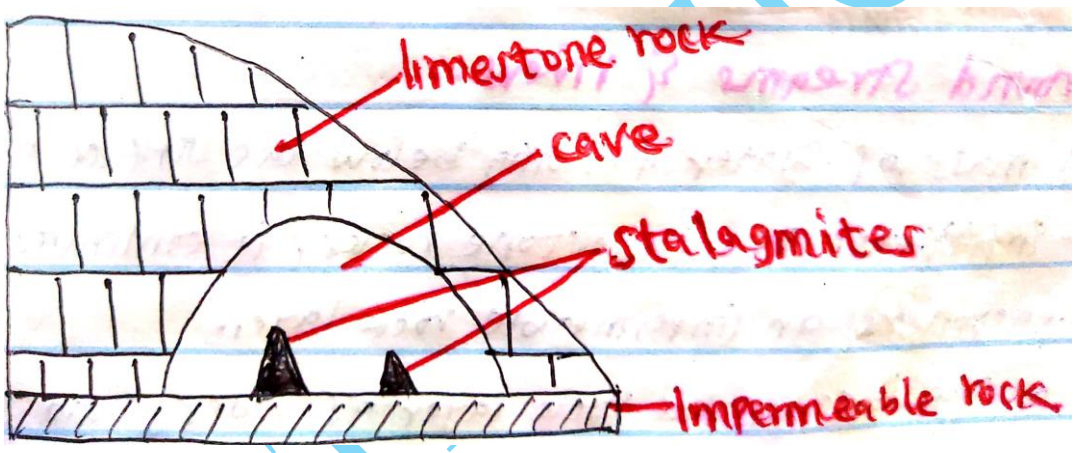

**(b) Stalactites.**

- They are underground finger-like projections formed by accumulation of calcium carbonate hanging vertically from the roof of a cave.
- **Formation;**
    - Rainwater water absorb carbon (iv) oxide in the atmosphere forming a weak carbonic acid.
    - The weak carbonic acid percolates through the joints in the rocks on the roof of a limestone cave.
    - It reacts with limestone rocks forming a soluble calcium bicarbonate.
    - The solution trickles down slowly through the roof of a cave/ cavern.
    - Solution droplets hang on the roof of the cave.
    - Water evaporates and calcium carbonate is precipitated.
    - Precipitated calcium carbonate gradually builds downwards.
    - Over a period of time, as the solution continue to drip from the roof, a finger-like projection hanging vertically from the roof of a cave is formed. This is called **stalactite.**



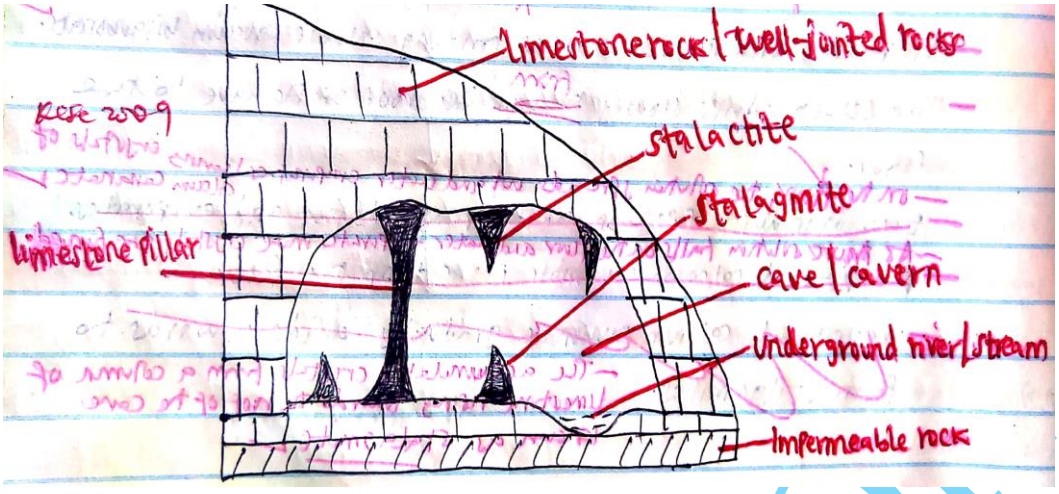
(c) **Stalagmites**

- They are underground stumpy rock masses which grow from the floor of the cave upwards.
- **Formation;** –kcse 2021
    - Rain water absorbs carbon (iv) oxide in the atmosphere forming a weak carbonic acid.
    - The weak carbonic acid percolates through the joints in the rocks on the roof of a limestone cave.
    - It reacts with limestone rocks forming soluble calcium bicarbonate.
    - The solution drips slowly from the roof of the cave to the floor.
    - On the floor, the solution spreads out and water evaporates leaving crystals of calcium carbonate.
    - As more solution falls on the floor and water evaporates, more crystals are formed.
    - The accumulated crystals form a column of limestone rising towards the roof of the cave known as **stalagmite.**




(d) **Limestone pillar.**

- This is a column of limestone which form a pillar-like structure joining the roof and floor of the cave.
- **Formation;** –kcse 2009
    - Rainwater water absorbs carbon (iv) oxide in the atmosphere forming a weak carbonic acid.
    - The weak carbonic acid percolates through the joints in the rocks on the roof of a limestone cave.
    - It reacts with limestone rocks forming a soluble calcium bicarbonate.
    - The solution trickles down slowly through the roof of a cave/ cavern.
    - Solution droplets hang on the roof of the cave.
    - Water evaporates and calcium carbonate is precipitated.
    - Precipitated calcium carbonate gradually builds downwards over a period of time from the roof of the cave forming **stalactite.**
    - The solution also splashes on the floor and water evaporates.
    - The precipitated calcium carbonate gradually builds upwards forming **stalagmite.**
    - Over time, the stalactite and stalagmite join to form a pillar-like structure called **limestone pillar.**



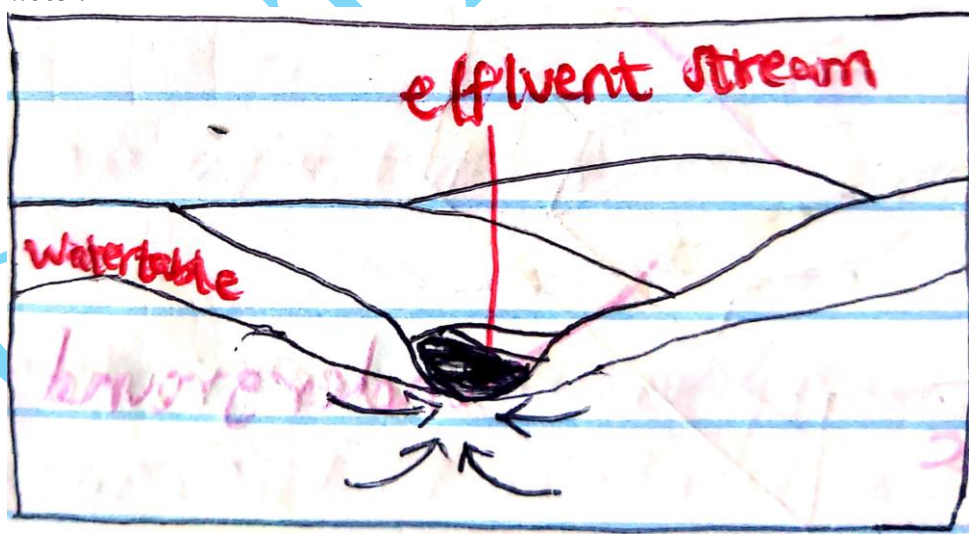

**(e) Underground streams/ rivers.**

- They are natural mass of water flowing below the surface of the earth.
- When rain water infiltrates the limestone rocks, it continues moving downward until it encounters an impermeable rock llayers.
- The water flows on the impermeable rock layer as underground streams.
- The streams flow for long distances until they re-emerge on the surface as springs.
- The point at which the stream appear at the surface is called **a resurgence.**

**Types of underground streams.**

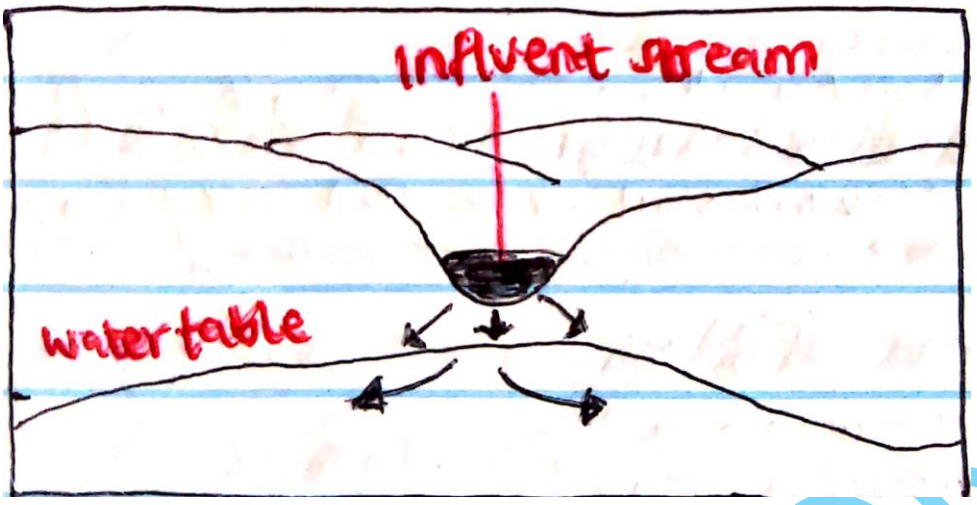
a) **Effluent streams.**

- They are underground natural mass of water fed by a water table over their level.
- They are underground natural mass of water which get their water from the ground water.



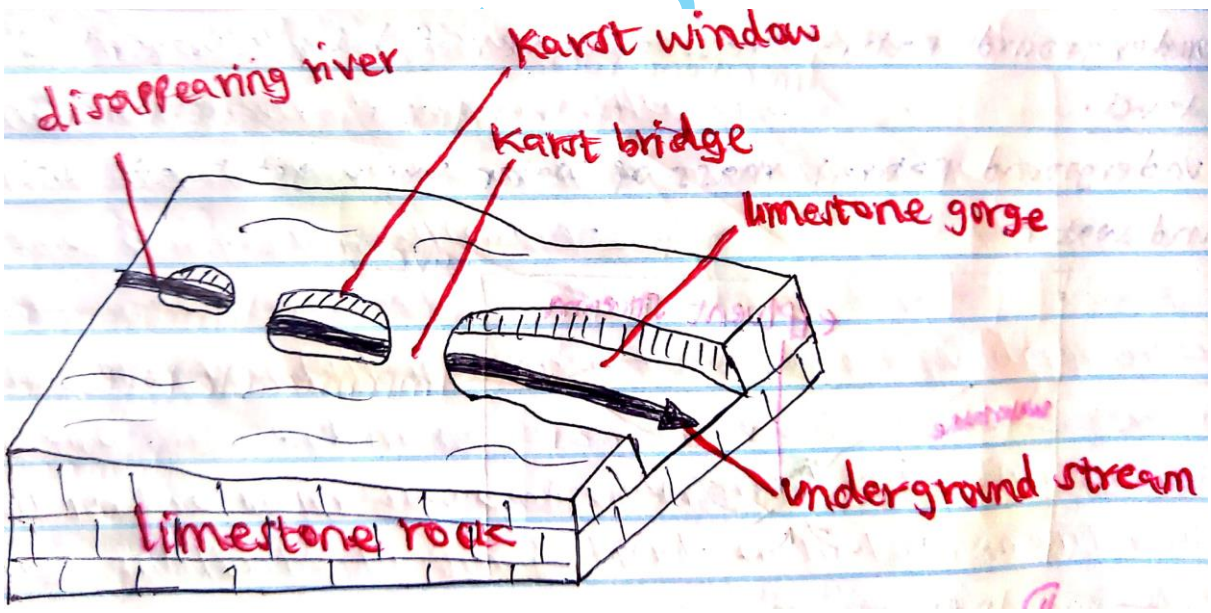

b) **Influent streams.**

- They are underground natural mass of water fed by water table below their level.
- They are underground natural mass of water that loses water as it flows downstream since water infiltrates into the ground.




**(f) Karst windows, Karst bridges and Hums.**

- Carbonation and solution processes occur along the joints and bedding planes of limestone rocks.
- Joints are enlarged forming underground chambers called caves/ caverns.
- Continuous growth of the cavern makes its roof to collapse leaving a hole called **karst window.**
- Karst window enlarges due to continuous collapse until a small part of the roof is left known as a **karst bridge.**
- When the limestone between the valleys eventually dissolves, some residual hills rounded by solution remain of the floor. These residual hills are called **hums.**



**Significance of the karst scenery/ resultant features of action of water in limestone areas.**

a. Features like limestone pillars and caves attract tourists earning a country foreign exchange.
b. Collapse of dolines and poljes in water table forms solution lakes that provide water for domestic and irrigation use.
c. Limestone blocks are used for building houses.
d. Limestone rocks are raw material in the manufacture of cement used in building and construction.
e. Limestone is used in iron and steel industry to separate iron from other impurities.
f. Limestone regions are very good for grazing sheep.
g. Karst landscape is rugged/ rocky discouraging settlement/ agriculture.
h. Karst landscape has intermittent streams/ no streams leading to scarcity of water supply.
i. Karst landscape has outcrop of bare rocks/ steep sided dry valleys/ gorges hindering development of transport networks.



……END……

# GLACIATION

## Definition of Glaciation: kcse 2023

- **Glaciation** is the process by which moving ice erodes, transports and deposits materials on the earth surface.
- **Glaciation** is the action of moving ice.

## Definition of Terms.

a) **Ice**

- **Ice** is the solid water formed by freezing and condensation of atmospheric water vapour or compaction of snow.

### How ice is formed on a high mountain –kcse 2008

- Due to low temperatures, water vapour freezes and forms snow which falls and accumulates on the mountain top.
- Snow continues pilling and new layers exert pressure on the lower layers.
- Lower layers become compressed or compacted as air is expelled from the spaces by snow particles.
- The compacted layers are ice.

### Conditions necessary for the formation of ice.

- ✓ Lower temperatures below 0ºc over a long time.
- ✓ High amount of water vapour in the atmosphere.
- ✓ High altitude above snowline.

b) **Snow.**

- **Snow** is the tiny ice crystals falling from the atmosphere.

c) **Snowline**

- **Snowline** is the lower limit of the area where tiny ice crystals falls.
- **Snowline** is the line beyond which there is permanent snow.

d) **Firn (in German) or Neve (in French).**

- **Firn/ Neve** is the compacted ice of seeping melted snow which re-freeze at lower levels and the snowflakes.

e) **Firn fields/ Neve fields.**

- **Firn fields/ Neve fields** are areas covered by compacted ice of seeping melted snow.

f) **Ice sheet** –kcse 2013

- **Ice sheet** is a large continuous mass of ice covering vast areas of land.

### Examples of ice sheets.

- ✓ Antarctica ice sheet.
- ✓ Greenland ice sheet.

### Reasons why there are no ice sheets in Kenya –kcse 2006

- ✓ Kenya experiences high temperatures under which ice sheets cannot form.
- ✓ Most parts of Kenya have low altitudes.
- ✓ Kenya is found at low latitudes.

g) **Nunatak.**

- **Nunatak** is the mountain peak projecting above an ice sheet.

h) **Ice cap.**

- **Ice cap** is an accumulation of ice covering the highest part of the mountain peak.
- It is of two types namely;
    - Island ice caps
    - Plateau ice caps

**Ice capped mountains** –kcse 2022

- ✓ Mt. Kilimanjaro
- ✓ Mt. Kenya
- ✓ Mt. Ruwenzori

i) **Ice bergs** –kcse 2021

- **An ice berg** is a large mass of ice floating in the ocean.

**Glacier** –kcse 2003

- **Glacier** is a mass of ice of limited width moving outwards from an area of accumulation.

**How glacier is formed.**

- Glacier is formed by accumulation and compaction of snow over a long time.
- During snowfall in high latitude and altitude areas, snow accumulates in pre-existing valleys/ depressions on the earth surface.
- Continued fall of snow increases its weight in the valleys.
- This compresses the layers at the bottom making them melt.
- The melted water flows and fills the existing air spaces before it freezes.
- Eventually the ice becomes thick, hard with glassy appearance because air has been squeezed out of it. This ice moves out of an area of accumulation forming **a glacier.**

**Types of glacier** –kcse 2008

i. **Valley glacier** is a mass of moving ice confined within a valley and which move forward from a central area of accumulation.
ii. **Cirque glacier** is a mass of moving ice confined / accumulated in depressions in the highlands.
iii. **Piedmont glacier** is a mass of moving ice accumulated at the foot of a glaciated mountain.
iv. **Ice sheet/ continental glacier** is a large continuous mass of ice covering vast areas of land.

**Ice Ages.**

- **An ice age** is a geological period during which ice sheets covered much of the earth. They include;
    - ❖ **Pre-cambrian period-** Occurred 5000 million years ago. It affected Central and Southern Africa e.g. Congo, Angola and Zambia.
    - ❖ **Ordovician period-** Occurred 500 million years ago. It affected North Africa and Sahara region.
    - ❖ **Carboniferous period-** Occurred 350-280 million years ago. It affected Central and Southern Africa e.g. Congo, Zambia and South Africa.

❖ **Pleistocene period-** Occurred 1 million year ago. It affected Ethiopia/ East Africa / Atlas Mountain.

## Ways in which ice moves –kcse 2023

i. **Basal slip-** The weight of the accumulated ice causes melting at the base which then acts as a lubricant facilitating the glacial flow.

ii. **Plastic flowage-** It is caused by melting and re-freezing of ice particles with slight displacement over a long period of time.

iii. **Internal shearing-** It involves differential sliding of broken mass of ice along planes within the ice.

iv. **Extrusion flow-** The weight of the accumulated ice compresses the layers beneath thus forcing them to spread out.

## Factors influencing movement of ice –kcse 2023

a. **Gradient of the land-** Ice moves faster on steep slopes than on gentle slopes due to the force of gravity.

b. **Thickness/ weight of glacier –** Thick masses of ice exert great pressure on the layers beneath inducing melting hence faster movement.

c. **Friction/ Nature of the surface-** The centre part of a glacier moves faster than the bottom and sides due to reduced friction/ resistance.

d. **Seasons/ Temperature change** – Ice movement is faster in warmer areas/ summer due to melt waters which acts as lubricant.

e. **Width of glacial valley-** Ice moves faster in narrow valleys/ slower in wide valleys.

## Action of Glaciation.

- This involves glacial erosion, glacial transportation and glacial deposition.

### Processes of Glacial Erosion.

- Plucking
- Abrasion
- Nivation

### (a) Plucking process–kcse 2010

- Also called sapping/ gouging/ quarrying process.
- Pressure from the overlying mass of ice cause freeze-thaw action.
- Melting water fills the cracks/ joints in the bed rock.
- As water freezes, it exerts pressure on the cracks enlarging them.
- The enlarged cracks lead to disintegration of the rock.
- The disintegrated rock eventually gets embedded within the mass of ice.
- As the ice moves, it pulls/ gouge out the ice embedded rocks from the mother rock by a process known as **plucking.**

### (b) Abrasion.

- This is the grinding process where the rock debris carried by the ice scrapes the floor and sides of the valley eroding them.

### (c) Nivation.

- This is where the freezing and thawing of ice in cracks widen the cracks leading to disintegration of rocks.

## Factors influencing glacial erosion.

a. **Nature of the underlying rock-** Well jointed/faulted rocks are easily eroded by plucking process since the joints allow water to enter into the rock. Soft rocks are eroded faster by abrasion compared to hard/resistant rocks.

b. **Availability of debris-** The more the debris embedded in the ice the more effective is abrasion process.

c. **The speed of the glacier-** The faster the speed of the glacier, the greater the erosive energy.

d. **The thickness and weight of the ice-** A thick glacier exerts great pressure on the underlying rock causing weathering. The rock debris embedded in the glacier is pressed down by the thick glacier to erode by abrasion.

## GLACIAL TRANSPORTATION.

- Materials transported by a glacier is called **moraine**. It consists of rock fragments, sand, gravel and boulders.

## Types of Moraine -kcse 2022

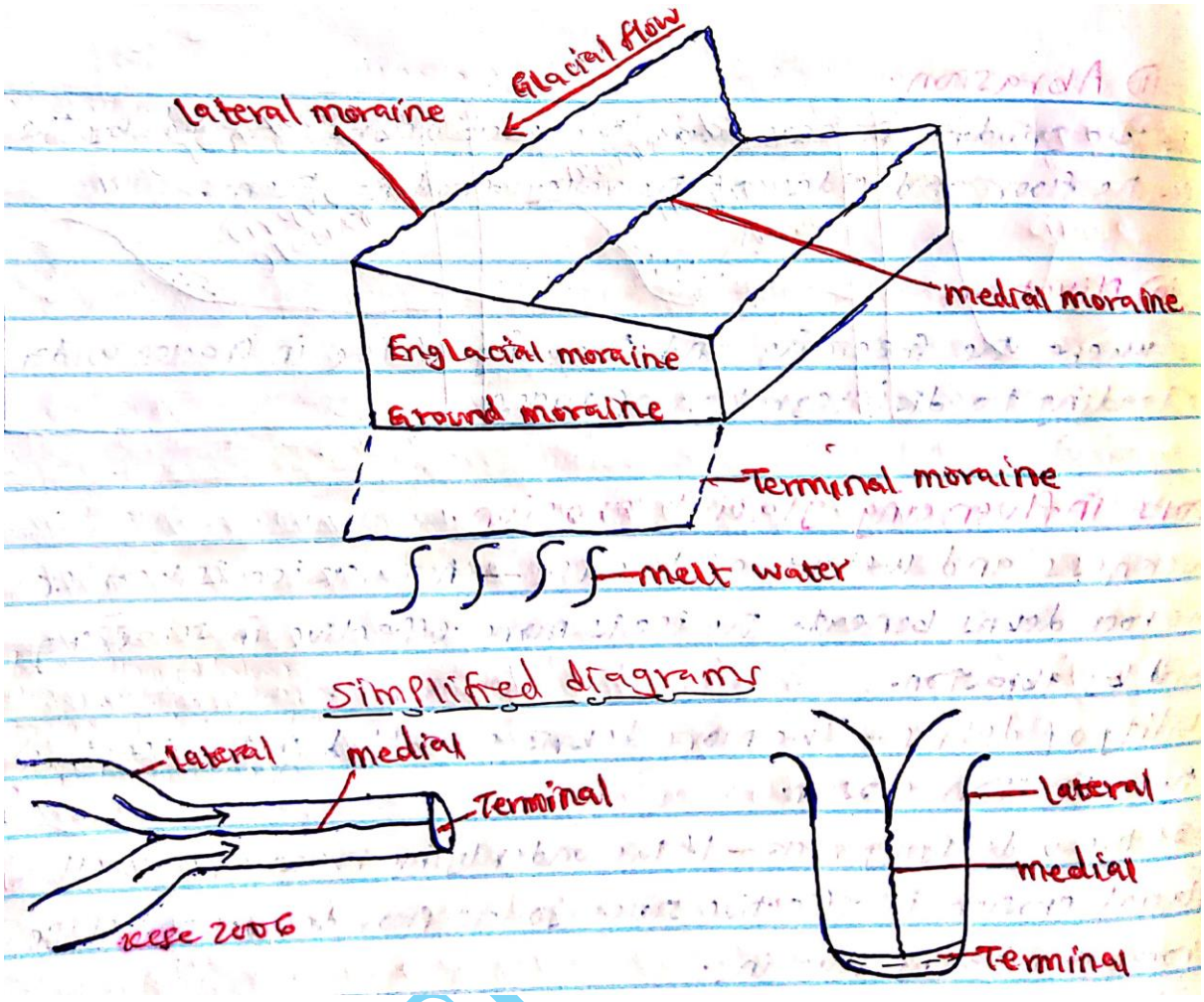
**a.** ***Ground moraine***- Materials carried at the base or underneath a glacier (sub-glacial).

**b.** ***Englacial moraine***- Materials carried within the ice.

**c.** ***Lateral moraine***- Materials carried along the sides of the glacier.

**d.** ***Medial moraine***- Materials carried on the surface but at the centre of the glacier.

**e.** ***Terminal moraine/ recessional***- Materials deposited by the glacier at the point where it melts.




## GLACIAL DEPOSITION.

- Glacial deposits are divided into fluvio-glacial and glacial till.
- Materials deposited by water from melting ice in a stratified manner are called **fluvio-glacial till.**
- Materials deposited by ice on melting in unstratified manner is called **glacial till.**
- The moraine and fluvial-glacial deposits found in a glaciated area are called **glacial drift.**

### Conditions that lead to glacial deposition- kcse 2010

a. **Rising temperatures** lead to melting of ice thereby causing the ice to deposit its load.
b. **Change of gradient to relatively flat surface** will reduce the velocity of the glacial movement which will subsequently lead to deposition of glacial materials.
c. **Alternating warm and cold periods** lead to seasonal melting of ice which allows materials embedded in the ice to be released and deposited.
d. **Obstruction/ stagnation/ accumulation of glacier** leads to pressure at the base of the glacier which in turn leads to melting of ice at the base.
e. **Friction at the base and sides of the glacier under a rough surface** leads to the melting of ice and deposition of materials.
f. **Increase in glacial drift** makes ice to be too heavy forcing it to deposit some of its load.

## Erosional features of glaciated highlands.

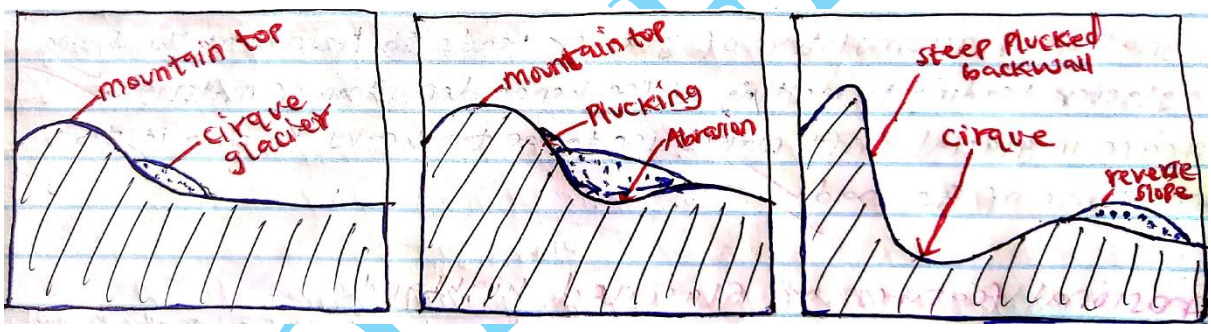
i. Corrie/ cirque
ii. Aretes
iii. Pyramidal peak
iv. Hanging valleys
v. Glacial trough/ U-shaped valley
vi. Fjords
vii. Rock basins and ribbon lakes
viii. Truncated spurs

### a.) Cirques/corries/tarns.

- These are deep-wide hollows/ arm chair shaped basins found on the sides of a glaciated highland.

Formation of cirque –kcse 2008

- Snow accumulates in a shallow pre-existing depression on the mountain side.
- The snow gets compacted into ice to form a cirque glacier.
- The ice erodes the bottom of the hollow by abrasion making it deeper.
- Plucking process operates on the sides of the depression steepening the backwall.
- Eventually a deep arm chair shaped basin called a **cirque** is formed.
- The cirque may be filled with melt water to form a **corrie lake/tarn lake.**




**Characteristics of cirque/ corrie/ tarn**- kcse 2008

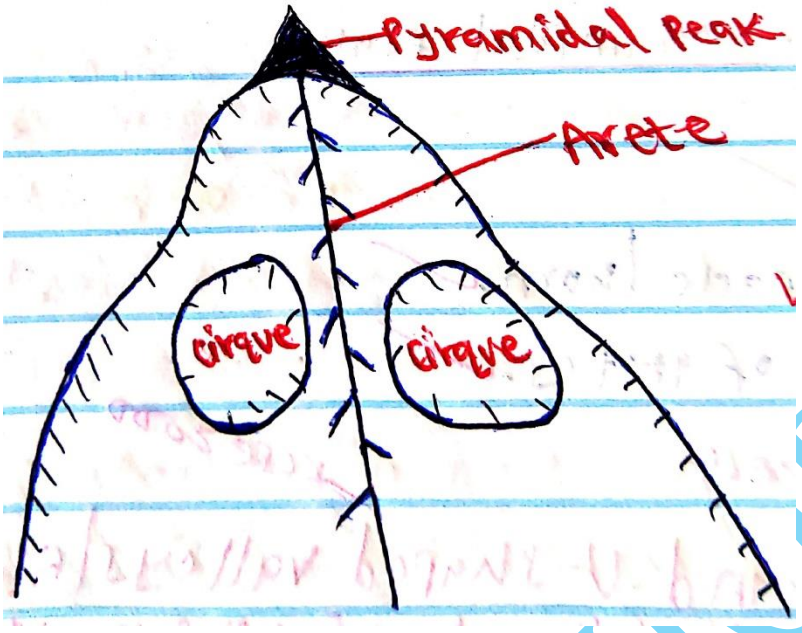
- ✓ It is a deep rock basin.
- ✓ It has steep sides.
- ✓ It is arm-chair shaped/ semi-circular.
- ✓ It has a high back wall.
- ✓ It has a reverse slope on the lower side.
- ✓

### b.) Arêtes.

- **An arête** is a narrow knife-edged steep sided ridge separating two cirques.

**Formation of arete**- kcse 2006

- Two adjacent hollows pre-exist on the mountain side.
- Ice accumulates in both hollows.
- The ice erodes the sides through plucking and deepens the hollow through abrasion.
- Through abrasion, the back walls of the hollows slowly recede and eventually the hollows/ cirques are separated by a knife-edged ridge called **an arête.**




***Characteristics of aretes.***

- ✓ It has steep sides.
- ✓ It is narrow.
- ✓ It is knife-edge shaped.
- ✓ It separates two cirques.

### c.) Pyramidal peak.

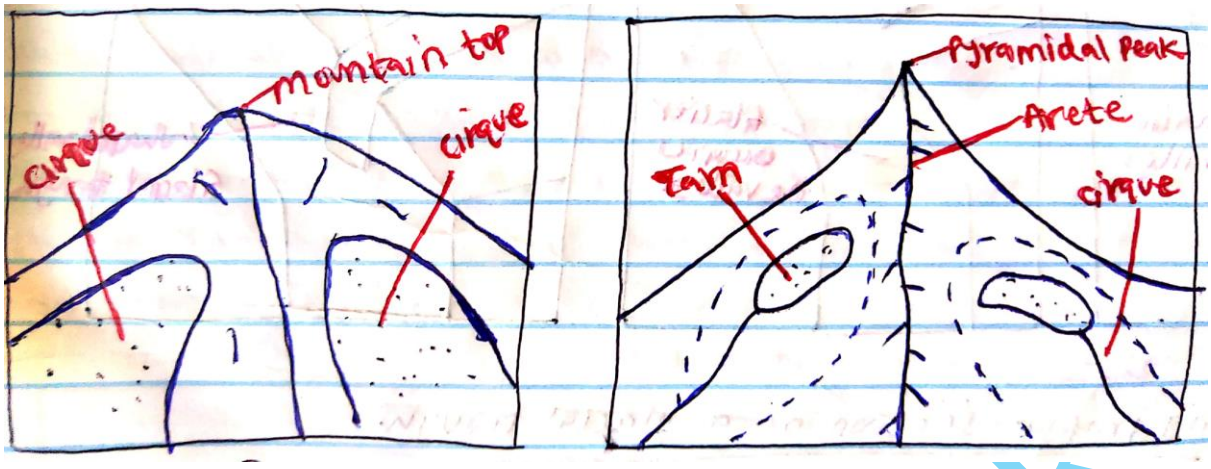
- This is a sharp point of convergence of arêtes on the mountain top.

**Formation of pyramidal peak** –kcse 2022

- Ice accumulates in several cracks/ hollows on mountain sides.
- Ice exerts pressure on the cracks/ hollows.
- Plucking action of ice enlarges and steepens the hollows allowing more ice to collect in them.
- Abrasion leads to deepening and enlargement of cracks/ hollows forming large basins called **cirques/ corries.**
- Moving ice plucks off loose rock materials from the basins thus enlarging them further.
- Nivation eats into the back wall of basins making them recede into the mountain side.
- Steep-sided knife edged ridges/ **Arêtes** are formed separating the basins.
- Three or more of these ridges/ arêtes converge at the mountain top forming a jagged peak known as **a pyramidal peak.**

**Examples of pyramidal peaks.**

- ➢ **On mount Kenya e.g.** Batian peak, Nelion peak, Lenana peak, Sendeyo peak, Shipton peak
- ➢ **On mount Ruwenzori e.g.** Margherita peak, Stanley peak, Speke peak, Baker peak
- ➢ **On mount Kilimanjaro e.g.**

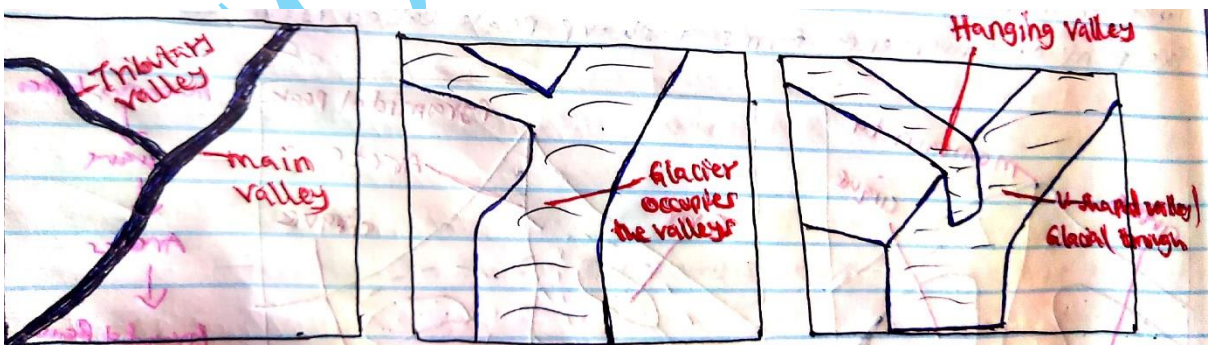


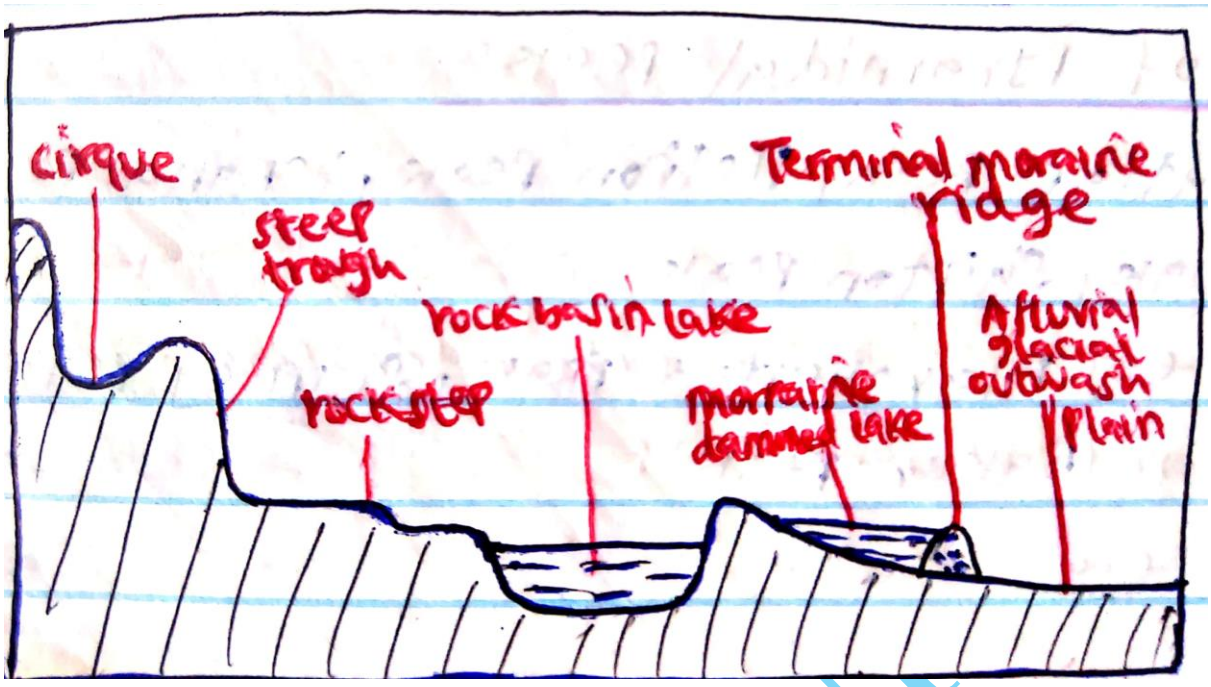

**Characteristics of pyramidal peak** –kcse 2008

- ✓ Has steep sides.
- ✓ Surrounded by cirques.
- ✓ It has a sharp rock pinnacle/ horn.
- ✓ Has a radiating system of aretes.

d.) **Hanging valleys** –kcse 2014 and **U-shaped valleys/glacial trough** –kcse 2000

- Formed in glaciated highlands where there is a main river valley and a tributary river valley.
- The two valleys get filled with ice and the main valley has more ice than the tributary valley.
- As the ice gets heavy/ thick, it begins to flow down the slope eroding by plucking and abrasion.
- The main river valley is deepened and widened more than the tributary valley.
- When ice melts, it exposes a deep, **U-shaped glacial valley/ Glacial trough** while the tributary valley is left at a higher level.
- The tributary valley above the main river valley is known us the **hanging valley.**






### e.) Fjords/fiords.

- This is a submerged glacial trough on a highland coast formed after a glaciated valley is drowned/submerged by sea/ocean.
- Action of ice through plucking and abrasion results in the widening and deepening of the lower sections of an already existing river valley.
- With time, glacier disappears after melting leaving behind a steep sided valley.
- When there is a rise in the sea level, the straightened and deep glacial valley is drowned/submerged by the sea water to form ***fiords/fjords.***
- They are mainly found in temperate lands along the Scandinavian countries.

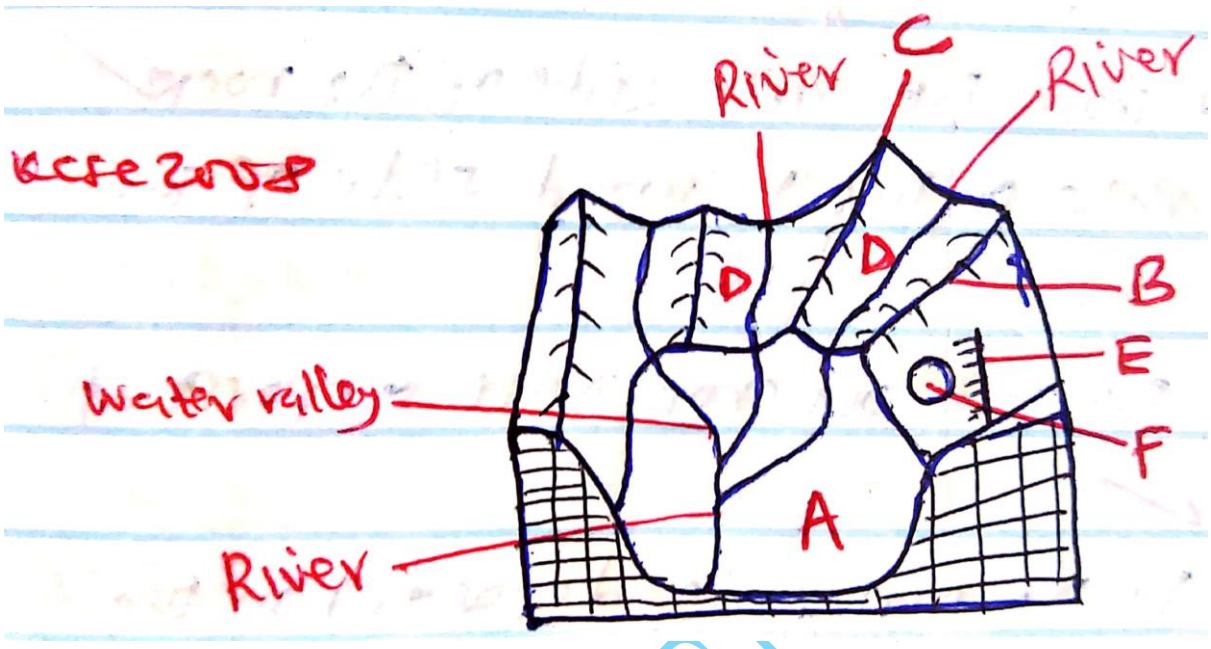
**Characteristics of fiord/ fjord** –kcse 2008

- ✓ Has steep walls.
- ✓ Has narrow sea inlets.
- ✓ Is U-shaped.
- ✓ Has hanging valleys.
- ✓ Has deep waters.
- ✓ It is shallower seawards/ deeper landwards.

### f.) Rock basin and Ribbon lakes.

- This is a depression within a glacial trough where differential erosion has taken place especially areas that have less resistant rocks.
- At the point where two glaciers converged erosion is greater resulting in the formation of a glacial depression called a ***rock basin***.
- They also form in areas with less resistant rocks where the glacier removes these (less resistant rocks) through abrasion and plucking; leaving behind a shallow depression called a ***rock basin.***
- Later, during the post glacial period, water may accumulate in the rock basin/depression/hollow to form lakes called ***finger*** or ***ribbon lakes.***

***QUIZ: The diagram below shows features of a glaciated highlands. Name the features marked A-F***




A- U-shaped valley/ Glacial trough.
B- Arete
C- Pyramidal peak
D- Hanging valley
E- Truncated spur
F- Cirque

**Erosional features of Glaciated lowlands** –kcse 2021

- ✓ Roche moutonnee.
- ✓ Crag and tail.
- ✓ Ice eroded plains.
- ✓ Depressions.

**i.) Ice eroded plains.**

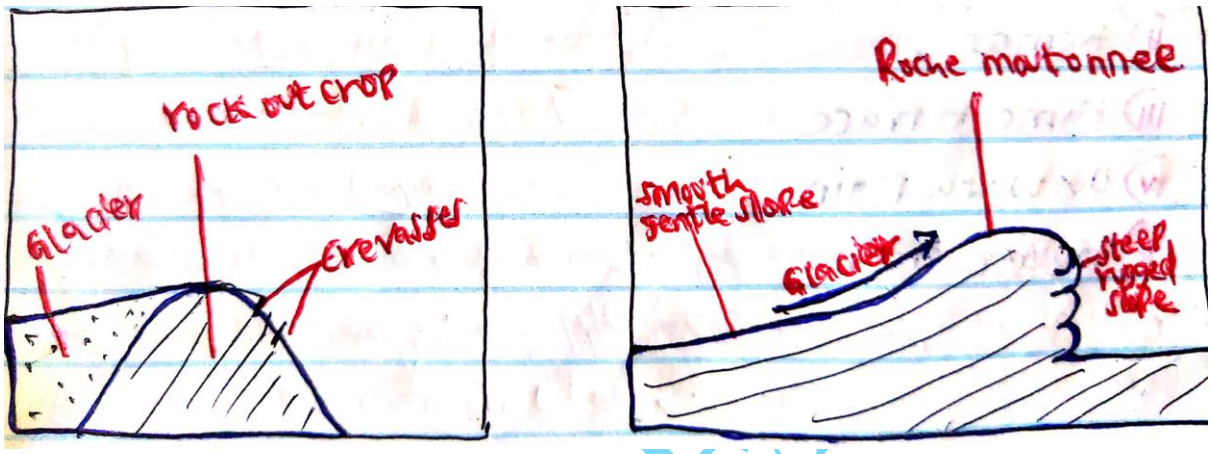
- These are extensive and almost level lowlands that were previously under ice sheets.
- During glacial transportation, ground moraine erodes the rocks on the existing landforms through abrasion and plucking to form long and extensive plains called ***ice eroded plains.***

**ii.) Depressions.**

- Lowland glacial areas may comprise of less resistant rocks that are easily eroded by ice sheets/glacier.
- The glacier scoops out the materials from the surface through plucking and then lowers it to form shallow ***depression***.
- This depression may later fill with melt water to form a glacial lake.

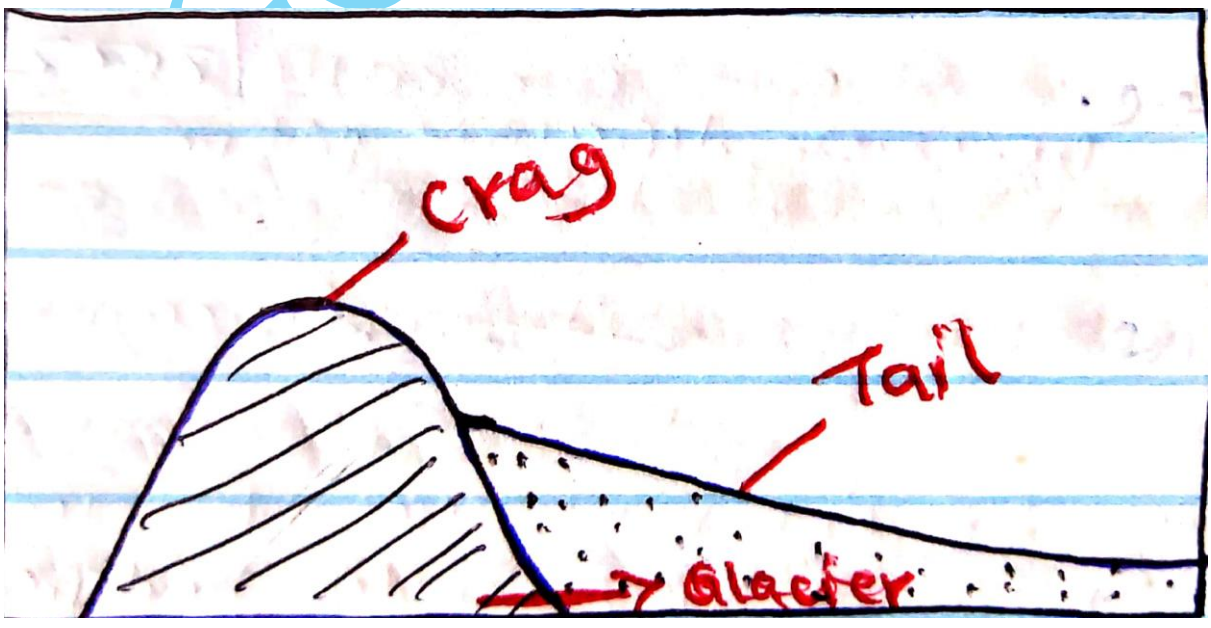
**iii.)** **Roche Moutonnee** –kcse 2023

- When an ice sheet erodes a low lying area and comes across a resistant rock.
- The resistant rock is eroded at a slower rate than the surrounding rocks.
- The upstream is eroded more through abrasion.
- On the downstream side, the ice erodes mainly by plucking.
- When the ice retreats, the underlying resistant rock is exposed.
- Consequently, the outcrop rock has a gentle and smooth upstream side while the downstream is steep and rugged forming a **Roche moutonnee.**




iv.) **Crag and tail** –kcse 2022

- A large block of rock stands on the path of oncoming glacier.
- The moving ice plucks off weak rock fragments from the upper side of the rock.
- As the ice moves round and over the resistant rock, it carries the eroded materials to the leeward side. (The leeward side does not experience erosion)
- Eroded materials are deposited on the leeward side of the rock.
- With time the moving ice smoothens the upslope side of the rock while deposited materials increase on the leeward side.
- The resistant rock is the **crag** while the materials deposited on the leeward side form the **tail.**



## Glacial Depositional features in lowlands.

1. **Those composed of unstratified till deposited by a glacier;**
    - **i.** Glacial till
    - **ii.** Drumlins
    - **iii.** Terminal moraine
    - **iv.** Kettle lakes
    - **v.** Erratics

2. **Those composed of stratified fluvio-glacial materials;**
    - **i.** Esker
    - **ii.** Kames
    - **iii.** Kame terrace
    - **iv.** Outwash plain
    - **v.** Boulder train

### i.) Glacial Till/ Boulder clay.

- These are materials directly deposited by ice on melting in unstratified manner e.g.
    a) **Lodgement till-** Materials deposited beneath the active/ moving ice.
    b) **Ablation till-** Materials deposited when ice melts away.
    c) **Basal till-** Materials deposited when the speed of glacier is slowed by an obstacle.
    d) **Flow till-** Suspended materials that settle into a depression existing within the ice.

Note: Till can cover former valleys and hills to produce **a till plain** of monotonous relief.

### ii.) Drumlins.

- They are rounded, elongated hills of glacial deposits resembling eggs.
- They are formed beneath the ice due to friction between the bedrock and the boulder clay.
- This results to deposition of clay at the valley bottom.
- Further deposition leads to large mounds of till forming.
- The moving ice streamlines the till that had been deposited irregularly resulting into elongated egg-shaped hills called ***drumlins.***

### iii.) Terminal moraines –kcse 2010

- Moving ice carries solid materials.
- The moving ice stagnates.
- Ice at the snout melts.
- Melting ice releases its load.
- The load gradually piles into a ridge.
- Overtime the ridge forms a horse-shoe shape or block of solid materials called **terminal moraine.**

Note: A series of almost parallel ridges of maoraine is called **recessional/ stadial moraine.**

### iv.) Kettle lakes.

- Refers to melt water that occupy depressions formed after blocks of ice are detached from the main glacier.

**v.) Erratics.**

- Large boulder rocks transported from highlands and deposited on a till plain.

**vi.) Boulder train.**

- Compose of series of erratics.

**vii.) Kames.**

- Kames are isolated hills made of sand and gravel which have been deposited in layers by glacial water.
- They are built by streams emerging at high levels from temporary and stagnant ice covers.
- As the glacier front recedes, unsupported back of deposits collapses leaving a steep faced hill called ***kames.***

**viii.) Eskers.**

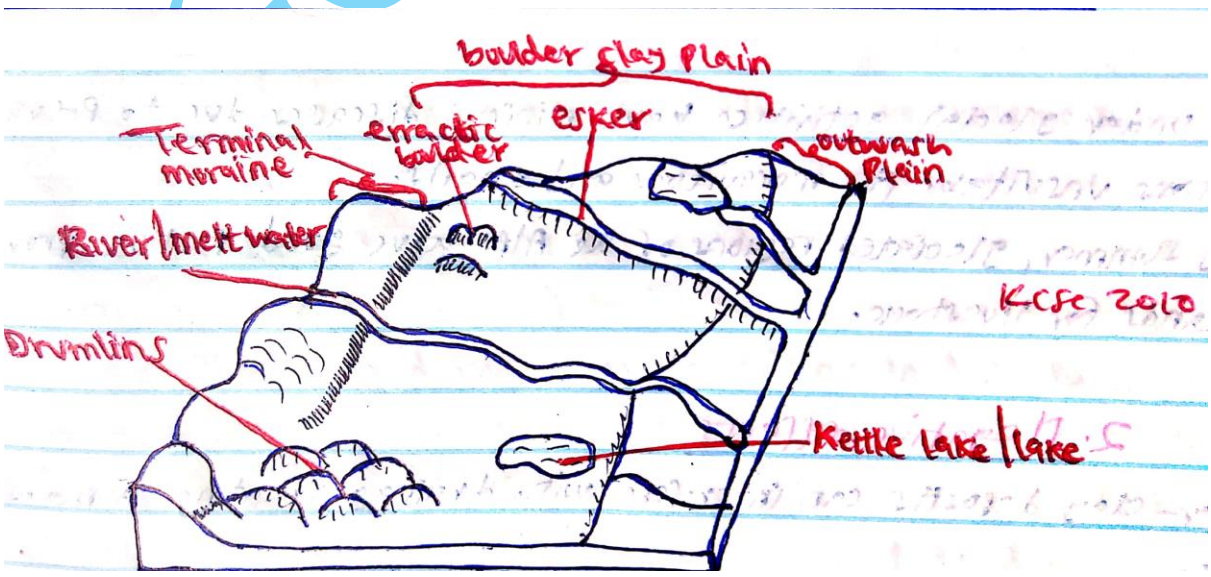
- Eskers are long winding ridge of coarse sand and gravel that is formed by streams that flow continuously beneath/within the ice but in a parallel direction to the moving ice.
- As the ice front recedes, the streams continuously deposit the materials to form a long winding ridge called ***eskers.***

**ix.) Kame terrace.**

- A discontinuous accumulation of sand and gravel along the valley side.

**x.) Outwash plain** –kcse 2023

- Large ice sheets stagnates on a gently sloping lowland/ landscape and start melting along the edge and at the bottom.
- The melt waters flow beyond the terminus carrying along rock materials.
- The melt waters deposit the rock materials as it flows.
- The fluvial glacial materials deposited fill in the pre-existing valley/ depressions.
- The loose clay, sand, silt and gravels are deposited in stratified order with the coarse materials first while fine ones carried further away.
- The retreat of the ice sheet leaves behind an undulating plain of unconsolidated materials/ silt/ sand/ gravel called an ***outwash plain.***



## QUIZS.

1. **Name three types of ice masses found on mountains in East Africa.**
   - ✓ Valley glacier.
   - ✓ Ice caps.
   - ✓ Cirque glacier.

2. **Describe how a moraine dammed lake is formed** –kcse 2023

- A mass of ice approaches a wide low lying area.
- Ice starts to melt at the edge.
- This leads to deposition of terminal moraine across the valley resulting to a transverse ridge (barrier).
- More deposition of the terminal moraine raises the transverse ridge.
- As the ice melts, the melt waters accumulates behind the ridge.
- The glacier continues to retreat towards the snow field as it is melting.
- The water that accumulates behind the ridge of terminal moraine forms **a moraine dammed lake.**

### Significance of Glaciation and glacial features –kcse 2010/ 2022

- ✓ Corrie lakes/ tarns offer suitable areas for trout fishing.
- ✓ U-shaped valleys form natural route ways.
- ✓ Fiord coastline form deep well sheltered natural habours/ good fishing grounds.
- ✓ Glaciated upland areas form magnificent features that encourage recreation/ tourism.
- ✓ Waterfalls formed in glaciated uplands provide suitable sites for hydro-electric power production.
- ✓ The warm glaciated valleys are suitable for livestock farming/ cultivation.
- ✓ Glacial erosion exposes minerals leading to mining.
- ✓ Melting glacier form Rivers which provide water for domestic / industrial / agricultural use.
- ✓ Glacial till provides deep well drained soils which are suitable for arable farming.
- ✓ Outwash plains comprise of sand and gravel which are used as building materials.
- ✓ Glaciated lowlands are generally flat and ideal for establishment of settlements/ development of transportation network.

### Negative effects of glaciation on human environment –kcse 2023

- ✓ The boulder clay deposited creates marshy landscape due to poor drainage making it unsuitable for human settlement.
- ✓ The infertile soil deposited makes it unsuitable for agriculture.
- ✓ The numerous lakes formed in the lowlands reduces the land available for use.
- ✓ Glaciation results into rugged landscape making construction of transport networks/ settlement/ agriculture difficult.
- ✓ Glacial deposits may bury minerals making mining difficult/ expensive.
- ✓ Avalanches may lead to destruction of property/ loss of life.

……..END…….

## TOPIC FOUR: SOILS.

### Definition of soil –kcse 2012

- **Soil** is a naturally occurring thin layer of loose/ unconsolidated materials which overlies the crustal rocks and on which plants grow.

### Components of Soil –kcse 2019

- ✓ Mineral particles/ inorganic matter.
- ✓ Humus/ organic matter.
- ✓ Water.
- ✓ Air.

### Ways in which humus contributes to the quality of soil –kcse 2021

- ✓ By retaining of moisture.
- ✓ By facilitating the aeration of the soil.
- ✓ By improving the soil texture.
- ✓ By providing mineral matter in soil.
- ✓ By providing food for micro-organisms in the soil.
- ✓ By binding the soil particles together.
- ✓ By improving soil structure.

### Soil forming processes/ ways.

- ✓ Weathering
- ✓ Decomposition of organic matter.
- ✓ Leaching.

#### a.) Through weathering.

- This involves breaking and disintegration of parent rocks through physical and chemical processes.
- This (weathering) results to regoliths that are further broken into smaller and finer particles to form soil.

#### b.) Through decomposition of organic matter.

- This involves the accumulation and decomposition of decaying plants and animal matter on the ground surface.
- This is done through mineralization and humification.
- ***Mineralization*** is the biological and chemical breakdown on dead plant tissues by soil microorganism to produce simple soluble organic substance.
- ***Humification*** involves regrouping of the mineralized materials into large molecules to form humus.

#### c.) Through leaching.

- **Leaching** is the process by which soluble mineral particles are carried in solution form from one soil layer to the other.

### Factors determining soil leaching –kcse 2012

- ✓ Nature of soil.
- ✓ Solubility of minerals.
- ✓ Amount of rainfall/ alternating wet and dry season.
- ✓ Nature of the slope.

## Soil leaching processes.

a) **Ferralisation/ Laterization** (kcse 2006).
- This is where soluble materials are carried from horizon A to horizon B leaving insoluble minerals that form laterites/ ferrisols on the top layer.

b) **Eluviation.**
- It is the downward movement of soluble materials from horizon A to horizons B and C.

c) **Illuviation.**
- It is the redeposition of soluble materials from horizon B back to horizon A.

d) **Podzolization** –kcse 2014
- It occurs in areas with high rainfall and low temperatures/ cool and wet conditions/ cool temperate regions/ humid temperate regions/ coniferous forest covered areas.
- Slow decomposition of vegetative matter results in formation of humic acid.
- Minerals such as calcium/ iron/ magnesium/ aluminium/ potassium/salts/bases/ carbonates in the soil are dissolved and moved/ translocated from horizon A to B.
- This leaves the soil extremely acidic/ humic/ ash grey/ light in colour/ grey-brown/ red-yellow/ white.

e) **Calcification.**
- It is the limited leaching which allows the redeposition of calcium compounds within the same soil profile.

f) **Ribification.**
- It is where soils are dehydrated during dry season and leached during the rainy season.

g) **Salinization.**
- It is where soils are leached upwards through capillarity depositing salts on the surface.

## Factors influencing soil formation.

i. Parent rock
ii. Climate
iii. Living organisms/ Biotic factors
iv. Relief
v. Time

### a.) Parent rock -kcse 2023

- Nature of parent rock determines the **mineral composition** of the soil.
- Resistant/ hard parent rock result in **coarse grained soils**/ soft rocks lead to fine textured soils.
- The minerals in the parent rock determine the **soil colour** while young.
- The nature of parent rock influences the **rate of weathering**, in that soft rocks weather fast while hard rocks weather slowly.

### b.) Climate –kcse 2023

- Rain water influences chemical and physical weathering leading to formation of soils through rock break up/ decay.
- Rainfall causes leaching resulting to laterite soils.
- High temperatures facilitates chemical/ physical weathering causing faster formation of soils/ lower temperatures slow down rate of soil formation.
- High temperatures quicken decay forming the organic matter in soils.
- Wind may expose parent rocks to weathering processes/ erode loose soil particles making them thin.
- Wind/ rain water may deposit light particles that accumulate to form soils.

### c.) Living organisms/ Biotic factors –kcse 2012

- Microorganisms in the soil assist in plant/ animal decay to form humus.
- The microorganisms mix and aerate the soils.
- The roots of plants penetrate the soil enabling it to become porous.
- When plants and animals die, they decay to form humus/ organic matter in the soil.
- Burrowing animals/ penetrating plant roots breaks up the rock into small particles forming soils.

### d.) Relief –kcse 2010

- Valley bottoms encourage formation of deep well drained soils due to deposition or accumulation of weathered materials.
- Steep slopes encourage rapid removal of the top soil thus slowing down soil formation. They have thin soil or underdeveloped.
- Flat areas may be saturated with water or are waterlogged and this slows down soil formation.
- Gently sloping areas have well developed soils since they are well drained.

### e.) Time –kcse 2017

- Where soil formation processes take a short duration, the soils are generally immature.
- Where soil formation processes has taken a long period of time, soils are generally well developed or mature.
- Young soils retain the characteristics of the parent rock since they have not been exposed to factors that may cause change.
- Mature soils may not display the characteristics of the parent rock.

## Properties of soil –kcse 2023

i. Soil structure
ii. Soil texture
iii. Soil colour
iv. Soil porosity
v. Soil permeability
vi. Soil acidity/ alkalinity

### a.) Soil texture –kcse 2017

- This is the degree of fineness or coarseness of the particles making up the soil.
- It is the size of the soil particles.
- The texture controls the size and spacing of the soil pores/ soil aeration.
- This affects the soil water content/ the drainage/ leaching.

## Importance of Soil Texture –kcse 2022

- ✓ It influences the ease of plant root penetration into the soil.
- ✓ It regulates the soil water content.
- ✓ It controls aeration of the soil.
- ✓ It controls the availability and retention of nutrients within the soil.
- ✓ It controls the size and spacing of pores in the soil.

## Types of soils by texture –kcse 2022

**i. Sandy soils.**

- Have high permeability because of large particles.
- Well aerated.
- Low mineral nutrients due to leaching.
- Low water content.
- Easy to cultivate.
- Ideal for horticulture.

**ii. Clay soils.**

- Very fine soil particles.
- Retain a lot of water i.e. are waterlogged.
- Contain little air.
- Rich in nutrients and organic matter.
- Difficult to cultivate.
- When dry, the surface becomes hard and concrete like.
- Ideal for paddy rice.

**iii. Loamy soils.**

- Consists of medium soil particles.
- High organic matter.
- Ideal for agriculture.
- Consists of a mixture of sandy, silty and clay particles.

**iv. Silt soils.**

- Medium size particles.
- High water content.
- High organic matter.

**b.) Soil structure** –kcse 2017

- **Soil structure** is the way the individual soil particles are arranged into aggregate compound particles.

### Types of soil structure.

- ✓ Crumb soil structure.
- ✓ Granular soil structure.
- ✓ Plate soil structure.
- ✓ Prismatic soil structure.
- ✓ Blocky soil structure.
- ✓ Columnar soil structure.

**Importance of soil structure.**

- ✓ It influences the rate at which soil absorbs and retains water.
- ✓ It determines soil stability.
- ✓ It determines the degree of soil aeration.
- ✓ It contributes to soil fertility as well as plant growth as it facilitate root penetration by plants.
- ✓ It influences the activities of microorganisms in the soil.
- ✓ It determines the ease with which a soil can be cultivated.
- ✓ It describes the characteristics of soils in terms of appearance and physical properties.

**c.) Soil acidity.**

- It is the high concentration of hydrogen ions in the soil solution.
- It is reduced by adding lime (calcium hydroxide) to the soil.

**Significance of soil acidity.**

- ✓ It reduces the rate at which bacteria decompose organic matters.
- ✓ It reduces the rate at which roots absorb minerals.
- ✓ It also determines the chemical environment in which plants grow.
- ✓ It also determines conditions under which microorganisms live.

**d.) Soil colour**- kcse 2017

- Soils have different colours influenced by parent rock/ vegetation/ leaching processes.
- Black/ dark brown soils denote a lot of humus.
- Grey soils are characteristics of poorly drained/ water logged soils.
- Whitish soils show high concentration of salts.
- Reddish soils have high concentration of iron.

**Factors determining the soil colour** –kcse 2006

- ✓ The type of parent rock.
- ✓ The amount of organic matter or humus.
- ✓ The chemical composition/ degree of concentration of minerals.
- ✓ The amount of water in the soil/ the drainage of the soil.

**e.) Soil porosity**- kcse 2017

- This is the amount of pore spaces in the soil.
- The size of the pore spaces determine the water flowing in the soil/ sandy soils have high porosity hence allow water to pass through / clay soils have many pores hence retain water.

**f.) Soil permeability.**

- This refers to the movement of water in the soil. It depends on the soil texture i.e. fine textured soils are impermeable.

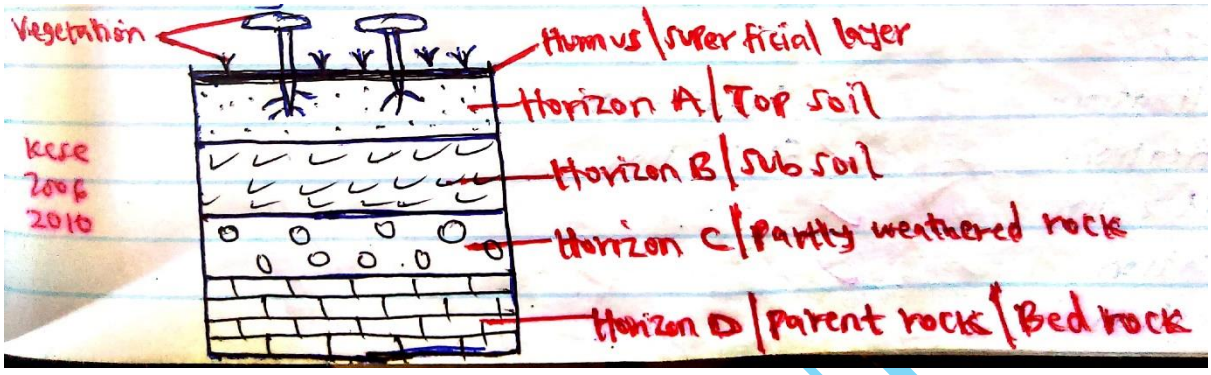
**Soil depth.**

- This is the mass of a unit volume of dry soil/ the amount of dry soil overlying a parent rock.
- Soil depth is influenced by the following factors;
  - ✓ Nature of the bed-rock/ the ease with which it weathers.
  - ✓ The length of time the soil has taken to form.
  - ✓ The vegetation cover existing in the area.

- ✓ The climate of the place.
- ✓ The rate of weathering of the mineral matter.

## Soil profile –kcse 2022

- This is the vertical arrangement of the soil into layers/ horizons from the surface to the bedrock.




### Horizon A/ Top soil

- Uppermost layer.
- Rich in humus.
- Leaching takes place here.
- Contains plant roots and micro-organisms.

### Horizon B/ Sub-soil –kcse 2010

- Found below the topsoil.
- An accumulation zone for leached minerals from horizon A.
- Mainly made up of inorganic materials.
- The soil texture is clay in nature.
- Soils are red/ brown in colour.
- The zone sometimes forms the hard pan/ murram.
- Subdivided into B1, B2 and B3.
- It is illuviation zone.

### Horizon C/ Partly weathered materials.

- Has weathered rocks.
- Very low content of organic matter.
- Deepest layer.
- No accumulated leached materials.

### Horizon D/ Parent rock/ Bed rock.

- This is the solid underlying rock.
- Forms the basis of soil formation.
- Rocks have not undergone weathering.

NOTE: **The development of soil profile is determined by the following processes:** Podzolization, Calcification, Ferralization, Desilication, Salinization, Solodization and Gleization.

**Factors used to identify the layers of a soil profile.**

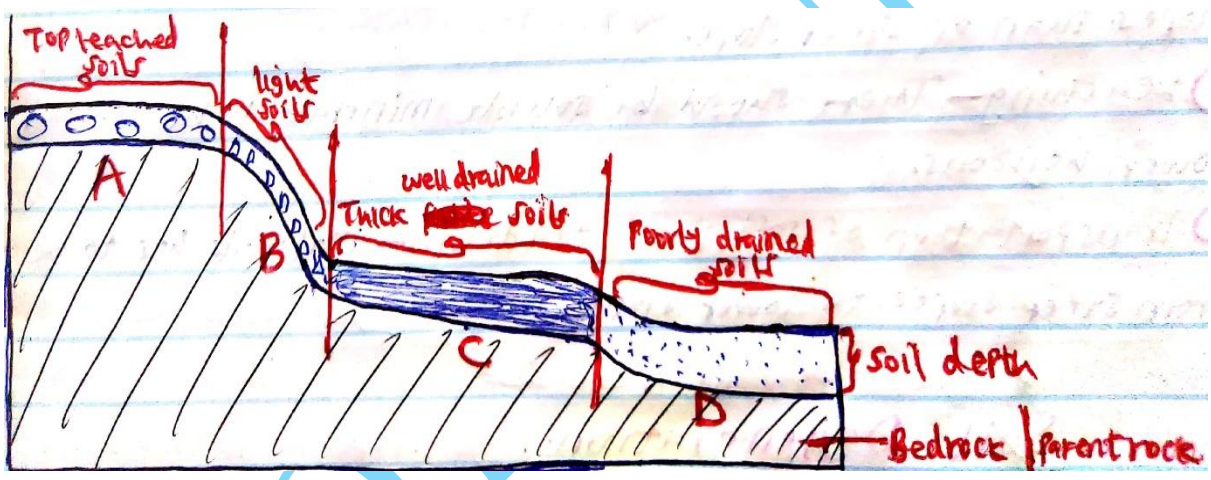
- ✓ Soil colour.
- ✓ Soil texture.
- ✓ Soil porosity.
- ✓ Chemical/ mineral composition.
- ✓ Soil thickness.

**Factors influencing the development of a soil profile.**

- ✓ Climatic elements e.g. rainfall and temperature.
- ✓ Vegetation cover.
- ✓ Drainage.
- ✓ Length of time taken for the soil to develop parent rock.
- ✓ Leaching process.
- ✓ Gradient of the slope.

**Soil Catena** –kcse 2022

- **Soil catena** is the sequence of different soils down a slope.




**Zone A**

- Laterite soils.
- Red in colour/ heavily leached.
- Acidic.
- Rich in iron and aluminium oxides.
- Have low humus content/ organic matter.
- Have developed soil profile.
- Are mature soil.
- Are of low agricultural value.

**Zone B**

- Soils are very thin because of high rates of erosion.

**Zone C**

- Well drained mature soils.
- Thick soils.

## Zone D

- Peat/ Bog soils.
- Poorly drained/ waterlogged.
- Grey/ Blue in colour.
- Are acidic.
- Have poorly developed soil profile.

## Factors influencing development of a soil catena.

**a.) Relief.**

- The top and bottom of the hill/ mountain must be gently sloping while the side should have a steep slope.

**b.) Drainage.**

- The rate of water percolation should be more on gentle slopes than on steep slope.

**c.) Leaching.**

- There should be soluble minerals to be carried to the lower horizons.

d.) **Transportation of soil particles/ debris.**

- Materials has to be moved from steep slopes to lower slopes.

## Soil Degeneration.

- Also called **soil degradation/ deterioration/ impoverishment.**
- It means the loss of soil fertility.
- It is the decline in the quality and productivity of soil due to both natural and human causes.

**Types of soil degeneration** –kcse 2013

- ✓ Physical degeneration.
- ✓ Biological degeneration.
- ✓ Chemical degeneration.

1. ***Physical degeneration*** is the decline in the usefulness of the soil due to **changes in its** physical properties like **soil texture, structure and moisture content**. It is due to the following **causes**;
   - ✓ Poor land-use practices such as overgrazing.
   - ✓ Excessive soil erosion due to heavy rainfall.
   - ✓ Drought.
   - ✓ Over-cultivation.
   - ✓ Use of heavy farm machines.

2. ***Biological degeneration*** is the decline in the usefulness of the soil due to **change in the organic content of the soil**. It is due to the following **causes**;
   - ✓ Overgrazing.
   - ✓ Deforestation.
   - ✓ Burning of land.
   - ✓ Soil water-logging.
   - ✓ Prolonged drought.

3. ***Chemical degeneration*** is the decline in the usefulness of a soil due to **change in the soil pH and mineral composition of soil**. It is due to the following **causes**;
   - ✓ Monoculture.
   - ✓ Over-cropping.
   - ✓ Excessive or wrong application of fertilizers.
   - ✓ Excessive leaching.
   - ✓ Excessive drought also leads to accumulation of salts in the top soil.

**Causes of soil degeneration** –kcse 2019

- ✓ **Soil erosion** interferes with soil structure leading to loss of top productive soil.
- ✓ **Excessive drought** leads to accumulation of salts in the top soil making it saline.
- ✓ **Leaching due to heavy rainfall** can lead to percolation of soil nutrients to the lower horizons leading to deficiency of the top soil.
- ✓ **Excessive/ wrong application of fertilizer** may affect the soil pH making it too acidic interfering with soil micro-organisms.
- ✓ **Poor agricultural practices** like burning of land/ over cultivation/ monoculture/ over cropping cause soil to be deficient in some mineral nutrients leading to loss of soil fertility.
- ✓ **Other human activities** like quarrying/ construction of roads interfere with soil structure leading to soil degeneration.
- ✓ **Mass wasting e.g. landslide** may bring sub-soil to the top causing soil degeneration.

## Soil Erosion.

- This is the removal of the top soil by the action of moving water, wind, glaciers, mass movements and human activities.

**Agents of soil erosion.**

- ✓ Moving water.
- ✓ Wind.
- ✓ Animals.
- ✓ Glacier.
- ✓ Mass movement.
- ✓ People.

**Types of soil erosion** –kcse 2019

- ✓ Splash erosion.
- ✓ Rill erosion.
- ✓ Gulley erosion.
- ✓ Sheet erosion.
- ✓ Wind erosion.

### a.) Splash Erosion.

- This is caused by heavy and sudden rainstorms that hit and loosens unconsolidated particles of soil on the earth's surface
- The impact of the heavy drops throws away or splashes the soil particles

### b.) Rill Erosion.

- The rain water cuts small channels called rills as it flows over the surface.
- It is most prevalent when rainfall exceeds the rate of infiltration.

**c.) Gulley Erosion.**

- Moving water or glaciers on the earth surface may cut deep and large channels through widening the existing rills.

**d.) Sheet Erosion.**

- This is the uniform removal of the top soil by rainwater moving downslope immediately after heavy downpour occurs in a flat area.

**e.) Wind erosion.**

- Prevailing winds may carry fine soil particles away and deposit them elsewhere.

## Causes of soil erosion.

i.) **Nature of the slope** i.e. steep slopes accelerate erosion while gentle slopes experience less erosion.

ii.) **Nature of the soil texture** i.e. areas with volcanic ash (fine textured soils) are vulnerable to soil erosion.

iii.) **Mass wasting** especially landslides and soil creep accelerate soil erosion.

iv.) **Climatic conditions** i.e. heavy rainfall accelerate erosion. Eddy currents of wind during dry season causes wind erosion.

v.) **Human activities i.e.** kcse 2001

- **Monoculture/ over-cropping** lead to soil exhaustion thus making the soil vulnerable to erosion –kcse 2006
- **Continuous ploughing** weakens the soil structure making it easy for agents of erosion to carry it away- kcse 2010
- **Overstocking** leads to trampling on the top soil by animals making them easy to be carried away by agents of erosion.
- **Overgrazing** reduces vegetation cover thus exposing the soil to agents of erosion –kcse 2010
- **Ploughing across the contour/ up and down the slope** creates channels which encourage easy removal of soil by running water/ agents of erosion.
- **Shifting cultivation/ Bush fallowing** may leave land abandoned or unprotected against erosion.
- **Deforestation and burning of vegetation** exposes the soil to agents of erosion –kcse 2006
- **Cultivation of crops on steep slopes/ along river banks** increases soil erosion process.
- **Continuous application of fertilizer** –kcse 2006
- **Road construction/ quarrying/ mining** loosens the soils making them easily eroded.

## Effects of Soil Erosion –kcse 2017

- It leads to loss of productive top soil lowering agricultural productivity of land.
- It causes uprooting/ blowing away of plants/ plants are washed away/ buried.
- It causes destruction of buildings/ bridges.
- Gulley erosion exposes underground water lowering the water table.
- It leads to destruction of vegetation cover which can cause desertification.
- It causes deposition of sediments into water reservoirs thus requiring dredging which is expensive.
- Contaminated sediments deposited into water bodies lead to water pollution.
- Sediments brought by water erosion to the beaches may make them muddy.
- It causes land dereliction.
- Sand eroded from steep slopes is deposited on the river beds and can be harvested for building and construction.
- During soil erosion, deep soils may be deposited e.g. alluvium that create productive lands for agricultural production.
- Eroded alluvial deposits on river beds make the river channel shallower resulting into frequent flooding.

QUIZ: **Explain three effects of soil erosion on water sources (6mks).**

- ✓ When the eroded soil is deposited into water reservoirs, it leads to **siltation of the reservoirs reducing the volume of water.**
- ✓ The eroded soil may contain pollutants like agricultural chemicals and industrial effluents which may **contaminate water sources.**
- ✓ When eroded soil accumulate in the water reservoirs making them shallow and eventually **plants may colonize** them forming swamps.
- ✓ Accumulation of eroded soils into river valleys makes the river shallow and this may lead to **frequent flooding** since river valleys cannot hold more water.
- ✓ When eroded soils accumulate in river valleys, they may block the path of the water **forming a lake** on the upstream side of the barrier.
- ✓ Siltation caused by deposition of eroded soil onto the river bed may **make river shallow and unsuitable for navigation.**

## Classification of Soils according to soil order –kcse 2023

- ✓ Zonal order soils.
- ✓ Intrazonal order soils.
- ✓ Azonal order soils.

### 1) Zonal order soil –kcse 2019

- These are mature soils that have undergone long time of soil formation/ have a well-developed soil profile.
- They include;
  - ✓ Podzol soils.
  - ✓ Podzolic soils.
  - ✓ Tundra soils.
  - ✓ Latosols.
  - ✓ Pedocals- Subdivided into Chernozems and *Vertizols.*
  - ✓ Phenozems.
  - ✓ Sierozems/ Desert soils.

**Characteristics of Desert soils** –kcse 2012

- ✓ The soils are of sandy or stony texture.
- ✓ Contain little or no humus.
- ✓ Are saline or contain a lot of salts.
- ✓ They have high lime content.
- ✓ Lack moisture.
- ✓ Are highly porous.
- ✓ May be light coloured.
- ✓ Are thin or shallow.
- ✓ Do not have a distinct profile.

2) **Intrazonal order soils** –kcse 2019

- These are soils that are formed under poor drainage conditions/ waterlogged areas.
- They include;
  - ✓ Hydromorphic soils.
  - ✓ Halmorphic soils.
  - ✓ Calcimorphic soils.
  - ✓ Andosols.

3) **Azonal order soils**–kcse 2019

- These are young soils that have not been affected by soil forming processes/ they do not have a well-developed soil profile/ they are immature and skeletal.
- They include;
  - ✓ Lithosols.
  - ✓ Regosols.
  - ✓ Alluvial soils.
  - ✓ Mountain soils.
  - ✓ Histosols.
  - ✓ Arenosols.

**Significance of Soils** –kcse 2023

- ✓ Soil is a medium through which natural vegetation and crops grow.
- ✓ Some soils e.g. clay is used in making ceramics/ pottery/ brick making.
- ✓ Soil may contain valuable minerals.
- ✓ Some soils are used for road construction/ laying foundation to structures.
- ✓ Some soils are consumed by livestock/ human beings.
- ✓ Organic soils like peat serve as fuel resources.
- ✓ Some soils have medicinal values.
- ✓ Some soils are used for decorative purposes e.g. red ochre.

**Management and conservation of soil.**

1. **Soil management.**

- These are measures undertaken to control processes and activities that can lead to soil degeneration.

**Measures of soil management.**

- ✓ Building of dykes and embakments.
- ✓ Construction of drainage ditches or channels.
- ✓ Control of soil erosion.
- ✓ Application of manure or chemical fertilizers.

- ✓ Application of lime to raise soil pH level.
- ✓ Draining water logged soils/ flooded areas.

## 2. Soil conservation.

- These are measures undertaken to protect the soil from destruction.

### Measures of soil conservation.

- ✓ Contour ploughing.
- ✓ Terracing.
- ✓ Planting cover crops.
- ✓ Regulation of livestock.
- ✓ Crop rotation.
- ✓ Mixed farming.
- ✓ Afforestation and reafforestation.
- ✓ Fallowing.
- ✓ Strip cropping.
- ✓ Building check dams.

Kcse 2014: **State three ways in which mulching helps in soil conservation.**

- ✓ Plant materials used decompose increasing soil humus.
- ✓ It protects the soil against erosion.
- ✓ It helps to increase infiltration rate of water into the soil.
- ✓ It helps reduce water loss from the soil/ retains soil moisture.
- ✓ It increases soil aeration.



**"END OF TOPIC FOUR"**

**TOPIC FIVE:** **AGRICULTURE.**

**Definition:-2013**

✓ **Agriculture** is the practice of cultivating crops and rearing of livestock.

**Factors Influencing Agriculture**

**1. Physical Factors.**

**a) Climate**

- ✓ Different crops require varying limits of rainfall, humidity and temperature.
- ✓ Moderate to high **temperatures** influences the growth of variety of crops and rearing of a variety of animals.
- ✓ Moderate to high rainfall/well distributed **rainfall** throughout the year support agriculture.
- ✓ Strong **winds** accelerate evaporation/transpiration and also destroy crops.
- ✓ Winds enhance seed dispersal and pollination favouring crop growing.

**b) Relief**

- ✓ Gently sloping/undulating landscape favours crop growing and animal rearing.
- ✓ Low to high altitude support the growth of a variety of crops and rearing of different animals.

**c) Soil**

- ✓ Deep, well drained, volcanic/clay/loam soils support crop growing and growth of pasture for animals.

**2.Biotic factors.**

- ✓ The presence of and/or absence of parasitic plants, insects, pests and diseases largely influence the type of agriculture.
- ✓ Insects like bees are useful for pollination of crops.
- ✓ Pests like termites, locusts and armyworms destroys plants.
- ✓ Pests like ticks and Tse tse flies transmit diseases to livestock which may cause animal death.

**3. Human factors.**

**a) Social factors –kcse 2014**

i. **Traditions**-kcse 2020

- The traditions of people determine the types of crops grown/livestock kept in order to help them meet their food requirements.
- Traditions determines the amount/type of labour hence the size of land farmed/crops/livestock kept.

- Traditional tools/technology/knowledge limit or encourage crop/livestock production.

ii. **Land tenure system-**kcse 2020
- It allows/limits communities/individuals to use the available land leading to increase/decrease produce.
- It may lead to land fragmentation/consolidation reducing/increasing land for large scale farming.

iii. **Religious beliefs**-kcse 2020
- Some religious beliefs determine the type of livestock farming since they discourage/encourage rearing of certain animals.
- Some religious groups are vegetarians hence promote vegetable production/limiting livestock production.

iv. **Gender** influences productivity as the produce will depend on effort of the gender involved.

v. **The interaction between people** leads to adoption of new techniques in farming/new foods/crops.

**b) Economic Factors.**

i. **Operational cost-** cost of growing crops and rearing animals.
ii. **Marketing expenses-** cost of storage and transport to the market.
iii. **Price fluctuation-** low international commodity prices may lower morale of farmers.

**c) Political Factors.**

i. **Government policy.** Some countries encourage productivity and efficiency by guaranteed prices and subsidies to farmers.
ii. **International agreements** which ensure that production does not greatly exceed demand.

## TYPES OF AGRICULTURE.

1. Arable farming
2. Mixed farming
3. Livestock farming

### 1. Arable Farming

- This is the growing of crops.

Types of Arable farming.

**a)** Simple subsistence farming
**b)** Plantation agriculture

**a. Simple subsistence farming/Shifting cultivation.**

✓ It involves growing of food crops for family consumption.

**Characteristics of shifting cultivation –kcse 2008**

- ➢ Vegetation is cleared by slashing and burning.
- ➢ There is the use of little or no manure.
- ➢ The land is communally owned.
- ➢ The yields decline after a certain period of continuous use/ The land is abandoned when the yield decline.
- ➢ Both settlements and plots are temporary.
- ➢ Farming depends mainly on family labour.
- ➢ The farmers use simple implements.
- ➢ It is mainly for subsistence.
- ➢ Plots are small and scattered.
- ➢ The siting of the land is in virgin forests.

**Disadvantages of shifting cultivation**

- ✓ Exposes land to soil erosion on the plots which have been left fallow.
- ✓ Doesn't guarantee sufficient food production.
- ✓ Extensive destruction of vegetation when fires get out of control.
- ✓ Wasteful because sections of land stay fallow for a very long time.
- ✓ Only practicable in areas with sparse population and plenty of land.
- ✓ There are hardly any monetary gains because the produce is only enough for home consumption.

**Types of simple subsistence farming.**

**i) Sedentary Subsistence Agriculture**

- ✓ Farming in which the community permanently stays in one place.
- ✓ **Areas where it's practiced**

  Tropical lowlands of Africa, Central America and South East Asia.

**Characteristics of sedentary subsistence agriculture.**

- ✓ The community occupies a permanent dwelling place.
- ✓ Fallowed lands are frequently used.
- ✓ Crop rotation is practiced in some areas.
- ✓ Crops sown are given much attention.
- ✓ More animals are kept e.g. oxen and horses.
- ✓ Both cash crops and subsistence crops are grown.
- ✓ Manure is used in the farms.
- ✓ More family labour is used in the field.
- ✓ Production is relatively large.

## ii) Intensive Subsistence Agriculture

- ✓ It involves maximum utilization of all cultivable land to sustain a large and fast-growing population.
- ✓ In kenya, intensive cultivation is carried out in counties like Kiambu, Thika, Nyeri, Kisii, Nyamira and Vihiga.

### Characteristics of intensive subsistence agriculture.

- ✓ Very small plots resulting from years of fragmentation.
- ✓ Intensive use of land.
- ✓ It is labour intensive.
- ✓ Simple tools are used.
- ✓ Both food and cash crops are grown.
- ✓ Several crops are grown on the same piece of land during the course of the year.
- ✓ Livestock rearing is practiced in small number.
- ✓ Use of manure and chemical fertilizers to sustain high soil fertility for maximum yields.
- ✓ Use of Irrigation to make up inadequacy of moisture.

## b. Plantation Agriculture.

- ✓ Cultivation of one cash crop on large tract of land called estates or plantations.
- ✓ Main plantation crops are coffee, tea, pineapples, maize, wheat, sunflower, sisal, sugar-cane
- ✓ Main plantations countries are Cameroon, Ghana, Kenya, Cote d'Ivore, Nigeria, Indonensia, Phillipines, Brazil and Colombia.

### Characteristics of plantations Agriculture –kcse 2013

- ✓ Large tracts of land are cultivated.
- ✓ Cash crops are grown e.g. coffee, tea, cocoa rubber, etc.
- ✓ A single crop is usually grown.
- ✓ Done for commercial purpose.
- ✓ High capital is required to start and meet recurrent expenditure.
- ✓ Production is high in quality and quantity.
- ✓ Soil gets exhausted due to monoculture
- ✓ Some farms are labour intensive.
- ✓ Plantations provide their workers with social amenities.
- ✓ Most plantations are owned by foreign companies/individuals/companies.
- ✓ Employment of scientific management to produce a lot of output.
- ✓ Plantations are seriously affected by price reduction in the world market.

## Problems facing plantation farming in Kenya- kcse 2020

- ✓ Excess rainfall/prolonged drought leads to low yield.
- ✓ Occurrence of pest/disease affects crops leading to loss/low yields.
- ✓ Soil exhaustion due to practice of monoculture.
- ✓ Plantation farming is costly since it requires a lot of money to operate/limited capital.
- ✓ Price fluctuation in the world market.
- ✓ Poor management of group owned plantations/Delayed payments.
- ✓ Fire outbreaks
- ✓ Competition from imports.
- ✓ Hailstones
- ✓ Rapid growth of weeds
- ✓ The muddy/impassable roads

## 2. Mixed farming- kcse 2010

- ➢ It is the growing of crops and rearing of livestock on the same farm.

### Characteristics of mixed farming

- ✓ Crops are grown and livestock raised on the same farm.
- ✓ Farms are moderate in size.
- ✓ A variety of crops are grown e.g. wheat, barley, oats, tobacco, sugar beet etc
- ✓ A portion of the farm may be reserved for animal pasture.
- ✓ It requires large capital.
- ✓

- ➢ **The ratio of animals reared to the crops grown depend on the following factors:**
  - Soil fertility
  - The market demands
  - The land carrying capacity
  - The government policy
  - The tradition of farming
  - The market price on crops and animal products.

### CROP FARMING IN KENYA

i. **Cereals e.g.** maize, wheat, rice, sorghum, millet
ii. **Beverage crops e.g.** coffee, tea
iii. **Industrial crops e.g.** pyrethrum, tobacco, fruits, sugarcane
iv. **Fibre crops e.g.** sisal, cotton
v. **Oil producing crops e.g.** sunflower, groundnuts, coconut
vi. **Root crops e.g.** irish potatoes, sweet potatoes, carrots, cassava
vii. **Vegetables e.g.** French beans, kale, cabbages, cucumber

# TEA FARMING IN KENYA

## Varieties of tea planted:

- Assamic tea
- Aswan tea
- China tea
- Purple tea
- Cambod tea

## Major Growing Areas

- ✓ **To the west of the Rift valley** – Kericho, Nandi, Kakamega, Cherangani hills, Kisii, Nyamira.
- ✓ **To the East of the rift valley(2007)** – Nyeri, Murang`a, Kiambu, Thika, Maragua,, Nyambane hills in Meru
- ✓ **In lowlands areas**- Kakamega, vihiga

## Physical factors favouring Tea growing in kenya-kcse 2013

- ✓ Moderate to high temperatures.
- ✓ Moderate to high rainfall.
- ✓ Well distributed rainfall throughout the year.
- ✓ Deep, well drained, volcanic/slightly acidic soils.
- ✓ Gently sloping/undulating land.

## Human factors favouring Tea growing in Kenya.

- ✓ **The large supply of labour from the local people** for cultivation and processing which are labour intensive.
- ✓ **Accessible roads** to deliver tea leaves to factory before they start withering.
- ✓ **Location of tea factories near farms** for quick processing of tea as soon as possible.
- ✓ **The large capital from cooperatives** to pay for the labour required in land preparation, planting, regular picking etc.
- ✓ **The advanced technology in tea farming** from the local people/expatriates.
- ✓ **Advanced scientific research in tea farming**/ pests and diseases that affect tea crops.
- ✓ **The large and ready internal or external market for** tea.
- ✓ **The government policy on diversification of crops** has led to tea growing.

## Tea cultivation from Land preparation to harvesting-kcse 2007

- ✓ The land is cleared of vegetation.
- ✓ Land is ploughed/tilled using tractors.
- ✓ The seedlings/cuttings are planted in nursery.
- ✓ Tea seedlings are then transplanted onto ploughed land.
- ✓ The plants are weeded manually.

- ✓ Manure is applied regularly.
- ✓ Spraying is done to control pests/diseases.
- ✓ Pruning is done to control heights.
- ✓ Harvesting is done by hand picking the two top leaves and buds.
- ✓ Green leaves are transported by Lorries in airy baskets to the factory for processing.

## Tea Processing

- ✓ At the factory **tea leaves are weighed**.
- ✓ Tea leaves are **spread out on long wire trays**.
- ✓ Tea leaves are **dried/withered by blasting of warm air** underneath the trays.
- ✓ Dry leaves are **passed through a set of rollers to chop them**.
- ✓ Chopped leaves are **placed in containers for fermenting**.
- ✓ **Fermented leaves are roasted** to turn to black tea.
- ✓ The **tea is given time to cool**.
- ✓ The cooled **tea is sifted, graded and then packed** in tea chests or bags to await sale or exportation.

## Marketing of Tea in Kenya-kcse 2013

- ✓ Major marketer is Kenya Tea Development Authority(KTDA)
- ✓ Some tea is sold through factory door sales.
- ✓ Some tea is sold directly to local/overseas buyers.
- ✓ Some tea is sold to Kenya Tea Packers Limited(KETEPA)/other packers.
- ✓ Some tea is sold through Mombasa tea auction.

### Leading consumers of Kenyan tea.

| | | |
|---|---|---|
| • France | Iran | Britain |
| • Germany | Saudia arabia | United Kingdom |
| • Netherlands | Egypt | USA |
| • Afghanistan | Sudan | Canada |

### Functions of KTDA

- ✓ Collection of tea from buying centres.
- ✓ Processing of tea.
- ✓ Providing farmers with inputs such as fertiliser.
- ✓ Sensitizes farmers on high quality production of tea.
- ✓ Facilitates sale of tea at best possible prices.
- ✓ Ensures prompt collection of payment from all tea buyers.
- ✓ Promotion of tea with the aim of expanding market share.

## Ways in which KTDA assists small scale tea farmers in Kenya-kcse 2007

- ✓ It conducts **research** on diseases/pests/improved tea for higher yields/better quality tea.
- ✓ It organizes farmer **education** days/provides extension services for the farmers to learn new ideas about tea growing.
- ✓ It establishes tea **factories** where the green tea leaves are processed.
- ✓ It **subsidizes** farm inputs lowering cost of production.
- ✓ It improves feeder **roads** to ease transportation of green leaves to the tea factories.
- ✓ It establishes tea **nurseries** from where tea farmers buy tea seedlings.
- ✓ It provides **credit facilities** for the farmers enabling them to purchase farm inputs promptly.
- ✓ It **collects** the green tea leaves and delivers to the factory on behalf of the farmers.
- ✓ It undertakes the **marketing** of tea on behalf of the farmers.

## Problems facing small scale tea farming in Kenya-kcse 2013

- ✓ **Pests like red spider weevils** and beetles destroy tea plants reducing quality/yields leading to low income for farmers.
- ✓ **Diseases like Ammilaria**, root rot, black tea thrip, tea blight destroy tea plants reducing the yields leading to low income for farmers.
- ✓ **Climatic hazards/Droughts**/Hail stones/Frost leads to destruction of the crop thus lowering quality/quantity of leaf production.
- ✓ **Fluctuations of tea prices in the world market** leads to uncertainity earnings making it difficult for farmers to plan ahead.
- ✓ **Inaccessible roads** lead to delays in collection of the harvested tea resulting into wastage/losses to farmers.
- ✓ **High cost of farm inputs** makes them unaffordable to the farmers leading to low yields/low profit margins.
- ✓ **Inadequate capital** from cooperatives to purchase inputs lower production.
- ✓ **Delayed payment to the farmers** by cooperatives lowers their morale.
- ✓ **Poor marketing strategies** leads to low earnings.
- ✓ **Mismanagement of cooperatives leads to low payment** to farmers which lowers their morale.

## Significance of Tea Farming in Kenya

- ✓ Tea is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Tea is **consumed locally saving some foreign exchange** that would be used to import tea.
- ✓ Farmers **sell** tea locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**

- ✓ **Tea is a raw material** for industries leading to **development of industries** such as processing factories, blending and packaging industries.
- ✓ Tea farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.
- ✓ Tea farming has led to **development of towns** such as Kericho which are **centre for economic activity**.
- ✓ It earns Kenya a lot of **revenue** through **taxation**/licenses.
- ✓ It leads to **development of social amenities** in tea growing areas **improving the living standards of people.**

## SUGAR-CANE FARMING IN KENYA

### Main Growing Areas

- ✓ Nyanza: Muhoroni, Miwani, Chemilil, Koru, Kibos and Awendo.
- ✓ Coastal: Ramisi.
- ✓ Western: Mumias, Nzoia, Kabras, Busia

### Physical conditions Favouring Sugarcane growing in Kenya- kcse 2023

- ✓ High temperatures/ moderate to high temperatures.
- ✓ High rainfall.
- ✓ Well distributed rainfall throughout the year.
- ✓ Dry/ sunny conditions for sucrose accumulation.
- ✓ Deep, well drained, loamy/black cotton/clay soils.
- ✓ Gently sloping/undulating land which enables mechanization.

### Human conditions favouring sugarcane growing in Kenya.

- ✓ **The large supply of labour from the local people** for cultivation and processing which are labour intensive.
- ✓ **Accessible roads** to deliver sugar canes to factory before they start withering.
- ✓ **Location of sugarcane factories near farms** for quick processing of canes as soon as possible.
- ✓ **The large capital from cooperatives** to pay for the labour required in land preparation, planting, harvesting etc.
- ✓ **The advanced technology in sugarcane farming** from the local people/expatriates.
- ✓ **Advanced scientific research in sugarcane farming**/ pests and diseases that affect sugarcane crops.
- ✓ **The large and ready internal or external market for** sugar.
- ✓ **The government policy on diversification of crops** has led to sugarcane growing.

**Sugarcane cultivation from Land preparation to harvesting-kcse 2008**

- ✓ The land is cleared off its vegetation.
- ✓ The land is ploughed using tractors.
- ✓ Shallow furrows are dug.
- ✓ Cuttings/seed cane are planted in the furrows.
- ✓ Top dressing/Nitrogenous fertilizers are applied.
- ✓ Weeding is regularly done.
- ✓ Spraying using herbicides is applied.
- ✓ Gapping is done in initial stages.
- ✓ Sugarcane is harvested manually using pangas and put in heaps.
- ✓ Harvested cane is loaded onto tracks/lorries, transported to the factory for processing.

**Processing of Sugarcane**-kcse 2015/2023

- ✓ The cane is received at the factory and **weighed**.
- ✓ The cane is **washed** and **chopped** into small pieces.
- ✓ The pieces are **crushed** to extract the juice.
- ✓ The juice is put into **clarifiers** to filter off the impurities.
- ✓ The juice is **boiled** to evaporate the water.
- ✓ The juice is further stirred in large tanks to allow **crystallization.**
- ✓ The crystals are separated from molasses.
- ✓ The sugar is **bleached** to whiten.
- ✓ Sugar is then **dried, cooled, graded, weighed and packed** ready for sale/export.

**Marketing of Sugar**

- ✓ Consumed locally.
- ✓ Factories sell to wholesalers and retail outlets to consumers.
- ✓
- ✓

**Uses of Sugar.**

- ✓ Brown sugar is used in baking to sweeten bread, cakes, etc.
- ✓ Sugar is used in sweetening foods and drinks e.g. porridge, chapatti, tea, coffee, etc.
- ✓ Sugar is used to make local brews.
- ✓ White Sugar is used in soft drinks industries e.g. soda, juice, etc.
- ✓ White Sugar is used in Making sweets and chocolates, etc.
- ✓ Sugar is used in manufacturing of drugs e.g. syrups and sugar coated tablets.

**By-products obtained from sugarcane processing**-kcse 2015/2023

- Bagasse
- Molasses
- Cane juice

- Filter cake/filter mud
- Jaggery
- Ethanol/ alcohol

**Uses of By-products**

- ✓ Molasses is used as a sweetener for livestock feeds.
- ✓ Molasses is also used to manufacture ethanol, acetone and ethyl-acetate.
- ✓ Bagasse or fibre left after squeezing the juice is used as fuel for boilers,
- ✓ Bagasse is used for preparing pulp for making paper used for making cement and fertilizer bags
- ✓ Bagasse is also used as manure, fodder, wax.
- ✓ Filter cake resulting from filtration process is used as manure for cane.

**Roles of the Out grower schemes.**

**Out grower scheme** is a partnership on contract between the farmers and a company.

- ✓ Providing extension services to farmers.
- ✓ Giving farmers selected seeds for planting.
- ✓ Providing fertilizers to farmers.
- ✓ Managing local sugar cane processing factories.
- ✓ Helping small scale farmers to grow and sell their canes to the factories.
- ✓ Increasing sugar cane production to meet the local needs.
- ✓ Constructing and maintaining access roads to the farmers.
- ✓ Providing credit facilities to farmers to improve their farms.
- ✓ Provision of tractors for ploughing and paying labour.

**Ways in which Kenya Government is promoting the sugar manufacturing industry**-kcse 2023

- ✓ Establishment of **Kenya Sugar Board** to advice on production/marketing of sugar.
- ✓ **Restricting sugar imports** to protect farmers from the flooding of the market with cheap sugar.
- ✓ **Establishing a scheme** for small scale out growers in production/marketing of sugar.
- ✓ **Enforcing laws** to protect the exploitation of farmers by brokers/ middlemen.
- ✓ **Financing research** on diseases/pests/improved sugarcane for higher yields/better quality sugar.
- ✓ Providing **financial assistance** to ailing sugar factories.
- ✓ Organizing farmer **education** days/provides extension services for the farmers to learn new ideas about sugarcane growing.
- ✓ Establishing **sugar factories** where the canes are processed.
- ✓ **Subsidizing** farm inputs to lower the cost of sugarcane production.
- ✓ Improving feeder **roads** to ease transportation of canes to the sugar factories.

- ✓ Providing **credit facilities** for the farmers enabling them to purchase farm inputs promptly.

## Problems Facing Sugarcane Farming In Kenya-kcse 2008/2023

- ✓ **Pests like termites, white grub** destroy sugarcane plants reducing quality/yields leading to low income for the farmers.
- ✓ **Diseases like sugarcane mosaic, smut, yellow wilt, ratoon stunting** destroy sugarcane plants reducing the quality/yields leading to low income for farmers.
- ✓ **Frequent fire outbreaks** which destroy sugarcane hence losses.
- ✓ **Climatic hazards/Droughts** leads to destruction of the sugarcane crop leading to heavy losses.
- ✓ **Fluctuations of sugar prices in the world market** leads to uncertainity earnings making it difficult for farmers to plan ahead.
- ✓ **Inaccessible roads** lead to delays in delivery of the canes to the factory lowering the quality/profit to farmers.
- ✓ **High cost of farm inputs** makes them unaffordable to the farmers leading to low yields/low profit margins.
- ✓ **Delayed payment to the farmers** by cooperatives lowers their morale.
- ✓ **Mismanagement of cooperatives leads to low payment** to farmers which lowers their morale.
- ✓ **Labour shortage** during harvesting
- ✓ **Delays in harvesting of sugarcane** disrupt farmer's planning/reducing farmers' earnings.

## Significance of sugarcane Farming in Kenya

- ✓ Sugar is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Sugar is **consumed locally saving some foreign exchange** that would be used to import tea.
- ✓ Farmers **sell** sugars locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**
- ✓ **Sugar is a raw material** for industries leading to **development of industries** such as processing factories, blending and packaging industries.
- ✓ Sugarcane farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.
- ✓ Tea farming has led to **development of towns** such as Mumias which are **centre for economic activity**.
- ✓ It earns Kenya a lot of **revenue** through **taxation**/licenses.
- ✓ It leads to **development of social amenities** in sugarcane growing areas **improving the living standards of people.**

# MAIZE FARMING IN KENYA

## Main Growing Areas

- ✓ Trans nzoia
- ✓ Nakuru
- ✓ Bungoma
- ✓ Uasin Gishu county

## Physical conditions favouring Maize Growing in Kenya-kcse 2009

- ✓ Moderate to high temperatures.
- ✓ Moderate to high rainfall.
- ✓ Well distributed rainfall throughout the year.
- ✓ Deep, well drained, volcanic/loam soils.
- ✓ Gently sloping/undulating landscape.
- ✓ Plenty of sunshine during harvesting.

## Human conditions for maize growing in kenya.

- ✓ **The large supply of labour from the local people** for cultivation and processing which are labour intensive.
- ✓ **Accessible roads** to deliver maize to the mills or market.
- ✓ **Large storage facilities** for harvested maize.
- ✓ **The large capital from cooperatives** to pay for the labour required in land preparation, planting, harvesting etc.
- ✓ **The advanced technology in maize farming** from the local people/expatriates.
- ✓ **Advanced scientific research in maize farming**/ pests and diseases that affect maize crops.
- ✓ **The large and ready internal or external market for** maize.
- ✓ **The government policy on diversification of crops** has led to maize growing.

## Maize cultivation from Land preparation to harvesting

- ✓ The land is cleared of its vegetation.
- ✓ The land is ploughed using tractors.
- ✓ Holes are dug in rows.
- ✓ Maize seeds are planted in the holes.
- ✓ Fertilizers are applied during planting.
- ✓ Gapping and thinning is done.
- ✓ Weeding is done manually/spraying is done to control pests/diseases.
- ✓ Nitrogen fertilizers are added.
- ✓ The dry cobs are picked by hand and put in sacks transported to the millers.

## Marketing of Maize

- ✓ Mainly sold by National Cereals and produce Board(NCPB)
- ✓ Farmers also sell directly to consumers and millers.

## Uses of Maize

- ✓ Maize grains are grounded and used as food Grains are also used in the manufacture of animal feeds e.g. maize jam.
- ✓ Tender maize plants are chopped and mixed with molasses to make silage for livestock.
- ✓ Green maize grain is used to make salad oil for cooking, industrial alcohol and starch.
- ✓ Stalks and cobs are used as organic manure
- ✓ Dry cobs and stalks are used to provide domestic fuel.

## Problems facing maize farming in Kenya-kcse 2009

- ✓ **Pests like weevils, rodents, birds, beetles** destroy maize plants reducing yields leading to low income for farmers.
- ✓ **Diseases like root rot, leaf rust** destroy maize plants reducing the yields leading to low income for farmers.
- ✓ **Climatic hazards/Drought** leads to destruction of the crop thus lowering quality/quantity of maize production.
- ✓ **Fluctuations of maize prices in the market** leads to uncertainity earnings making it difficult for farmers to plan ahead.
- ✓ **Inaccessible roads** lead to delays in delivery of maize to millers or market resulting into wastage/losses to farmers.
- ✓ **High cost of farm inputs** makes them unaffordable to the farmers leading to low yields/low profit margins.
- ✓ **Inadequate capital** from cooperatives to purchase inputs lower production.
- ✓ **Delayed payment to the farmers** by cooperatives lowers their morale.
- ✓ **Poor marketing strategies** leads to low earnings.
- ✓ **Mismanagement of cooperatives leads to low payment** to farmers which lowers their morale.

Kcse 2023: **State three reasons for the increase in the price of maize in Kenya.**

- ✓ Adverse climate conditions/ prolonged drought experienced leading to low maize production.
- ✓ Prevalence of pests like army worms, locusts/ diseases like maize rust, smut.
- ✓ High demand for maize/ competition for maize as a raw material in manufacturing industries.
- ✓ A rise in the cost of inputs/ increased cost of production.
- ✓ Reduction in land acreage under which maize is planted.
- ✓ Global rise in food prices.

- ✓ Restrictions in importation of maize.
- ✓ Hoarding.

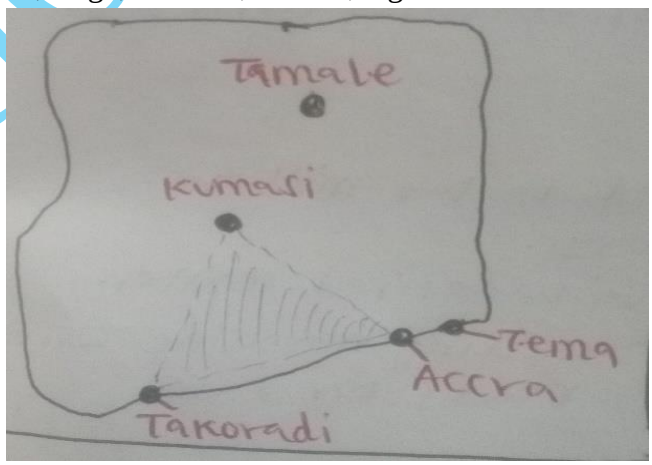
## Significance of Maize Farming in Kenya

- ✓ Maize is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Maize is **consumed locally saving some foreign exchange** that would be used to import maize.
- ✓ Farmers **sell** maize locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and millers which **improves their standards of living.**
- ✓ **Maize is a raw material** for industries leading to **development of industries** such as processing factories and packaging industries.
- ✓ Maize farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.
- ✓ Maize farming has led to **development of towns** such as Kitale which are **centre for economic activity**.
- ✓ It earns Kenya a lot of **revenue** through **taxation**/licenses.
- ✓ It leads to **development of social amenities** in maize growing areas **improving the living standards of people.**

## COCOA GROWING IN GHANA

### Main Growing Areas

- ✓ Cocoa triangle formed by Accra, Kumasi and Takoradi.
- ✓ **2019- Other African countries growing cocoa** are Nigeria, Cote dÍvoire, Cameroon, Siera lione, Benin, Togo, Rwanda, Liberia, Uganda and Guinea.



## Physical conditions favouring Cocoa farming in Ghana-kcse 2010/2019

- ✓ High temperatures/hot/warm conditions.
- ✓ High and well distributed rainfall throughout the year.
- ✓ Deep, well drained, loamy/volcanic soils.
- ✓ A sunny period for ripening.
- ✓ High relative humidity.
- ✓ Low altitude.
- ✓ Gently sloping/undulating landscape.
- ✓ Protection of young plants from direct sunshine.
- ✓ Protection from strong winds that blow away pods.

## Human conditions favouring cocoa farming in Ghana.

- ✓ **The large supply of labour from the local people** for cultivation and processing which are labour intensive.
- ✓ **Accessible roads** to deliver cocoa to the factories or market.
- ✓ **Large storage facilities** for harvested cocoa.
- ✓ **The large capital from cooperatives** to pay for the labour required in land preparation, planting, harvesting etc.
- ✓ **The advanced technology in cocoa farming** from the local people/expatriates.
- ✓ **Advanced scientific research in cocoa farming**/ pests and diseases that affect cocoa pods.
- ✓ **The large and ready internal or external market for** cocoa.

## Process of cocoa cultivation in Ghana-kcse 2019

- ✓ Land is cleared off its vegetation and ploughed.
- ✓ Cocoa trees are grown from seedlings sown in nurseries.
- ✓ Holes are dug in the farm.
- ✓ Seedlings are transplanted to the field in rows.
- ✓ Nurse crops like cassava/yams/bananas are planted.
- ✓ The crop is weeded, pruned and manure/fertilizer added.
- ✓ Cocoa trees are sprayed/fungicides.
- ✓ Cocoa trees produce mature pods that grow on the trunks.
- ✓ They become yellow/orange when ripe.
- ✓ There two main harvesting periods.
- ✓ The crop is harvested manually using long sharp knives.

## Processing of Cocoa.

- ✓ The **cocoa pods are split open** with a sharp knife and **beans scooped** out by hand.
- ✓ Beans are **put in heaps** or mats and **covered with banana leaves**.
- ✓ They are allowed to **ferment** during which the juicy pulp drains away.
- ✓ Fermented beans are **washed** and **cleaned**.
- ✓ Beans are **spread on tables** covered with mats to **dry** in the hot sun.

- ✓ The **beans are turned frequently** as they dry and slowly turn brown.
- ✓ **Dry beans are put in sacks** and sent to the harvest buying centre.
- ✓ At the centre, dry beans are weighed and graded ready for export.

## Marketing of Cocoa

- ✓ Farmers take dried beans to the collecting centres.
- ✓ Licensed agents buy the produce e.g. Ghana Co-operative Marketing Association and Cocoa Merchants Limited.
- ✓ The beans are weighed and cash paid to farmers.
- ✓ They are then transported to the ports of Tema and Takoradi.
- ✓ The Cocoa Marketing Board then exports the beans to countries such as U.S.A, Germany and Britain.

## Uses of Cocoa-kcse 2019

- ✓ It is used as a beverage.
- ✓ It is used to manufacture cosmetics.
- ✓ It is used in baking/confectionary.
- ✓ It is used to make sweets/ice cream/flavourings.
- ✓ It is used as an animal feeds.
- ✓ It is used as a soft drink.
- ✓ It is used in the production of drugs.
- ✓ It is used in the production of alcohol.
- ✓ It is used in the production of fertilizers.
- ✓ It is used in mulching.

## Problems facing cocoa farming in Ghana-kcse 2019

- ✓ **Pests like capsid bug** destroy cocoa trees reducing yields leading to low income for farmers.
- ✓ **Diseases like swollen shoot, black pod** destroy cocoa trees reducing the yields leading to low income for farmers.
- ✓ **Climatic hazards/Droughts**/Hail stones lead to destruction of the crop thus lowering quality/quantity of cocoa.
- ✓ **Fluctuations of cocoa prices in the world market** leads to uncertainity earnings making it difficult for farmers to plan ahead.
- ✓ **Inaccessible roads** lead to delays in delivery of cocoa to the factories resulting into wastage/losses to farmers.
- ✓ **High cost of farm inputs** makes them unaffordable to the farmers leading to low yields/low profit margins.
- ✓ **Inadequate capital** from cooperatives to purchase inputs lower production.
- ✓ **Delayed payment to the farmers** by cooperatives lowers their morale.
- ✓ **Poor marketing strategies** leads to low earnings.

- ✓ **Mismanagement of cooperatives leads to low payment** to farmers which lowers their morale.
- ✓ **Low labour supply during harvesting season** increases cost of production.
- ✓ **The limited storage facilities** lead to wastage/spoilage of cocoa leading to losses to farmers.
- ✓ **Competition for land from other crops** leads to low production.
- ✓ **Competition from other beverages** lowers the market/demand for cocoa.
- ✓ **The poor extension services** leads to low quality cocoa production.

## Significance of Cocoa farming to Ghana's Economy-kcse 2019

- ✓ Cocoa is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Cocoa is **consumed locally saving some foreign exchange** that would be used to import cocoa.
- ✓ Farmers **sell** cocoa locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**
- ✓ **Cocoa is a raw material** for industries leading to **development of industries** such as processing factories and packaging industries.
- ✓ Cocoa farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.
- ✓ Cocoa farming has led to **development of towns** such as Takoradi which are **centre for economic activity**.
- ✓ It earns Kenya a lot of **revenue** through **taxation**/licenses.
- ✓ It leads to **development of social amenities** in cocoa growing areas **improving the living standards of people.**

**Quiz: 2006- State three economic problems experienced in cocoa farming in Ghana (3marks)**

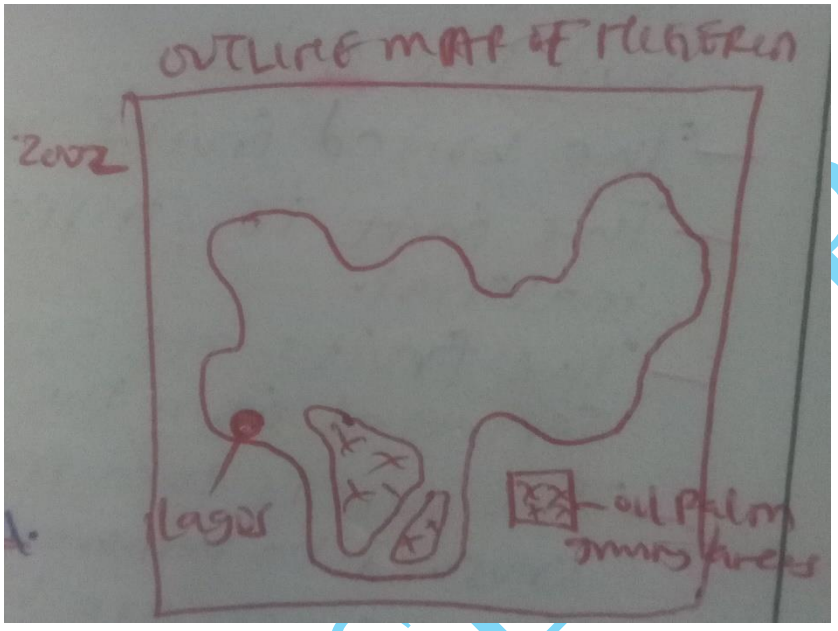
- ✓ Fluctuation of prices in the world market.
- ✓ Competition from other land use.
- ✓ Inadequate labour during harvesting.
- ✓ High production costs.
- ✓ Competition from other beverages.

## OIL PALM FARMING IN NIGERIA

### Main Growing Areas

√ Port Harcout √Sapele √Calabar √Enugu √Onitsha

- **Other African countries growing oil palm are** Cameroon, D.R.C, Liberia, Sierra leone




### Physical conditions favouring oil palm farming in Nigeria-kcse 2007

- ✓ High temperatures throughout the year.
- ✓ Moderate to High and well distributed rainfall throughout the year.
- ✓ High relative humidity.
- ✓ Plenty of sunshine during ripening season.
- ✓ Deep, well drained, loams soils
- ✓ Gently sloping/undulating land.
- ✓ Low altitude
- ✓ Shelter from strong winds
- ✓ Shade from direct sunlight for the young plants.

### Human factors favouring oil palm farming in Nigeria.

- ✓ **The large supply of labour from the local people** for cultivation and processing which are labour intensive.
- ✓ **Accessible roads** to deliver oil palm seeds to the factories.
- ✓ **Large storage facilities** for harvested oil palm seeds.
- ✓ **The large capital from cooperatives/government** to pay for the labour required in land preparation, planting, harvesting etc.
- ✓ **The advanced technology in oil palm farming** from the local people/expatriates.
- ✓ **Advanced scientific research in oil palm farming**/ pests and diseases that affect oil palm.
- ✓ **The large and ready internal or external market for** plam oil.

## Cultivation of Oil Palm-kcse 2014

- ✓ Land is cleared of its vegetation.
- ✓ Land is ploughed.
- ✓ Oil palm seeds are planted in nursery.
- ✓ The holes are dug in ploughed land.
- ✓ Seedlings are transplanted into the holes.
- ✓ Weeding is done regularly.
- ✓ Spraying id done regularly.
- ✓ Manure/fertilizer is applied.
- ✓ Mature/ripe fruits are harvested using a curved knife.
- ✓ Fruits are carried in baskets onto lorries to the factory.

## Processing/Extraction of Oil from Oil Palm Fruit-kcse 2002

- ✓ At the factory, oil palm fruits are **weighed.**
- ✓ Fruits are put in the tube-like cage/truck and **boiled** by steam.
- ✓ Top cover of the boiled fruits is **stripped** off.
- ✓ Fruits are again **cooked** in digester separating pulp from kernel.
- ✓ Pulp is **pressed** to extract **palm oil.**
- ✓ Kernels are **crushed** to remove their shells to extract kernel oil.
- ✓ The oil is graded and **packed** ready for sale/export.

## Uses of Oil Palm/Palm Tree-kcse 2002

- ✓ Making oil.
- ✓ The leaves are used for roofing.
- ✓ The shell and fibres are used as fuel.
- ✓ The leaves are used for making baskets, huts, mats and brooms.
- ✓ The stems are used as building poles.
- ✓ The sap from the stem is used for making wine.
- ✓ The fruit is used for cosmetics, soap and candles.
- ✓ Crushed nut is used for animal feeds and fertilizers.

## Uses of Palm Oil-kcse 2014

- ✓ It is used for cooking.
- ✓ It is used in making cosmetics.
- ✓ It is used in making candles.
- ✓ It is used as a lubricant.
- ✓ It is used as cleaning agent in the tin industry.
- ✓ It is used in pharmaceutical industries for making medicine.
- ✓ It is used in production of soap and paints.

## Marketing of Oil Palm

- ✓ Most of palm oil and kernels are consumed locally and less than 50% is exported.
- ✓ Most of the kernels are exported to Britain, W. Europe and U.S.A.

## Significance of Oil Palm to Nigeria's Economy

- ✓ Palm oil is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Palm oil is **consumed locally saving some foreign exchange** that would be used to import palm oil.
- ✓ Farmers **sell** palm oil locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**
- ✓ **Palm oil is a raw material** for industries leading to **development of industries** such as processing factories and packaging industries.
- ✓ Oil palm farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.
- ✓ Oil palm farming has led to **development of towns** such as Port Harcout which are **centre for economic activity**.
- ✓ It earns Kenya a lot of **revenue** through **taxation**/licenses.
- ✓ It leads to **development of social amenities** in oil palm growing areas **improving the living standards of people.**

## Problems Facing Oil Palm Farming in Nigeria

- ✓ **Pests like anthrascnose** and **Diseases like blast/root rot** which destroy crops lowering the quality/yields and income.
- ✓ **Inadequate capital** from cooperatives to purchase inputs lower production.
- ✓ **Impassable roads** during rainy seasons delays delivering of the crop leading to wastage/losses to farmers.
- ✓ **High cost of inputs** lowers production of palm oil reducing profit margin.
- ✓ **The government policy on food crop production** has led to more land being put under food crops at the expense of oil palm.

## Crops grown in Kenya that produce vegetable oil- kcse 2002

| | |
|---|---|
| √maize | √cashew nuts |
| √sunflower | √soya beans |
| √ground nuts | √coconut |
| √simsim | √cotton |

**Quiz: kcse 2007- Give two problems experienced in the marketing of palm oil in Nigeria(2mks)**

- ✓ Competition from other vegetable oils.
- ✓ Impassable roads
- ✓ Production of low-quality oil.
- ✓ Reduced production which has lowered the amount of oil exported.

# COFFEE FARMING IN KENYA AND BRAZIL

## COFEE FARMING IN KENYA

**Coffee species grown:** Arabica and Robusta

### Main Growing Areas

- ✓ Central Province - Nyeri, Muranga, Kiambu, Thika and Kirinyaga.
- ✓ Eastern Province - Embu, Machakos, Tharaka, Makueni and Meru.
- ✓ Coast Province - Taita Taveta in Wundanyi area.
- ✓ Western Province - Bungoma, Vihiga, Kakamega.
- ✓ Nyanza Province - Kisii, Nyamira, Nyabondo, Oyugis.
- ✓ Nairobi Province - outskirts bordering Kiambu and Thika.

### Physical conditions favouring Coffee Growing in Kenya-kcse 2021

- ✓ Cool/warm/hot conditions.
- ✓ High and well distributed rainfall (1000-2030mm) annually.
- ✓ Moderate/high temperatures.
- ✓ Deep, well drained, volcanic/acidic soils.
- ✓ Gently sloping/undulating landscape.
- ✓ High altitude.
- ✓ Shelter from direct sunlight.
- ✓ Frost free conditons.
- ✓ Requires two months dry period for flowering

### Human factors favouring coffee growing in Kenya.

- ✓ **The large supply of labour from the local people** for cultivation and processing which are labour intensive.
- ✓ **Accessible roads** to deliver coffee berries to the factory.
- ✓ **Location of coffee factories near farms** for quick processing of coffee berries as soon as possible.
- ✓ **The large capital from cooperatives** to pay for the labour required in land preparation, planting, regular picking etc.
- ✓ **The advanced technology in coffee farming** from the local people/expatriates.
- ✓ **Advanced scientific research in coffee farming**/ pests and diseases that affect coffee plants.
- ✓ **The large and ready internal or external market for** coffee.
- ✓ **The government policy on diversification of crops** has led to coffee growing.

### Coffee cultivation from land preparation to harvesting.

- ✓ Land is **cleared** off its vegetation.
- ✓ Land is **ploughed** using tractors.
- ✓ Coffee seeds are sown in a **nursery**.

- ✓ Shallow **furrows** are dug in the ploughed farm.
- ✓ Seedlings are **transplanted** into the furrows.
- ✓ Seedlings are **sheltered** from strong sunlight.
- ✓ **Mulching** is done.
- ✓ **Weeding** is done regularly.
- ✓ **Fertilizers/manure** are applied.
- ✓ **Spraying** is done to control pests/diseases.
- ✓ Plants are **pruned** regularly to control cropping and facilitate picking.
- ✓ Coffee berries are **harvested by manual hand picking** of red berries only.

## Coffee processing-kcse 2009

- ✓ Ripe red berries are **weighed** at the factory.
- ✓ The berries are **sorted out** to remove unripe/diseased berries.
- ✓ Then taken through a machine to **remove outer covering pulp**.
- ✓ Berries are **fermented** in tanks for a while.
- ✓ Fermented beans are **washed**, then **dried** for about a week.
- ✓ The **husks are removed** and the beans **winnowed.**
- ✓ The beans are **sorted** out and **graded**.
- ✓ The beans are **roasted, ground into powder and packed** ready for sale/export.

### Marketing of coffee in Kenya

- ✓ Handled by co-operatives which own factories.
- ✓ After processing they sell coffee to KPCU.
- ✓ KPCU then passes to Coffee Board of Kenya.
- ✓ Owners of large plantations can directly export their coffee.
- ✓ Exported to countries such as **Britain, Germany, Finland, Norway, Japan and N**. through the world market where quota is allocated each country.

### How the Kenyan Government is assisting coffee small Scale Farmers

- ✓ Carrying out research into new species of coffee and control of pests and diseases.
- ✓ Construction of new roads and improvement of the existing ones to enhance transportation of coffee.
- ✓ Providing extension workers through the ministry of agriculture to advice farmers on the best farming methods.
- ✓ Advancing loans to farmers through K.P.C.U. to assist them improve on their farming.
- ✓ It helps the farmers to market their produce through Coffee Board of Kenya.
- ✓ It holds courses and has set demonstration farms to update farmers on new farming methods.

## Problems Facing Coffee Farming in Kenya-kcse 2021

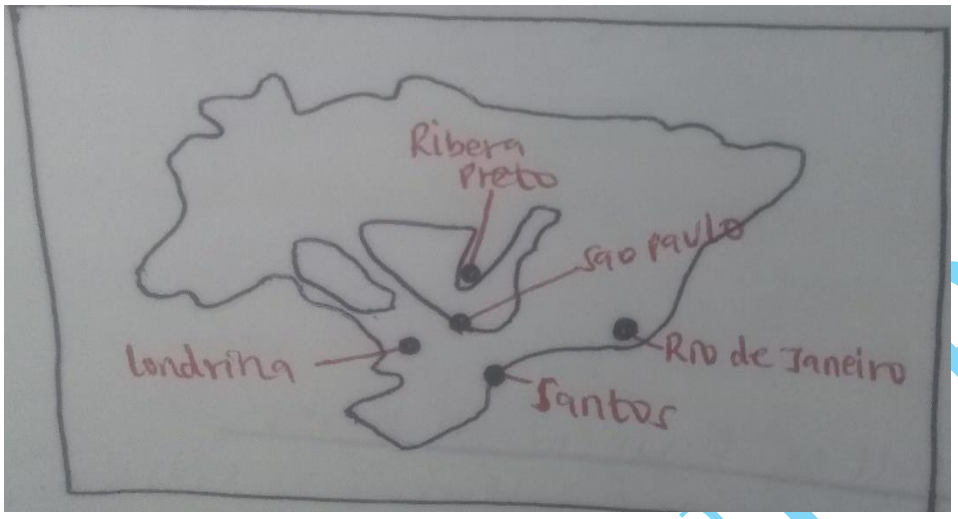
- ✓ Diseases like root rot, leaf rust which reduce the coffee yields leading to losses to farmers.
- ✓ Pests like aphids, leaf miner which attacks coffee leaves causing them to fall off reducing the yield leading to losses to farmers.
- ✓ Mismanagement of some co-operatives and embezzlement of funds by leaders which has caused some co-operatives to close up.
- ✓ Exhaustion of soil due to monoculture as coffee uses a lot of nutrients from the soil.
- ✓ Inadequate capital making the farmer unable to buy inputs such as fertilizers and chemicals leading to low production.
- ✓ Unreliable rainfall and drought conditions which causes young berries to ripen prematurely and fall off resulting to low yields hence loss to farmers.
- ✓ Competition from other crops which have caused farmers to abandon coffee due to low prices.
- ✓ Delayed payments to farmers which has lowered their morale.
- ✓ Impassable roads during rainy season delays delivery of coffee berries to the factory reducing their quality leading to losses to farmers.
- ✓ Fluctuation of coffee prices in the world market making farmers unable to plan ahead.
- ✓ High cost of farm inputs lowers coffee production reducing profit margin.
- ✓ Shortage of labour supply during harvesting season increasing the cost of production hence low profit margins.

## Significance of coffee Farming in Kenya

- ✓ Coffee is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Coffee is **consumed locally saving some foreign exchange** that would be used to import coffee.
- ✓ Farmers **sell** coffee locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**
- ✓ **Coffee is a raw material** for industries leading to **development of industries** such as processing factories, blending and packaging industries.
- ✓ Coffee farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.
- ✓ Coffee farming has led to **development of towns** such as Embu which are **centre for economic activity**.
- ✓ It earns Kenya a lot of **revenue** through **taxation**/licenses.
- ✓ It leads to **development of social amenities** in coffee growing areas **improving the living standards of people.**

## 2. COFFEE FARMING IN BRAZIL

### Main growing areas.




### Physical factors favouring coffee growing in Brazil.

- ✓ Moderate to high temperatures.
- ✓ High and well distributed rainfall throughout the year.
- ✓ Deep, well drained, terra rossa soils.
- ✓ Undulating surface at the Brazilian plateau around Sao Paolo.
- ✓ High altitude.

### Human factors favouring coffee growing in Brazil.

- ✓ Availability of cheap labour from tenant labourers given small plots to grow subsistence crops which makes production costs to be low.
- ✓ Well-developed roads and railways linking estates to export ports and cities like Sao Paolo, Salvador and Rio de Janeiro.
- ✓ Advanced scientific research in coffee growing.
- ✓ The large capital from the government/cooperatives.
- ✓ Advanced technology in beef farming from the local people.
- ✓ Presence of coffee processing factories.
- ✓ The large and ready internal and external market for coffee.

### Problems facing coffee farming in Brazil-kcse 2009

- ✓ The wasteful techniques of growing the crop leads to soil exhaustion which makes the coffee yield per hectare low.
- ✓ Climatic hazards/frost destroy coffee plants reducing the yields.
- ✓ Unplanned planting leads to overproduction/surplus production which lowers the prices.
- ✓ The fluctuating coffee prices in the world market sometimes leads to low profits.

- ✓ Stiff competition from other coffee producing countries threatens Brazil's dominance in the world coffee market.

**How Brazilian Government respond to the problems facing coffee.**

- ✓ The government lobbies for higher quotas in the world market.
- ✓ Prohibiting new planting.
- ✓ Buying and storing surplus coffee to artificially stabilise supply to maintain profit margins.
- ✓ Creation of artificial shortage of coffee in the world market by the institute for permanent defence of coffee to maintain high prices.
- ✓ Encouraging crop diversification and mixed farming to reduce overdependence on coffee.

**Reasons for decline of coffee production in Brazil**

- ✓ Falling profits
- ✓ Introduction of new crops(diversification)
- ✓ Increased competition from other coffee producing countries.
- ✓ Climatic hazards
- ✓ Indiscriminate picking of ripe and unripe berries.

**Significance of coffee Farming in Brazil**

- ✓ Coffee is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Coffee is **consumed locally saving some foreign exchange** that would be used to import coffee.
- ✓ Farmers **sell** coffee locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**
- ✓ **Coffee is a raw material** for industries leading to **development of industries** such as processing factories, blending and packaging industries.
- ✓ Coffee farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.

**Similarities between Coffee Farming in Kenya and Brazil.**

- ✓ Both Kenya and Brazil grow **similar varieties of coffee** i.e. Arabica and Robusta.
- ✓ In both countries, coffee is a major **foreign exchange earner.**
- ✓ In both countries, coffee is grown by **small- and large-scale** farmers.
- ✓ Coffee farming in both countries is **affected by falling prices in the world market**.
- ✓ Coffee experiences **stiff competition** from other producing nations in both countries.
- ✓ **Problem of soil exhaustion** is common in both countries.
- ✓ In both countries, coffee farming is **scientifically managed**.
- ✓ In both countries **the governments are involved in coffee marketing.**

- ✓ Brazil **exports coffee to the same countries** as Kenya e.g. Britain, Germany, etc.
- ✓ **Cultivation and processing** in both countries is done in much the same way.

## Differences between Coffee Farming in Kenya and Brazil.

- ✓ There is more extensive **land** for coffee farming in Brazil while in Kenya land is limited.
- ✓ In Brazil, farmers grow **other crops**/soya beans alongside coffee whereas Kenyan farmers mainly grow coffee.
- ✓ Brazil has more efficient coffee **marketing systems** while Kenya has poor coffee marketing system.
- ✓ In Kenya **land ownership** is individual while in Brazil, the land tenure allows tenants to work for rich land owners.
- ✓ In Kenya, farmers rely on the use of artificial **fertilizers** while in Brazil, there is little use of fertilizers.
- ✓ In Brazil there is a good network of **roads** and railways connecting plantations to export ports while in Kenya transport system is poorly developed.
- ✓ Frost is the main **climatic hazard** facing coffee farming in Brazil while Kenya's main climatic hazards are heavy rainfall and prolonged drought.
- ✓ In Brazil work is done by tenants while in Kenya it's done by family members or casual **labourers.**
- ✓ Brazil earns more **foreign exchange** from coffee while Kenya earns little foreign exchange from coffee.
- ✓ In Kenya only ripe berries are picked while in Brazil ripe and unripe berries are picked due to little supervision which affects the quality of coffee.
- ✓ In Brazil, coffee is mainly grown on plateaus while in Kenya it's mainly grown in the highlands.
- ✓ Brazil's coffee production is high so it's allocated a bigger quota in the world market while Kenya's coffee production is low.
- ✓ In Kenya coffee is grown in soils such as red volcanic soils while in Brazil it's grown mainly in terra rossa soils which are quite good for coffee.
- ✓ In Kenya most coffee is produced by small scale holders while in Brazil it's by large holders.

# WHEAT FARMING IN KENYA AND CANADA

## 1. Wheat Growing in Kenya.

### Main Growing Areas –kcse 2017

- ✓ **Uasin Gishu**
- ✓ **Nakuru**
- ✓ **Narok**
- ✓ **Meru**
- ✓ **Nyandarua**
- ✓ Elgeyo marakwet
- ✓ **Laikipia**

√ Nanyuki
√ Nyeri
√ Trans Nzoia
√ Keiyo

### Physical conditions favouring Wheat growing in Kenya-kcse 2005

- ✓ Gently sloping/undulating landscape for proper drainage and allow use of machines.
- ✓ Moderate/high temperature/Warm conditions.
- ✓ High and well distributed rainfall throughout the year.
- ✓ Deep, well drained, volcanic/loam/clay soils.
- ✓ Dry spell for ripening of wheat.
- ✓ High altitude.

### Human factors favouring wheat farming in Kenya.

- ✓ The large supply of labour from the local people.
- ✓ The large and ready market for wheat.
- ✓ Well-developed roads for transportation of wheat.
- ✓ The large capital from the cooperatives/government.
- ✓ Advanced scientific research in wheat farming.
- ✓ Advanced technology in wheat farming.

### Wheat cultivation

- ✓ Land is cleared off its vegetation.
- ✓ Land is ploughed using tractor.
- ✓ Harrowing is done.
- ✓ Fertilizer is added before sowing.
- ✓ Sowing is done during cool season.
- ✓ Weeding is done/herbicides applied.
- ✓ Small scale farmers use sickles/knives to cut wheat heads.
- ✓ Large scale farmers use combine harvesters during harvesting.
- ✓ The cut wheat is threshed, dried and winnowed.

## Uses of wheat-kcse 2005

- Wheat is used as animal feed.
- It is used for making adhesives/glue
- It is used in manufacturing paper/straw boards.
- It is used as human food.
- Wheat bran is used as chicken/dairy feed.
- Wheat flour is used industrially in distilleries/bakeries/straw plating.

## Problems facing wheat farming in Kenya

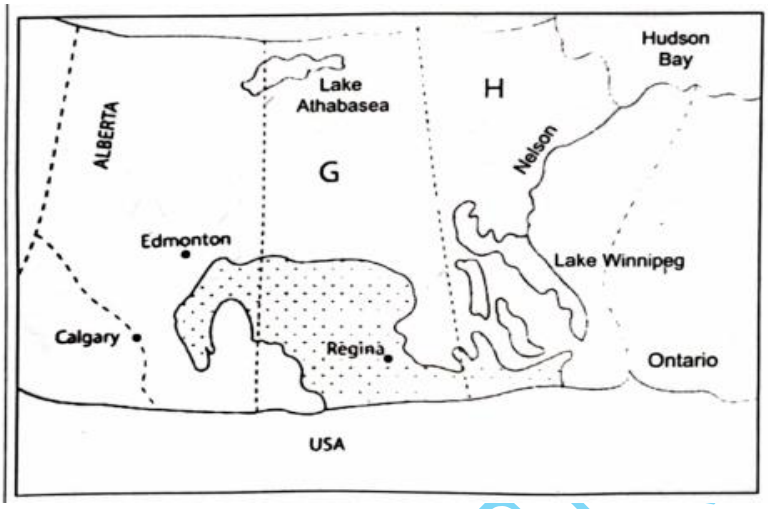
- ✓ Farmers have **inadequate capital** to buy inputs which lowers the yields.
- ✓ **Pests such as dusty brown beetle**/aphids/birds destroy crops lowering yields.
- ✓ **Diseases such as the leaf rust**/stem rust/glume blotch destroy crops lowering the yields.
- ✓ **Price fluctuations on the domestic market** especially when selling through middle men leading to losses to farmers.
- ✓ **Limited storage facilities** lead to wastage/spoilage of wheat hence losses to farmers.
- ✓ **Climatic hazards (kcse 2017)** such as the strong winds/frost/unreliable rainfall/prolonged cold/drought destroy crops lowering yields.
- ✓ **Soil exhaustion** due to monoculture reducing yields hence low income to farmers.

## Significance of wheat farming in Kenya.

- ✓ Wheat is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Wheat is **consumed locally saving some foreign exchange** that would be used to import wheat.
- ✓ Farmers **sell** wheat locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**
- ✓ **Wheat is a raw material** for industries leading to **development of industries** such as processing factories and packaging industries.
- ✓ Wheat farming has led to **development of feeder roads** that **eases movement of goods**/increasing volume of trade.
- ✓ Wheat farming has led to **development of towns** such as Narok which are **centre for economic activity**.
- ✓ It earns Kenya a lot of **revenue** through **taxation**/licenses.
- ✓ It leads to **development of social amenities** in wheat growing areas **improving the living standards of people.**

## 2. Wheat farming in Canada.

- Wheat in Canada is grown in the **Prairie Provinces** of:-2011/2012/2023
  - Alberta
  - Manitoba (H)
  - Saskatchewan (G)




**Physical conditions that favour wheat farming in Canada –kcse 2005/2011/2012**

- ✓ Moderate temperatures/warm conditions.
- ✓ Moderate rainfall.
- ✓ Availability of extensive land/undulating land.
- ✓ Deep, well drained, Brown chernozemz soils/Prairies soils.
- ✓ Sunny summer/conditions.
- ✓ Well distributed rainfall throughout the year.

**Human conditions that favour wheat farming in Canada.**

- ✓ Well-developed railway network.
- ✓ Large and ready internal or external market for wheat.
- ✓ Large capital from the government.
- ✓ Advanced scientific research in wheat farming.

**Problems facing wheat farming in Canada-kcse 2012**

- ✓ **Pests such as rodents**/birds/weevils/grasshoppers attack the crops lowering the quality/quantity of produce.
- ✓ **Diseases such as stem rust**/leaf rust/glume blotch affect the crops leading to low yields.
- ✓ **The soils have become exhausted** due to monoculture leading to low yields/lower quality yields.
- ✓ **Adverse climatic conditions** such as frost, hailstones, summer heat waves, prolonged winters and drought leading to low yields/lower quality yields.

- ✓ **Fluctuation in world prices of wheat** has led to farmers being uncertain about their earnings unable to plan ahead.
- ✓ **Canada faces competition** from other wheat producing countries which has reduced the market for her produce.
- ✓ **Frozen water in winter** limits accessibility to market.

## Significance of wheat farming in Canada.

- ✓ Wheat is **exported** therefore earns **foreign exchange** used to develop other sectors of economy.
- ✓ Wheat is **consumed locally saving some foreign exchange** that would be used to import wheat.
- ✓ Farmers **sell** wheat locally earning **income** improving their living standards.
- ✓ It creates **employment opportunities** such as for people working in farms and factories which **improves their standards of living.**
- ✓ **Wheat is a raw material** for industries leading to **development of industries** such as processing factories and packaging industries.

## Similarities between farming in Kenya and Canada.

- ✓ In both countries there is mechanization of wheat farming.
- ✓ In both countries wheat is grown by large scale farmers.
- ✓ In both countries wheat farming is favoured by a dry sunny spell
- ✓ Both countries experience the problem of pests and diseases.
- ✓ Wheat in both countries is grown in areas with gently sloping terrain.
- ✓ Wheat growing in both countries is affected by climatic hazards.

## Differences between wheat farming in Kenya and Canada.

- ✓ In Kenya, little **research** is being undertaken on wheat farming while in Canada there is advanced research on wheat farming.-2012
- ✓ In Kenya there is no **government policy** on subsidies/incentives to wheat farmers while in Canada the government subsidizes the farmers in case of crop failure.-2012
- ✓ In Kenya, there is poor **road networks/railway networks** in wheat growing areas while in Canada there is elaborate railway network/roads/water networks in wheat growing areas.-2012
- ✓ There are more extensive tracts of **land** for wheat farming in Canada while in Kenya land is limited.
- ✓ In Kenya wheat is mainly for local **consumption** while in Canada wheat is mainly for export.
- ✓ Canadian farmers **specialize** while Kenyan farmers carry out mixed farming.
- ✓ In Canada, wheat farming is more **mechanized** while in Kenya it is less mechanized.
- ✓ In Kenya farming is all year round whereas Canada experiences winters.
- ✓ In Kenya farming is carried out on plateaus while in Canada it's on plains.
- ✓ Canada produces more wheat grain while Kenya produces small wheat grain.

- ✓ Kenya grows spring **wheat** while Canada grows both spring and winter wheat.

## HORTICULTURAL FARMING IN KENYA AND NETHERLANDS

- ✓ **Horticulture** is the cultivation of **fruits, vegetables and flowers for sale/commercial purposes** –kcse 2023
- ✓ **Market gardening** is the intensive cultivation of **vegetables and fruits for sale in the nearby urban centre.**

### Characteristics of horticultural farming in Kenya –kcse 2023

- ✓ The farms are **scientifically managed.**
- ✓ The farms are usually small.
- ✓ The farms are located **near well- established transport routes** leading to urban areas.
- ✓ It requires heavy capital investment.
- ✓ It is **market oriented/ export-oriented.**
- ✓ Farming is highly specialized
- ✓ **Land is intensively used** to get maximum benefits.
- ✓ Produce output is high.
- ✓ The produce is highly perishable.

### 1. HORTICULTURE FARMING IN KENYA

### Physical factors favouring horticultural farming in Kenya –kcse 2023

- ✓ Deep, well drained, volcanic/ loamy soils which provides nutrients/support a variety of crops.
- ✓ Moderate temperatures/hot wet climate favours the growth of tropical crops.
- ✓ Cool wet climate in the highlands favours the growth of temperate crops.
- ✓ Availability of water/ rivers/ lakes.
- ✓ Relatively gentle sloping land/ undulating landscape.

### Human conditions favouring horticultural farming in Kenya

- ✓ High demand for horticultural products both in local and international market.
- ✓ Technical and financial assistance from friendly countries.
- ✓ The large capital from large and local overseas companies e.g. Del Monte, Kakuzi, etc.
- ✓ High labour due to high population as it is labour intensive.
- ✓ Enhanced research on better seeds or pest/diseases affecting horticultural crops.
- ✓ The government policy on diversification of export crops.

### Main Horticultural crops grown in Kenya-kcse 2021/ 2023

i. **Flowers e.g.** roses, orchids, carnations, gladioli, lillies
ii. **Vegetables e.g.** carrots, beans, cabbbages, kales, onions, tomatoes, spinach

iii. **Fruits e.g.** oranges, lemons, pawpaws, pineapples, avocadoes, watermelons, passions**.**

**Horticultural growing areas in Kenya.**

- ✓ Kiambu
- ✓ Nakuru
- ✓ Kericho
- ✓ Embu
- ✓ Kirinyaga
- ✓ Machakos
- ✓ Muranga
- ✓ Nyeri
- ✓ Kisii

**Leading imports of Kenya's horticultural products.**

- ✓ Netherlands √ Belgium
- ✓ Germany √ Japan
- ✓ Norway √ USA
- ✓ England

**Problems facing horticultural farming in Kenya**

- ✓ **Inadequate capital** in part of small-scale farmers to buy inputs which lowers yield quality and quantity.
- ✓ **Impassable roads** during rainy season delays delivery of horticultural products to the market leading to losses to farmers.
- ✓ **Pests like nematodes**/aphids and **Diseases like leaf blight**/root rot which destroy the crops leading to losses.
- ✓ **Poor marketing structure** leads to reliance on middlemen who exploit the farmers.
- ✓ **Freight charges are very high** leading to low profit margins.
- ✓ **High cost of farm inputs** lowers production reducing profit margins.
- ✓ **Stiff competition** from established producers in world market limit the quantity Kenyan farmers sell.
- ✓ **Low quality produce** may lead to rejection in the market hence farmers incur losses.
- ✓ **Price fluctuations in the world market** demoralizes farmers/unable to plan ahead.

**Contribution of horticulture to the economy of Kenya-kcse 2021**

- ➢ Horticulture has offered employment opportunities to many people/farmers who earn income from sale of produce hence raising their living standards.
- ➢ It has provided raw materials to agro-based industries thus promoting their growth/diversifying the economy.
- ➢ It earns the country foreign exchange through exportation of horticultural crops which is used to develop other sectors of the economy.

- It has led to the expansion and development of transport thus improving accessibility to many areas.
- It earns government revenue through taxes/licenses which is used to develop the country.
- Horticulture has utilized marginal/swampy land hence putting more land into use.
- It has increased food supply hence promoting food security.

## Reasons why horticultural farming is encouraged in Kenya –kcse 2014

- ✓ To earn foreign exchange which help to improve the economy.
- ✓ To create employment which enables people earn income hence improve their living standards.
- ✓ To provide raw materials which support the development of related industries.
- ✓ To enable farmers with small pieces of land earn (high) income to improve their standards of living.
- ✓ To improve food supply in the country thereby ensuring food security.
- ✓ To diversify agricultural production reducing over reliance on few cash crops/increase earnings.

## Challenges that horticultural farmers experience in marketing their produce- kcse 2011/2023

- ✓ The impassable roads during the rainy season make it difficult for the perishable goods to reach the market on time/ losses to the farmers.
- ✓ The cost of transporting produce by air is high thus lowering the profit margin.
- ✓ Poor marketing strategies leads to reliance on middlemen who exploit the farmers.
- ✓ Low quality produce may lead to rejection in the market hence making the farmers incur losses/farmers are demoralized.
- ✓ The farmers face stiff competition from the established/upcoming producers which limits the quantity the farmers are able to sell.
- ✓ Stringent quality standards required at the international market increases the cost of production thus lowering the profit margin.
- ✓ Fluctuations of the world market prices discourages farmers.
- ✓ Limited preservation facilities/refrigeration facilities leads to spoilage of the produce hence losses to farmers.

## Advantages of Green Houses

- ✓ Plants don't suffer effects of excessive rainfall.
- ✓ Plants aren't affected by drought.
- ✓ Pest and disease spread are controlled.
- ✓ Uniformity of climate is created for all plants.
- ✓ Plants are protected from damaging effects of strong winds and airborne diseases.
- ✓ Crops can be grown throughout the year.

- ✓ It's easier to control weeds by chemicals because the area is small.

**Reasons why flowers are mostly grown in green houses in Kenya-kcse 2021**

- ✓ In order to protect flowers from excessive rainfall/strong wind/hailstones.
- ✓ To enable plants to be watered constantly.
- ✓ In order to control pest/diseases easily.
- ✓ To enable plants enjoy controlled/optimum moisture/temperatures.
- ✓ To allow flowers to be grown throughout the year.
- ✓ In order to control weeds easily.

**Reasons why horticultural produce is mainly exported by air –kcse 2021**

- ✓ Horticultural crops are highly perishable.
- ✓ They are in high demand hence require urgent supply.
- ✓ Some crops are light in weight thus suitable for export by air.
- ✓ They are highly priced hence can compensate for cost of air transport.
- ✓ Most of the markets are located in far countries.

Kcse 2023: **State four factors that have contributed to fast growth of flower farming sub sector in Kenya.**

- ✓ Rise in local demand for flowers/ market.
- ✓ Increased investment in greenhouses ensuring high quality flower products.
- ✓ Low cost of production of flowers compared to other crops.
- ✓ Increased international demand due to high quality of Kenyan flowers.
- ✓ Shift from growing traditional cash crops that are less profitable.
- ✓ Well organized marketing system/ cooperatives help farmers to export their produce.
- ✓ High level research has led to development of high yielding varieties of horticultural crops.
- ✓ Improved transport network/ roads/ airports/ quick transportation/ export of produce to the market.
- ✓ Availability of skilled manpower.
- ✓ High population provides cheap labour.

## 2. HORTICULTURE FARMING IN THE NETHERLANDS.

### Major farming areas and crops grown.

i. **The Wasteland area-** carrots, lettuces, cucumbers, spinach, grapes, peaches, leeks
ii. **Leiden-Harlem area-** roses, clematis, rhododendrons
iii. **Arnhem-Nijmegen area-** jam making fruits, soft fruits like raspberries, red-currants, gooseberries

## Conditions favouring horticulture farming in Netherlands.

- ✓ Deep, well drained, sandy soils.
- ✓ Warm Gulf Stream Current provide free frost condition throughout the year.
- ✓ Accessibility to foreign markets due to central position in Europe.
- ✓ Shortage of land making it appropriate to establish horticultural farms.
- ✓ Advanced technology such as the use of glass houses.
- ✓ Fast and efficient transport system easing movement of horticultural products throughout the country e.g. good harbours like Rotterdam, canals, navigable rivers, roads and railways.
- ✓ Skilled labour which ensures high production and quality packaging.
- ✓ High demand in the populous urban areas of continental Europe.
- ✓ Large capital from highly organised co-operative societies which provide loans to farmers.
- ✓ Advanced technology in horticultural farming.

## Markets for horticultural products.

**a) Local markets-** Towns like Hague, Rotterdam, Amsterdam, Utrecht, Arnhem

**b) Foreign markets-** Britain, Germany, France, Sweden, England

## Contribution of horticulture to the economy of Netherlands.

- ➢ Horticulture has offered employment opportunities to many people/farmers who earn income from sale of produce hence raising their living standards.
- ➢ It has provided raw materials to agro-based industries thus promoting their growth/diversifying the economy.
- ➢ It earns the country foreign exchange through exportation of horticultural crops which is used to develop other sectors of the economy.
- ➢ It has led to the expansion and development of transport thus improving accessibility to many areas.
- ➢ It earns government revenue through taxes/licenses which is used to develop the country.
- ➢ Horticulture has utilized marginal/swampy land hence putting more land into use.
- ➢ It has increased food supply hence promoting food security.

## Features of horticultural farming in the Netherlands-2011

- **i.** The farms are generally small in size.
- **ii.** Most farmers practice mixed farming.
- **iii.** The farms are intensively used.
- **iv.** Farming is largely labour intensive.
- **v.** Farming is scientifically managed.

## Similarities between horticulture farming in Kenya and Netherlands.

- ✓ Similar crops are grown in both countries e.g. fruits, flowers and vegetables.
- ✓ In both countries there is use of green houses on horticultural land.
- ✓ Horticultural farming in both countries is export-oriented.
- ✓ In both countries, there is employment of scientific methods of farming.
- ✓ In both countries, horticultural farming is done intensively to get maximum returns.
- ✓ Crops grown partly on reclaimed land in both countries.

## Differences between horticulture farming in Kenya and Netherlands –kcse 2021

- ✓ In Netherlands, there is more **advanced technology** used to enhance horticulture while in Kenya, the **technology is low**.
- ✓ In Netherlands, there is **well developed transport system** which facilitates movement of horticultural produce while in Kenya, **transport networks are less developed**.
- ✓ In Netherlands, there is **highly skilled manpower** while in Kenya there is **low skilled manpower.**
- ✓ In Netherlands, farmers have **more access to capital** while in Kenya they have **limited access to capital.**
- ✓ Netherlands has **well organized marketing strategies** while in Kenya **marketing is poorly coordinated.**
- ✓ In Netherlands horticulture farming enjoys more **advanced research** while in Kenya **research in horticulture is low**.
- ✓ Netherlands horticultural crops are in **high demand** both locally and internationally while in Kenya the **local demand is low**.

## Common factors in Kenya and Netherlands that have favoured horticultural farming- kcse 2011

- ✓ Both countries have a varied climatic condition.
- ✓ In both countries, horticultural farming is practiced in areas with well drained soils.
- ✓ In both countries, irrigation is carried out.
- ✓ Both countries sell their horticultural produce in the local and international market.
- ✓ In both countries large companies/private organizations have invested in horticultural farming.
- ✓ In both countries, greenhouses are used.
- ✓ In both countries, transport is well developed.
- ✓ Availability of labour in both countries.
- ✓ Use of advanced technology in both countries.

# LIVESTOCK FARMING.

- ✓ **Livestock farming** is the rearing of domestic animals like sheep, goats, cattle and also poultry.
- ✓ **They are of two types namely;**
  - Nomadic pastoralism
  - Livestock ranching
  - Dairy farming
  - Beef farming

## 1. Nomadic pastoralism.

- ✓ It is the rearing of animals on natural pasture involving seasonal migration in search of water and pasture.

### Main Areas of pastoral farming in Kenya

- Turkana
- Wajir
- Garissa
- Marsabit
- Kajiado
- Narok

- ✓ **Pastoral communities in Kenya** are Maasai, Samburu, Turkana, Somali, Borana, Rendile and Pokot. **In Africa**(Fulani, Karamojong, Tswana, Maasai)
- ✓ **Animals kept are** cattle, goats, sheep, camels and horses.
- ✓ **Animal products are** milk, meat, blood and hides.s
- ✓ **Transhumance pastoralism** involves herdsmen moving with their livestock to the lowlands during winter and to the uplands during summer.
- ✓ **Sedentary pastoralism** involves people rearing their animals near their permanent homesteads.

### Factors Influencing Nomadic Pastoralism

- ✓ Grazing areas are free from animal pests especially tsetse flies for being dry and hot.
- ✓ Savannah grassland and semi-desert conditions which cause grass to sprout during rains and drying during the hot dry season.
- ✓ Availability of grass most times of the year in the bush and wooded savannah.
- ✓ Gentle/undulating plains which makes it easy for the movement of animals from one place to another.
- ✓ Sparse population of N and N.E region due to harsh climatic conditions which encourages nomadic pastoralism because each community is able to occupy large tracts of land.

- ✓ Desert and semi-desert conditions which don't favour agriculture making livestock rearing to be way of earning livelihood.
- ✓ Tradition of the people whereby animals are a sign of wealth and are used for paying dowry and slaughtered for festivals.

## Characteristics of Nomadic Pastoralism –kcse 2017

- ✓ They keep large numbers of animals.
- ✓ There is uncontrolled breeding of animals.
- ✓ Many kinds of animals are kept e.g. cattle, sheep, goats and camels.
- ✓ They keep animals as a sign of wealth/prestige.
- ✓ Land in which animals are kept is communally owned.
- ✓ The animals are weakened by pests and diseases/have low value/unhealthy.
- ✓ The animals are moved seasonally in search for pasture and water.
- ✓ There is inefficient marketing system/walking for long distances to the market.
- ✓ Animals are exposed to cattle rustling/frequent raids.
- ✓ Animals are reared for subsistence not for commercial purposes.
- ✓ They keep indigenous cattle which are hardy such as **Zebu and Boran.**

**QUIZ:-2008 Discuss nomadic pastoralism in Kenya under;**

i. **The cattle breeds kept(2mks)**
   - ✓ The pastoralists keep mainly indigenous breeds like zebu and Boran.

ii. **Pattern of movement(2mks)**
   - ✓ Their movement is seasonal
   - ✓ During dry season, the pastoralists migrate with the livestock to highlands where there is pasture and water.
   - ✓ During the wet season, they move to the plains since pasture is available.

iii. **Marketing of animal(2mks)**
   - ✓ Some cattle are sold to slaughter house/to individuals.
   - ✓ Some pastrolists sell their livestock through community groups.
   - ✓ Some livestock are sold to the livestock marketing department.
   - ✓ Some pastoralists sell their animals to Kenya Meet Commission(KMC)

**2008- Give three reasons why nomadic pastoralists keep large herds of animals.**

- ✓ It is a form of insurance against natural calamities such as diseases and drought.
- ✓ Animals are kept as a sign of wealth/prestige/social status.
- ✓ Animals are kept for use to pay dowry.
- ✓ Animals are used as a source of food/milk/meat/blood.
- ✓ Animals are source of income when sold.

## Problems facing nomadic pastoralism in Kenya –kcse 2015

- ✓ **Shortage of water and pasture** due to long dry spell making animals to be of poor quality.
- ✓ **Pests such as ticks and fleas** which weaken animals and **Diseases such as east coast fever, foot and mouth and anthrax** which cause heavy losses of stock.
- ✓ **Cattle rusting/raids** from neighbouring communities make the area insure.
- ✓ **Poor marketing strategies**
- ✓ **Competition from other land uses/decrease in grazing land**
- ✓ **Impassable roads** within the areas limiting the market.
- ✓ **Prolonged drought** leads to death of animals due to shortage of water and pastures.
- ✓ **Poor stocks management** which leads to poor- or low-quality animals.
- ✓ **Exploitation by middlemen** so herders make little profit.
- ✓ **Inadequate veterinary services** hence difficult to treat animals.

### Measures taken by the Kenya Government to improve pastoral Farming

- ✓ Encouraging pastoralists through the ministry of livestock to start ranching in order to improve the quality of their animals.
- ✓ Improvement of water supply in drier areas by sinking boreholes, wells, construction of dams, etc.
- ✓ Establishment of demonstration ranches to sensitize pastoralists on better methods of animal husbandry.
- ✓ Construction of cattle dips, and setting animal pest and disease organizations to control pests and diseases.
- ✓ Providing extension services to advice pastoralists and offer drug treatment to animals.
- ✓ Teaching pastoralists through formal education about advantages of keeping manageable sizes of herds.
- ✓ Encouraging them to keep smaller number of animals to solve the problem of quality.
- ✓ Ploughing and resowing pasture with more nourishing drought resistant grass.
- ✓ Purchasing pedigree animals and cross breeding with indigenous animals resulting in hybrid stock which is able to resist many tropical diseases, give more milk and better-quality meet.



## 2. Livestock Ranching

- ✓ This involves keeping of livestock (cattle) in marginalized areas in large fenced farms(ranches).
- ✓ It is common in USA, Australia, Argentina
- ✓ In Kenya, ranches are practiced in areas like Athi River, Narok, Kajiado, Taita Taveta, Machakos, Makueni, West Pokot, Laikipia and Samburu.

## Characteristics of Livestock Ranching

- ✓ Farms are scientifically managed.
- ✓ Animals are provided with water in the farms.
- ✓ Farms are fenced/Ranches are divided into paddocks.
- ✓ Variety of animals are kept
- ✓ Pasture is improved by applying manure
- ✓ Animals are improved through cross-breeding
- ✓ Animals are given supplementary feeds/fodder during dry period
- ✓ There is minimal movement of animals
- ✓ Overstocking is controlled
- ✓ Grazing is controlled
- ✓ Large tracts of land.
- ✓ Ranchers live in permanent dwelling.

## DAIRY FARMING IN KENYA.

- ➢ Definition kcse 2020: **Dairy farming** is the practice of keeping animals/cattle for milk/milk products.
- ➢ Dairy farming counties in Kenya are **Nakuru, Uasin Gishu, Laikipia, Kericho, Nyeri, Trans Nzoia**, Kiambu, Nyandarua, Meru, Nandi, Kisii, Nyamira, Tharaka Nithi, Machakos, Vihiga, Kakamega, Makueni, Kisumu

## Characteristics of Dairy farming.

- ✓ Specific cattle breeds that produce high milk yield are reared.
- ✓ Practiced in cooler and wetter areas.
- ✓ Milking is mechanized/high technology is used.
- ✓ Animals are kept for milk production.
- ✓ Small farms
- ✓ Ranches/animals are restricted in an area.
- ✓ Intensive farming
- ✓ Zero grazing and fodder feeding practiced
- ✓ Open grazing is common

## Dairy cattle breeds reared in Kenya-kcse 2007/2012/2016

- ✓ Friesian/Holstein
- ✓ Guernsey
- ✓ Jersey
- ✓ Ayrshire
- ✓ Sahiwal
- ✓ Alderney
- ✓ The Channel Island cows

## Physical conditions favouring Dairy Farming.

- ✓ Moderate/high rainfall.
- ✓ Deep, well drained, volcanic/loam soils.
- ✓ Moderate/high temperatures.
- ✓ Cool/warm/hot conditions.
- ✓ Gently sloping/undulating landscape.
- ✓ Constant supply of natural pastures.
- ✓ Supply of water from rivers.

## Human conditions favouring Dairy farming in Kenya-kcse 2012

- ✓ High population in the area offers **ready market** for milk and other dairy products/provide **labour**.
- ✓ There are **milk processing factories** which help in milk processing/storage.
- ✓ Many parts of Kenya highland are well served by **road network** which supports fast transport of milk to processing plants.
- ✓ **Co-operative societies** have been set up to market the dairy products.
- ✓ Provision of **veterinary services** that treat sick animals.
- ✓ Provision of **extension officers** to educate the farmers on cattle rearing.

## Processing of Milk

- ✓ At the creameries, milk is weighed.
- ✓ Pasteurization - Heating liquid milk to 75◦c for about 15 minutes.
- ✓ Sterilization - Heating to 100◦c for a short time to kill bacteria which survived pasteurization.
- ✓ Homogenizing - Breaking and distributing fat particles throughout the milk to ensure a layer of cream doesn't form of milk.
- ✓ Ultra-heat treatment - Heating milk beyond 100◦c.
- ✓ Processed further into products such as **butter, powdered milk, ghee or cheese**.
- ✓ The products are packed ready for distribution to consumers.

## Marketing of milk Kenya

- ✓ It's done by Kenya Co-operative Creameries (KCC) and Dairy board of Kenya.
- ✓ Farmers may take the milk to KCC by themselves.
- ✓ Local co-operatives also collect milk from farmers at various collection points and take it to KCC.
- ✓ After processing the products are sent to KCC depots for distribution to consumers.
- ✓ Some is exported to neighbouring countries such as Uganda.
- ✓ Other processors also market their milk locally and internationally.

## Problems Facing Dairy Farming in Kenya

- ✓ Small scale dairy farms face **stiff competition** from other cash crops like tea, coffee, vegetables and passion fruits, etc.
- ✓ **The cost of inputs is very high** which has minimized mechanization and resulted into to low profit margins.
- ✓ **Impassable roads** during the rainy season making milk delivery difficult hence spoilage.
- ✓ **Drought/unreliable rainfall** which result in inadequate pastures which causes temporary milk shortage.
- ✓ Risk of cattle **pests like ticks/Tse tse fly** and **Diseases like east coast fever** which affect dairy animals lowering yield.
- ✓ **Poor management of dairy co-operatives** at grassroots resulting to delayed payments which kills farmers' morale.
- ✓ **Shortage of proper storage facilities** at the collecting centres such as cooling plants causing milk to go bad before it gets to processing factories leading to losses for farmers.
- ✓ **AI services have been privatized making them very expensive** and inaccessible to many small-scale farmers resulting in low quality breeds and hence low milk production.
- ✓ **Fluctuating milk prices**/low prices make farmers unable to plan ahead.
- ✓ **Inadequate capital** to purchase expensive farm inputs hence limit dairy farming in large scale.

## Steps taken by Kenyan government to improve dairy farming.

- ✓ Appointing supervisory boards for dairy co-operatives.
- ✓ Extending credit facilities to farmers through co-operatives.
- ✓ Holding agricultural shows to educate farmers on good dairy farm management.
- ✓ Setting up demonstration farms which breed high quality bulls to be released to farmers.
- ✓ Establishing well maintained roads for delivery of milk.
- ✓ Carrying out extensive research on possible solutions to diseases.

## Contribution of Dairy farming to the Economy of Kenya.

- ✓ Earns Kenya foreign exchange by exporting milk and dairy products.
- ✓ Milk/milk products are consumed locally saving foreign exchange.
- ✓ Government also earns revenue by taxation from the sale of dairy products which is used to fund various development projects.
- ✓ Provides employment in dairy farms, milk processing plants and dairy related industries enabling farmers to earn income improving their living standards.
- ✓ Gives farmers an income which has alleviated poverty and raised living standards.

- ✓ Promoted development of industries such as milk processing plants, input manufacturing industries which has created more employment and raised per capita income.
- ✓ Promotes good health and nutrition by providing proteins, fats and vitamins that are essential for human growth and development.
- ✓ Has led to improvement of transport networks in Kenya by government improving existing roads to ease milk delivery.

## DAIRY FARMING IN DENMARK.

### Types of Animals kept.

- Danish Red
- Friesian
- Ayrshire
- Channel island cows

### Physical conditions favouring dairy farming in Denmark-kcse 2016

- ✓ The landscape is gently sloping which is suitable for grazing.
- ✓ The climate has warm/sunny summer that allow outdoor grazing.
- ✓ There is cool climate suitable for pasture growing.
- ✓ The moderate rainfall that supports growth of grass/fodder crops.
- ✓ Deep, well drained, clay soils that support growth of high-quality pasture.

### Human conditons favouring dairy farming in Denmark.

- ✓ Mechanization of most dairy farms e.g. machines for milking are widely used.
- ✓ Large market for dairy products locally and in other European countries due to a high purchasing power.
- ✓ Availability of adequate capital and modern technology which has improved production and storage of dairy products.
- ✓ Extensive use of artificial insemination which improves the quality of breeds making dairy farming a success.
- ✓ Rapid growth of co-operative movement which are very competitive causing farmers to strive to get products of high quality.

### Problems facing dairy farming in Denmark

- ✓ Rare incidents of diseases such as mastitis and Salmonella Dublin affect dairy cattle.
- ✓ It's expensive to run farms in winter when animals are kept indoors and fed on fodder.
- ✓ Dairy animals emit a considerable amount of carbon dioxide and methane which contributes to greenhouse effect.

- ✓ Reduced market shares due to competition from other dairy producing countries and restrictions.
- ✓ Occasional spells of drought causing a considerable drop in milk production.

## Similarities between dairy farming in Kenya and Denmark.

- ✓ Dairy farmers in both countries sell their products to co-operatives.
- ✓ Both countries experience similar problems of adverse weather changes and diseases.
- ✓ Animals kept are similar e.g. Friesian, Ayrshire, Jersey, in both countries.
- ✓ Milk processing and dairy products are similar e.g. liquid milk, cheese and butter in both countries.
- ✓ In both countries milk is consumed locally and for export.
- ✓ Both countries keep traditional and exotic breeds.
- ✓ Open and zero grazing are practiced in both countries.
- ✓ Artificial insemination is used in both countries.

## Differences between dairy farming in Kenya and Denmark –kcse 2012

- ✓ In Kenya, cattle mainly depend on naturally growing **grass/pasture** whereas in Denmark, the cattle is fed on fodder/commercial grass/commercial feeds.
- ✓ In Kenya, mechanization is limited/mainly labour intensive while in Denmark, mechanization is widely used.
- ✓ In Kenya, most farmers practice mixed farming while in Denmark dairy farming is highly specialized.
- ✓ In Kenya, most of the dairy products are consumed by the domestic market while in Denmark, the products are mainly exported.
- ✓ In Kenya, dairy production is affected by variation in climate while in Denmark dairy farming is least affected by variation in climate.
- ✓ In Kenya, dairy cooperatives are least developed while in Denmark, dairy cooperatives are highly developed.
- ✓ In Kenya artificial insemination/extension services is limited to a few farms while in Denmark, artificial insemination/extension services is widely used.
- ✓ In Kenya animals graze outdoor throughout the year while in Denmark, animals are kept indoor during winter.
- ✓ In Kenya research is limited while in Denmark research is extensive.
- ✓ In Kenya, dairy farming is practiced in highlands while in Denmark it is found throughout the country.

## BEEF FARMING

- **Definition:-kcse 2017- Beef farming** is the rearing of cattle for production of meat.
- **The major world exporters of beef are** Argentina, Australia, New Zealand, USA and Europe.

### 1. BEEF FARMING IN KENYA.

#### a) Traditional Beef farming

- **Done by the pastoral communities like** Maasai, Turkana, Pokot and Somali.
- **Occupy counties like** Kajiado, Turkana, West Pokot, Garissa, Wajir and Mandera.
- **Types of animals kept** are **Zebu, Boran** and **Sahiwal** breeds.

#### b) Commercial Beef farming

- **Occupy counties like** Laikipia, Nakuru, Trans nzoia, Kajiado, Kwale and Kilifi.
- **2011- Types of animals kept are;**
  - Aberdeen Angus
  - Galloway
  - Short horn
  - Hereford
  - Charolais

### Factors favouring Beef Farming in Kenya –kcse 2014/2017

- ✓ Extensive flatlands with natural grass.
- ✓ Moderate temperatures.
- ✓ Moderate rainfall which ensures there is enough pasture.
- ✓ Availability of watering points/sites such as swamps.
- ✓ Availability of ranching schemes which control overgrazing and the spread of pests and diseases.
- ✓ Cultural practice of local people who carry out livestock keeping as their occupation.

### Marketing of beef products in Kenya

- ✓ Small scale farmers sell their animals to butchers who slaughter and sell to consumers after it's inspected.
- ✓ Livestock Marketing Division is in charge of marketing beef from pastoral areas.
- ✓ It acts as a co-operative society and buys beef cattle and puts them in holding grounds.
- ✓ The animals are vaccinated against diseases and then sold to individual butchers or to slaughter houses through auction.
- ✓ Pastoralists sell to middlemen who transport livestock to big towns like Nairobi.

## Problems Facing Beef farming in Kenya.

- ✓ High temperatures in the country makes it hard to rare cattle of high quality.
- ✓ Unreliable rainfall leads to inadequate pasture for cattle.
- ✓ Thin soils leads to poor natural grass unsuitable for the quality animals.
- ✓ Overstocking by pastoralists ruin pasture land leaving less for beef farming.
- ✓ Pests like ticks and tse tse fly attack animals lowering the yields.
- ✓ Diseases like nagana, rinderpest, foot and mouth affects the animals lowering yields.
- ✓ Competition from other land use activities like wildlife hence affecting beef farming.
- ✓ Poor quality animals due to poor pastures hence low profit margins.
- ✓ Inadequate capital for development of the beef industry.

## Measures taken by the Kenyan government to improve beef farming –kcse 2008

- ✓ It encourages the cross-breeding of traditional cattle breeds with exotic ones to improve the quality of animals.
- ✓ It strengthens community education to teach beef cattle farmers better livestock management.
- ✓ It sets up demonstration ranches for farmers to learn new trends in livestock management.
- ✓ It has constructed roads to make services accessible to farmers/make transportation of animals to markets easier.
- ✓ It encourages the replacement of the coarse grass with nutritious pasture to improve the quality of animals.
- ✓ It has sunk boreholes/dug wells/constructed dams to provide water for the animals.
- ✓ It has revived Kenya Meat Commission (KMC), a government parastatal that buys animals from farmers for slaughter.

## Significance of Beef farming in Kenya –kcse 2017

- ✓ It's a source of foreign exchange when beef and beef products are exported.
- ✓ It provides employment to many people working in ranches, slaughter houses, butcheries who earns income improving their living standards.
- ✓ It saves foreign exchange by supplying beef for local consumption.
- ✓ It has promoted development of industries by providing raw materials e.g. shoe making.
- ✓ The governments earn revenue from tax levied on beef products.
- ✓ It leads to development of roads that ease movement of goods.
- ✓ It leads to development of towns Kajiado which are centre for economic activity.
- ✓ It leads to development of social amenities improving the living standards of people.

## 2. BEEF FARMING IN ARGENTINA.

- **Main areas-** The Pampas e.g. Fray Bentos, Rosario, Buenos Aires, Bahia Blanco
- **Types of beef animal breeds kept-** Short horn, Aberdeen Angus, Galloway, Hereford, Brangus

### Physical conditions favouring beef farming in Argentina.

- ✓ Extensive pampas grasslands which provide good natural grazing landscape and allows cattle to graze freely.
- ✓ Deep, well drained, volcanic soils from the slopes of Andes which have given rise to good natural pasture.
- ✓ Moderate and well distributed reliable rainfall for the growth of pasture.
- ✓ Moderate temperatures which enable grass to grow throughout the year.
- ✓ Gently sloping/undulating landscape provide suitable site for grazing.
- ✓ Maritime/warm and wet climate make cattle grazing possible throughout the year.

### Human conditions favouring beef farming in Argentina.

- ✓ High quality exotic breeds such as Short horn and Hereford which mature faster and have quality and quantity beef.
- ✓ Availability of alfalfa which matures faster and is more nutritious which has been planted to replace natural grass.
- ✓ Well-developed roads like the railway network used for movement of beef cattle from ranches to factories and to the markets.
- ✓ Availability of large-scale ranches which are well managed and mechanized.
- ✓ Availability of adequate capital making it possible to have refrigeration for proper storage of beef products.
- ✓ Availability of local markets in E.U and U.S.A.

### Problems facing Beef farming in Argentina.

**a)** Diseases like foot and mouth which affect animals lowering yields.
**b)** Stiff competition from other leading beef producers like New Zealand, US and Australia.
**c)** Drought which affects beef farming.

### Significance of Beef farming in Argentina

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- ✓ The governments earn revenue from tax levied on beef products.
- ✓ It leads to development of roads that ease movement of goods.

## Similarities between beef farming in Argentina and Kenya –kcse 2011

- ✓ In both countries, the cattle are mainly reared in areas of natural pasture/grazing.
- ✓ In both countries beef cattle are reared mainly in ranches.
- ✓ Indigenous and exotic breeds are kept in both countries.
- ✓ Beef animals kept are similar e.g. Aberdeen Angus, Hereford, etc.
- ✓ Beef cattle/products is for local and export market in both countries.
- ✓ There is employment of modern methods of farming in both countries e.g. cross breeding, AI and research.
- ✓ Both countries experience the problem of pests and diseases.

## Differences between beef farming in Kenya and Argentina.

- ✓ Argentina has extensive **natural pastures**/pampas while Kenya has inadequate pastures.
- ✓ There is a high local demand/**market** for beef in Argentina while there is low local demand/ market for beef in Kenya.
- ✓ **Pests and diseases** are a major problem in Kenya while in Argentina the problem has been controlled.
- ✓ In Argentina beef farming is mainly carried out in extensive **ranches** while in Kenya it's mainly carried out by small scale farmers and ranches are few.
- ✓ Farmers in Argentina have more access to **capital** while Kenyan farmers have inadequate capital.
- ✓ There is a well-developed **transport network** in Argentina while Kenyan roads are impassable which hinders transport to markets.
- ✓ Beef farming is more highly **mechanized** in Argentina while in Kenya beef farming is less mechanized.
- ✓ Kenya has few beef **processing factories** while Argentina has many beef processing factories.
- ✓ In Kenya both exotic and local **breeds** are kept while in Argentina, most of the breeds are exotic.
- ✓ In Argentina, farmers also **grow crops** like wheat while in Kenya farmers practice only beef farming.
- ✓ In Kenya, most of beef products are for local consumption with little for **export** while in Argentina most of beef products are for export with little sold for in the local market.

**Quiz:-kcse 2017- Give reasons why beef production is higher in Argentina than Kenya (6mks)**

- ✓ Argentina has larger/better organized/managed ranches than in Kenya.
- ✓ Argentina has high quality cattle.
- ✓ Argentina has better methods of animal husbandry/control of diseases/extension services than Kenya.
- ✓ Argentina has more nutritious grass/fodder/alfafa.
- ✓ Argentina ranches are well watered by wind pumps which reduces movement/weight loss/in search for water.
- ✓ Argentina has more capital for intensive care.
- ✓ Argentina has well developed railway/road network that transports beef cattle to the factories.
- ✓ Argentina has high advanced technology/external market for beef than Kenya.
- ✓ Argentina has large local market for beef.



**"THE END OF GEOGRAPHY FORM THREE WORK."**

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**TO GOD BE THE GLORY.**