Geography s5

Student's Book

Kigali,January 2019

FOREWORD

Dear student,

Rwanda Education Board is honoured to present to you this Geography Book for Senior five which serves as a guide to competence-based teaching and learning to ensure consistency and coherence in the learning of geography subject. The Rwandan educational philosophy is to ensure that you achieve full potential at every level of education which will prepare you to be well integrated in society and exploit employment opportunities.

The government of Rwanda emphasizes the importance of aligning teaching and learning materials with the syllabus to facilitate your learning process. Many factors influence what you learn, how well you learn and the competences you acquire. Those factors include the instructional materials available among others. Special attention was paid special attention to the activities that facilitate the learning process in which you can develop your ideas and make new discoveries during concrete activities carried out individually or with peers.

In competence-based curriculum, learning is considered as a process of active building and developing knowledge and meanings by the learner where concepts are mainly introduced by an activity, a situation or a scenario that helps the learner to construct knowledge, develop skills and acquire positive attitudes and values. For effective use of this textbook, your role is to:

- Work on given activities which lead to the development of skills
- Share relevant information with other learners through presentations, discussions, group work and other active learning techniques such as role play, case studies, investigation and research in the library, from the internet or from your community;
- Participate and take responsibility for your own learning;
- Draw conclusions based on the findings from the learning activities.

I wish to sincerely extend my appreciation to the people who contributed towards the development of this book, particularly REB staff who organized the whole process from its inception. Special gratitude goes to the University of Rwanda which provided experts in design and layout services, illustrations and image anti-plagiarism, lecturers and teachers who diligently worked to successful completion of this book. Any comment or contribution would be welcome for the improvement of this textbook for the next edition.

Dr. Irénée NDAYAMBAJE

Director General, REB

ACKNOWLEDGEMENT

I wish to express my appreciation to all the people who played a major role in development of this Geography textbook for senior five. It would not have been successful without active participation of different education stakeholders.

I owe gratitude to different Universities and schools in Rwanda that allowed their staff to work with REB in the in-house textbooks production project. I wish to extend my sincere gratitude to lecturers, teachers and all other individuals whose efforts in one way or the other contributed to the success of writing of this textbook.

Special acknowledgement goes to the University of Rwanda which provided experts in design and layout services, illustrations and image anti-plagiarism.

Finally, my word of gratitude goes to the Rwanda Education Board staff particularly those from the Curriculum, Teaching and Learning Resources Department (CTLR) who were involved in the whole process of in-house textbook writing.

Joan MURUNGI,

Head of Curriculum, Teaching and Learning Resources Department (CTLR)

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UNIT 1

STATISTICAL GRAPHS, DIAGRAMS AND MAPS

UNIT 1: STATISTICAL GRAPHS, DIAGRAMS AND MAPS

Key unit competence:

By the end of this unit, I should be able to interpret statistical data, construct statistical graphs, diagrams and maps

Introductory activity

Read the story below and use it to answer the questions that follow:

Rwanda exported over 250b frw Agricultural products in 2017. The National Agriculture Exports Development Board (NAEB), says the country's agricultural exports generated revenues amounting to 304.6 million frw from January to September 2017 compared to 232.65 million earned in the same period in 2016. In the first quarter of 2017/18, agricultural exports generated 116 million frw against 82,809,581 frw in the first quarter of 2016/17. Agricultural crops locally produced and exported like coffee, tea, and pyrethrum generated 108 million frw from January to September of 2017, compared to 89 million in the same period in 2016. The volume of exported vegetables was 18.98 million kilograms from January to September 2017, compared to over 15.61 million kilograms in the same period of 2016, meaning that the quantity of exports increased by only 21.56%. The value of exported vegetables was 8 billion frw from January to September 2017, against 4.2 billion frw in the same period of 2016, implying an increase of 98.65 percent, and a rise in price per unit of the vegetables.

Now answer the following questions:

a. Name the data which are represented in the passage?

b. Using the past studies in both ordinary level, senior four and personal research:

   i. Identify other methods to represent the data displayed in the passage.

   ii. Discuss the importance of the geographical data identified in (a) above and make a class presentation, if possible using ICT tools, or flip charts or any other resource available.

   iii. Comment on the Rwanda's exports between January 2017 to Oct 2017 and account for the variations in the trend of exports.

1.1. Definition of statistics and importance of statistical graphs and diagrams in geography

Learning activity 1.1

Read the story below and use it to answer the questions that follow:

Micomyiza Jeanne and Habinshuti Gilbert made their field study on 'The effects of human activities on the physical environment in Twubahane village. They used various methods of data collection. Jeanne was interested in writing down every observed aspect in a descriptive manner while Gilbert filled his note book with tables and charts that he would interpret after the field trip. Some other students who had also attended the fieldwork study, used various methods of noting down data, such as line graphs, bar graphs with description foot notes. They could look at the graphs and charts drawn and easily understand the content contained therein. The collected numerical data revealed that 12 farmers were using poor methods of farming, 20 farmers had applied agro-forestry and tree planting, 2 farmers were engaged in charcoal burning, 7 people had large herds of cattle whose impact on the environment was so evident. All data collected were presented and recorded on a chart.

a. Explain why most students were interested in using the statistical way of data recording.

b. Does the passage above represent statistics? Explain your answer.

c. Using the example of Habinshuti, examine the importance of statistical graphs and diagrams in Geography.

1.1.1 Definition of Statistics

The term statistics is defined in many ways by various authors. The term holds its origin from the Latin word "Statisticum collegium" that stands for council of state, later it changed into the Latin word "Status" that means a group of numbers or figures, the Italian word "Statista" (statesman) and German: "statistic" that means (Analysis of data about the state). This shows that originally statistics were used for governmental purposes. However, later the usefulness of statistics in the real-world experiences increasingly became important.

The term statistics therefore, refers to the science of collecting, analyzing, interpreting and presenting various data. It is a science of how data are collected, analyzed and interpreted. Statistics deals with data. It is very necessary to understand the meaning of the term data. Data is a word used to mean the information used as a foundation for reasoning, discussing and calculating. This implies that statistics and

data go hand in hand.

1.1.2: Importance of statistical graphs and diagrams in geography

Statistical graphs and diagrams play a key role in geography. They are needed in various aspects of human activities in this 21st century. They are important in the following ways:

1. Statistical graphs and diagrams help students to summarize huge and a wide range of information for future analysis. Diagrams and graphs hold huge information in accurate way.
2. The geographers can identify and interpret the relationship existing between various variables. For example, the relationship between the increase of prices for commodities and increase in cost of fuel.
3. Facilitate easy understanding of various geographical variables and clearly show the trend and variations of production, trade, among many others.
4. Statistical diagrams and graphs enable the learners to acquire various skills such as analytical skills, interpretation and presentation of geographical data. Such skills can be used in other areas after school.
5. Most of statistical diagrams and graphs enable the students and geographers to save time as data is being recorded down.
6. Statistical graphs and diagrams provide a good and attractive visual impression. Therefore, arousing the interest of the reader or geographer in what is portrayed by the graph or diagram.
7. The data contained thereon the statistical graphs and diagrams, are used in making effective decisions. Therefore, logical judgmental conclusions are made based on factual data.
8. Statistical diagrams and graphs facilitate easy memory of the reader or students/geographers. Data and geographical information presented on diagrams and graphs are easily remembered than the data presented in a descriptive manner.
9. They help geographers to predict the trend of geographical events of various phenomena. For example, if a given graph shows a positive increase trend of coffee in country X, for some considerable years, it becomes easy to make predictions.

Application Activity 1.1

Using first hand experiences and skills acquired in statistics, explain how statistics is important in your daily life and show how it would help to understand geography.

1.2. Line and curve graphs

Learning activity 1.2.1

Land use in country X from 2015 to 2017

Year	Activity per hectares of land ('000 ha)
2015	250
2016	350
2017	650

Using the knowledge and skills acquired from Mathematics and the data provided in the table above, answer the following questions:

a. Draw a simple line graph to represent the above information

b. Use the same data indicated in the table above, to construct a simple curve graph

c. Using both the data and the graphs drawn, comment on the trend of land use in country X from 2015 to 2017.

d. Discuss the advantages and disadvantages of simple line graph

There are several types of line and curve graphs. They range from simple to more complex depending on the composition and nature of the statistical data to be represented or portrayed. Under this category of statistics in geography, the following are the main line graphs:

i. Simple line and curve graph

ii. Group or comparative line graph

iii. Compound line graphs

iv. Divergence graphs

1.2.1. Simple line and curve graphs

A line graph is one which shows plotted points connected by a series of short straight lines. This distinguishes it from the simple curve graph in which plotted points are joined by a single smooth line. The illustrations 1.1 and 1.2 display the sample examples of the simple line and curve graphs used in Geography.

With line graphs plotted points are observable while with curve graphs points are not noticeable. Also, with a simple line graph, the line suspends without touching the two-vertical axis while in a simple curve graph the smooth line drawn touches the two-vertical axis.

Construction of a simple line graph

The following are steps to be followed while constructing a simple line graph. The same applies to the drawing of a simple curve graph. These steps are stated as follows:

1. The independent variables are indicated on horizontal axis. (Independent variables mean that when there is a change in the independent variable or variables, this results into a direct reaction of the dependent variables.)
2. The dependent variables are represented on the vertical axis. (Dependent variables are items that are reliant on the independent variables. That is to say; these are measurable responses from the reaction caused by a change in the independent variables).
3. The vertical axis should start from Zero. While the top part be slightly greater than the maximum value to be indicated or recorded on it.
4. The length of the horizontal line is determined by the number of the independent values in relation to the scale.
5. Draw two vertical lines on both sides and exact numbers of values of constant relationship recorded on the two axes. However, this is not a must be done condition.
6. When plotting points in correspondence to both independent variables and dependent variables, it is appropriate to put the dot in the middle of the two vertical lines as shown below:

Worked example

Table 1. 1: The table showing temperature recorded at station B

Months	J	F	M	A	M	J	J	A	S	O	N	D
Temp. 0C	22	20	19	21	23	27	28	20	19	24	24	20

Use the data presented in the table above to answer the following questions that

follow:

a. Construct a simple line graph to portray the above statistical data.

b. Draw a simple curve graph to illustrate the above statistics shown on the table.

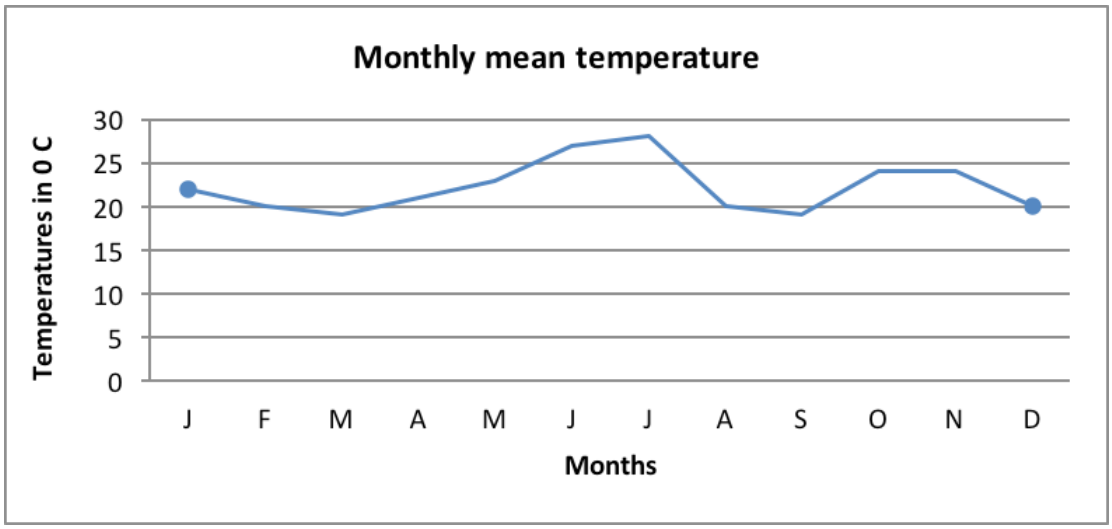


Figure 1. 1: Simple line graph of monthly mean temperature

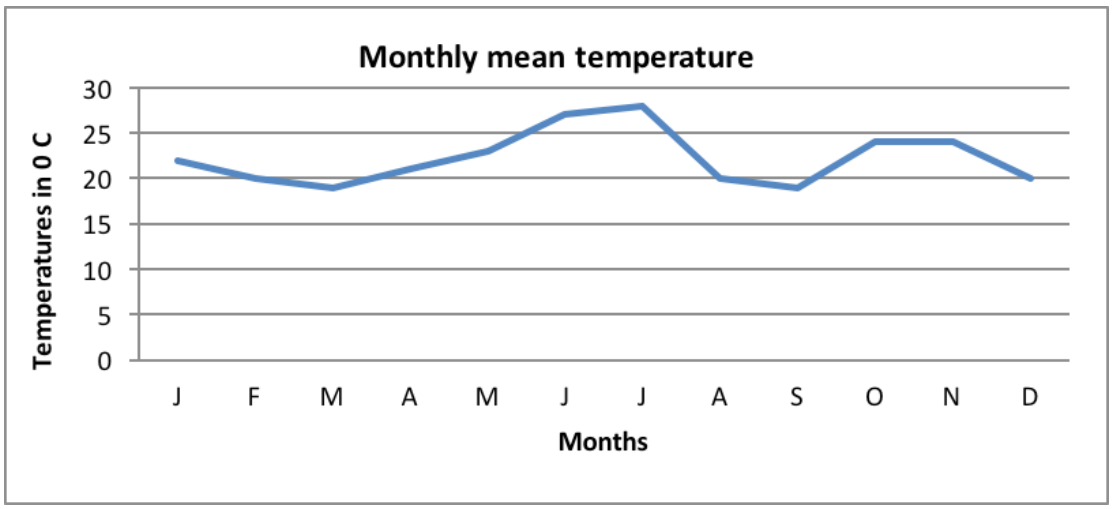


Figure 1.2: Simple curve graph of monthly mean temperature recorded at station B

Advantages of simple line and simple curve graphs

1. They are simple to draw or construct.
2. When neatly drawn, they provide a good visual impression.
3. They are easy to interpret.
4. Less time is needed to construct them.

5. Simple errors or error free because of the simplicity nature of the methods.
6. Simple calculations are involved.
7. They can be used together with other statistical methods and diagrams such as dot maps in a super-imposition manner.
8. They have a multi-purpose service. For example, they are used in representing several geographical aspects such as the trend of crop production, variation in temperature, minerals, etc.

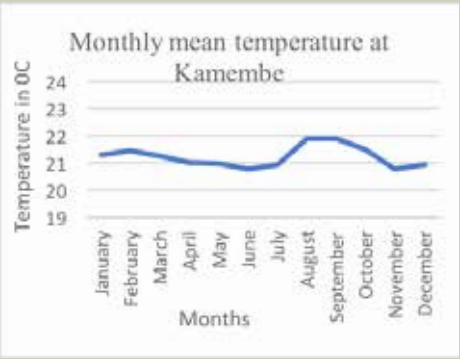
Disadvantages of simple line and simple curve graphs

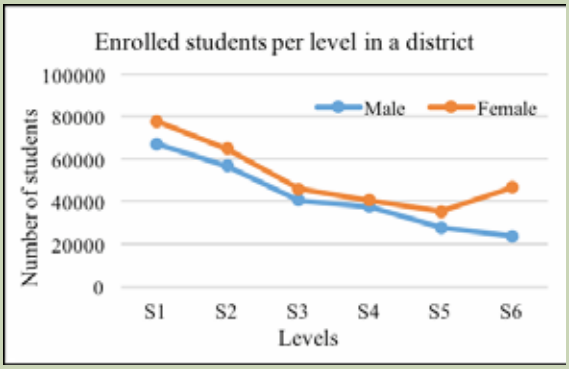
1. There is no accurate interpretation because of some points are plotted basing on estimation of values.
2. There are difficulties in determining the appropriate scale especially when large figures or values are used.
3. The curve graphs are less accurate in comparison to simple line graphs.
4. It is not easy to use the simple line and curve graphs to compare various categories of data.
5. Changing scale of either axes, can greatly change the visual impression of the graph.
6. They are only used while dealing with continuous data.

1.2.2. Group or comparative graphs

Learning activity 1.2.2

The following are selected graphs





Refer to the above figures to answer the questions below:

a. Explain the differences existing between the two graphs shown above.

b. Describe the features represented on graph of enrolled students per class.

c. Explain the advantages and disadvantages of graph showing the enrolled students per class.

Group or comparative line graphs are also known as multiple line/curve graphs. This form of statistical method is used to portray more than one dependent variable. It uses several lines of which each represents a given specific variable of individual item. For group or comparative line graphs, the table has many dependent variables as shown below:

Table 1.2: Crop production from 2012 to 2016 in Country X in '000,000 tons

	2012	2013	2014	2015	2016
Coffee	19	15	45	82	109
Tea	50	36	30	70	80
Wheat	15	38	19	45	59

The above table shows several dependent variables as well as the independent variables. There are 5 years and three crops such as coffee, tea and wheat. When critically analyzed, you find that for each independent variable in the left column (Crops) can be represented by a single simple line graph. The difference comes with group graph or comparative graph, each crop will be represented on the same graph.

As earlier said, a comparative line graph has several lines as shown by the sample below:

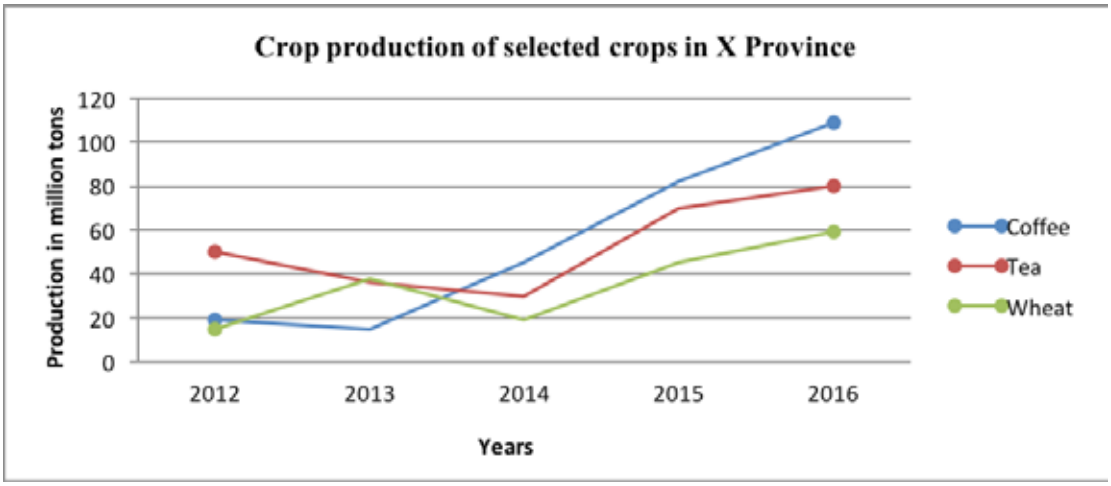


Figure 1.3: Group/comparative line graph of selected crops in X province

Construction of group or comparative line/curve graph

Below are steps or guidelines to be followed while drawing a Group or comparative/ multiple line/curve graphs:

1. Several lines are constructed on the same graph.
2. The lines drawn representing individual variables or items should be easily distinguishable from one another. It is advised to use varying colours.
3. Avoid congesting the graph with many lines. The recommendable maximum

number of lines is five. However, if the data given is having more than five independent variables that determine number of lines to be drawn.

4, The lines/curve should not cross each other unless the data given requires it. If it happens therefore, strictly varying colours or shading must be used.

5. Lines should not touch the vertical axis.

6. Names of variables being represented should be written directly on each line.

Worked example:

Table 1.3: Trends in the area cultivated ('000 ha) for selected crops in country X

Year	Cash crops	cereals	Vegetables	Fruits
2010	1110	786	700	150
2011	1230	840	720	250
2012	1330	850	790	100
2013	1290	900	800	150
2014	1396	950	830	56

Construction of a graph using the statistical data presented above.

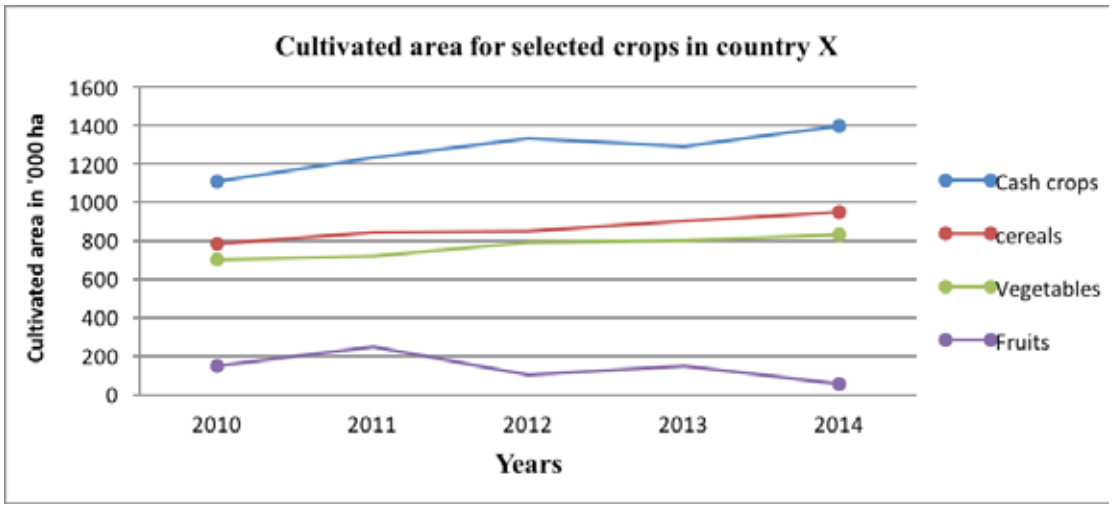


Figure 1. 4: Group/comparative line graph of cultivated area for selected crops in country X

It is important to realize that lines are not crossing each other. The graph drawn shows that there was an increase in cultivated areas for all cash crops with exception for the area under fruits where a decreasing trend was observed.

Advantages of group/comparative line graph

1. It is a simple method as it does not involve a lot of calculations.
2. It gives a clear impression of the different variables presented on one graph.
3. It can be used to show comparison of different items.

Disadvantages of group/comparative line graph

1. The presence of many variables on the same graph makes their interpretation more difficult.
2. The values for each period are not easy to determine.

1.2.3. Compound line graph

Learning activity 1.2.3

The table below shows the crop production from 2005 to 2010 in '000 tons in country Y:

Crops/ Years	2005	2006	2007	2008	2009	2010
Sorghum	1158	1100	1027	1008	1192	1198
Maize	888	853	725	1151	1941	2487
Beans	637	823	924	916	944	1027

Using the previous knowledge and skills acquired in Mathematics and the data presented in the table above, answer the following questions:

a. Calculate the cumulative totals.

b. Construct a compound line and shade every component.

c. Research on the advantages and disadvantages of compound line graphs.

A compound line graph is also known as a cumulative line graph. It is the type of graph where a variety of variables are presented as subsequent lines. Therefore, a compound line graph displays cumulative totals. It is drawn in a way that lines are super-imposed above each other; creating several segments or components.

Construction of a compound line graph

The following are the steps that must be followed while constructing a compound line graph:

1. Make a cumulative table representing progressive or cumulative totals of the provided variables.
2. Select the appropriate scale for both dependent and independent variables.
3. Follow the steps used when a simple line graph is being drawn. It should be the variables with large or biggest values to begin.
4. The lines constructed for each variable should connect onto the two vertical lines on both sides.
5. Super-impose other lines on top of the first line beginning from each segment or component. Indicate the name of the variable in each section shaded.
6. The lines drawn must begin from or attached to the vertical axis as earlier emphasized.

7. Since plotting of points is dependent on the calculated values in a cumulative manner, lines therefore, must not cross each other. In case they do so, then, the data given, or the calculated cumulative totals will be having a problem.
8. If the statistical data is in large numbers, it is very advisable to convert the value of each variable into percentage. Thereafter, calculate the cumulative totals. Such calculations should be indicated.

Worked example:

Table 1. 4: Table of total exports in million tons for country X for 2015-2017

Years / Crops	2015	2016	2017
Cocoa	46.0	74.0	69
Cassava	11.0	24.5	27.7
Beans	13.0	11.5	33.3

Use the data presented in the table above to construct a compound line graph

Table 1.5: Table of cumulative total exports in million tons for country X from 2015-2017

Years / Crops	2015	2016	2017
Cocoa	46.0	74.0	69
Cassava	57.0	98.5	96.7
Beans	70	110	130

The above cumulative totals can now be used to construct a compound line graph; as shown below:

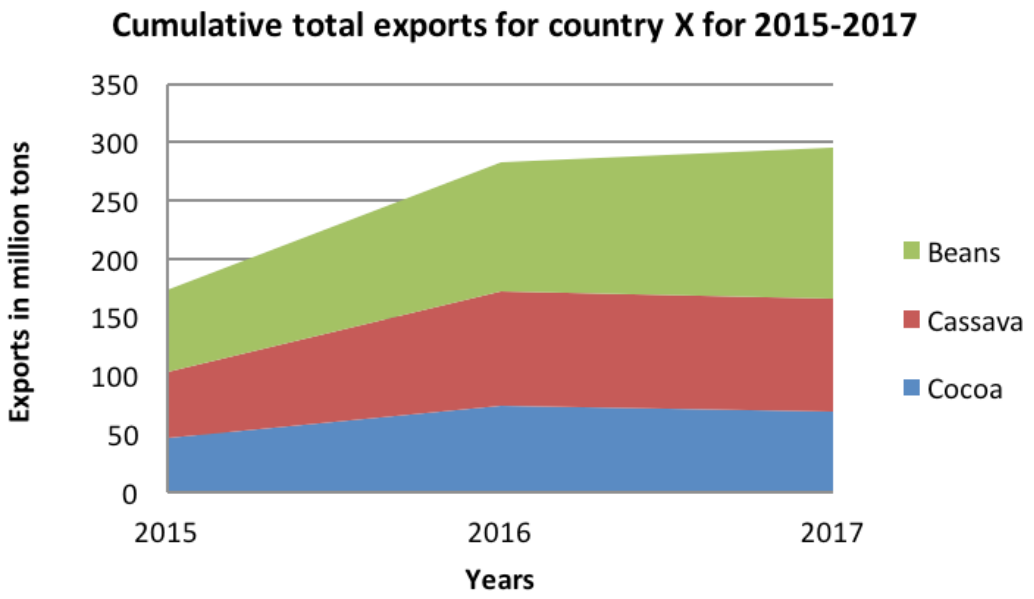


Figure 1. 5: Compound line graph showing cumulative total exports for country X for 2015-2017

Advantages of compound line graph

1. They are easy to interpret.
2. They provide a good visual impression.
3. They are simple to draw.
4. Less space is used.
5. They can be used to present a variety of variables.
6. They are suitable for comparison purposes.

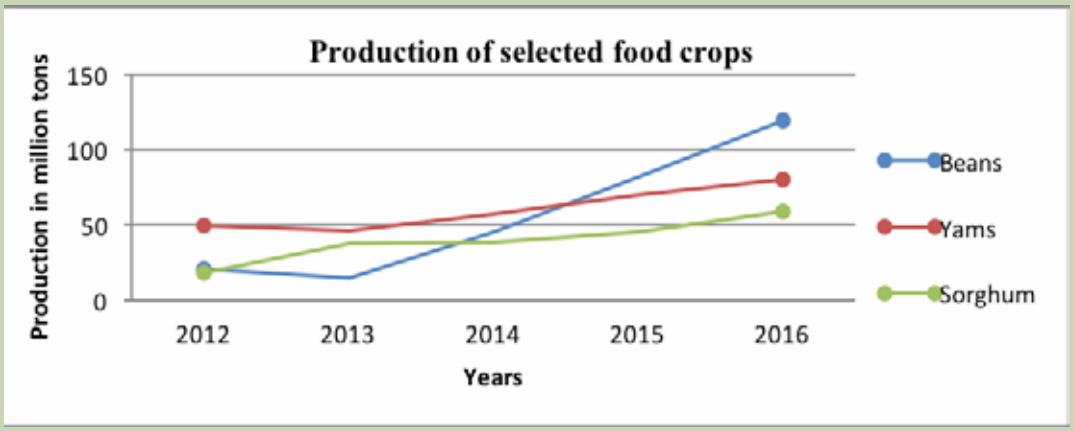
Disadvantages of compound line graph

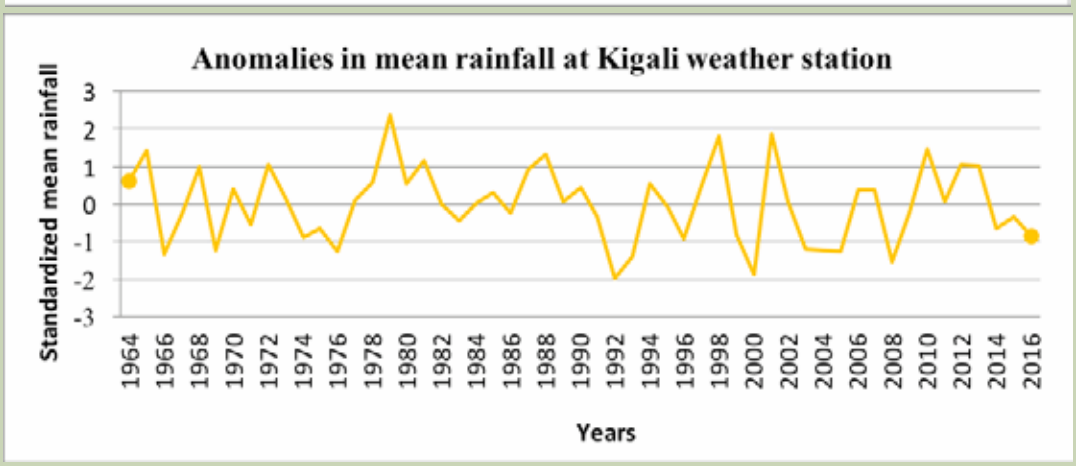
1. When large numbers are used, selecting a suitable scale becomes more challenging.
2. It or they involve calculations such as converting the values into percentages and then determining the cumulative totals.
3. The use of cumulative totals while constructing the compound line graphs makes it difficult to find precisely the actual values of the variables.

1.2.4. Divergence line graphs

Learning activity 1.2.4

Below are two statistical graphs representing different statistical data:





Use the diagrams above to answer the following questions:

a. Identify the differences existing between the two graphs presented above.

b. Research on advantages and disadvantages of the graph showing the anomalies in mean rainfall at Kigali weather station.

Divergence line graphs are statistical graphs that directly portray variations in values. When there is a rise in values; a plus sign (+) is used in the figure while a fall or decrease in values is portrayed using a negative sign (-). This type of graph is used while dealing with variables whose values are highly changing spatially and

temporally.

Construction of a divergence line graph

There are six steps to follow when one is drawing a divergence line graph. These are:

1. Draw two vertical lines (axis) and leave a reasonable space for the baseline; on which the independent variables are to be indicated.
2. Draw the average line commonly known as the zero line. This should join the center of the two-vertical axis.
3. Draw a basement line for independent variables; joining the bases of the two vertical lines. The length of the horizontal line is determined by the number of independent variables and the horizontal scale used.
4. Determine the average values of all the values indicated in the table. This is obtained using the following formula:

$$Average\ value = \frac{Total\ value}{Number\ of\ variables}$$

For example,

Table 1. 6.Production of cars in country X

Years	2013	2014	2015	2016	2017
No. of cars	6700	6800	7000	7500	4500

Therefore, the average value can be calculated as below:

$$Average\ value = \frac{6700 + 6800 + 7000 + 7500 + 4500}{5} = 6500\ cars$$

5. Deduct the average value from each value. The positive and negative signs should be indicated or shown.
6. The figures or values with positive sign (+) are plotted above the Zero line or average line. While the negative values are plotted below or beneath the zero or average line.
7. While determining the scale, the vertical scale should be determined basing on the calculated divergences. The horizontal scale is chosen normally depending on the independent variables provided.
8. Thicken or darken the zero line/average line.

Worked example:

Table 1.7: The table of monthly pineapple production in different areas

Areas	Monthly production in '000 tons
A	10,527
B	10,038
C	3920
D	3770
E	2550
F	1833
G	884
H	825
I	744

The divergence values can be calculated as follows:

$$Average\ value = \frac{10527 + 10038 + 3920 + 3770 + 2550 + 1933 + 884 + 825 + 744}{9} = \frac{35191}{9}$$

$$= 3910.11$$

The average value = 3,910.11 (in 000 tons)

Therefore, the divergence table will be constructed below:

Table 1.8: The table of monthly pineapple production in different areas

Area	Monthly production in '000 tons	Divergence values
A	10,527 -3 ,910.11	+6618.89
B	10,038 - 3,910.11	+6127.89
C	3920 - 3,910.11	+9.89
D	3770 - 3,910.11	-140.11
E	2550 - 3,910.11	-1360.11
F	1833 - 3,910.11	-1977.11
G	884 - 3,910.11	-3026.11
H	825 - 3,910.11	-3085.11
I	744 - 3,910.11	-3166.11

A divergence line graph showing monthly pineapple production in different areas

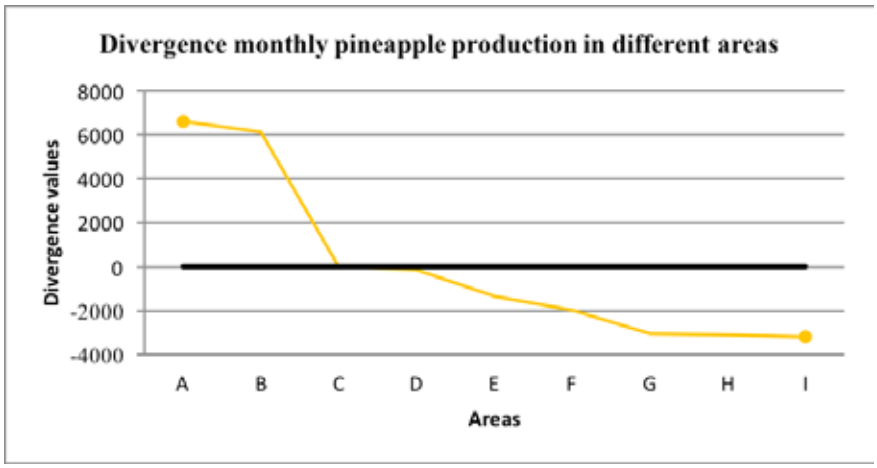


Figure 1. 6: Divergence line graph of monthly pineapple production in different areas

Advantages of divergence line graph

Below is an outline of the main advantages of divergence line graph:

1. It is easy to construct
2. It provides a good visual impression.
3. It is easy to interpret
4. It is an appropriate method of representing items that need comparative analysis.
5. It requires limited space.

Disadvantages of divergence line graph

1. It involves several calculations for example the total value, getting average or finding divergences.
2. The actual figures are not shown, only divergences are indicated instead.
3. There are some difficulties while determining the scale mostly when the divergences are composed of bigger values and very low ones.
4. Its construction is time consuming.
5. The method allows some inaccuracy while being drawn. This is because if large values are used, decimal points are neglected.
6. To be used, it requires the reader to have the original raw data or a table of values.

Application activity 1.2

1. Collect data on the students' performance in any subject of your choice and use the scores to construct the following line graphs: simple and curve line graph, comparative, compound and divergence line graphs.
2. Comment on the distribution of statistical data displayed on the constructed graphs.

1.3. Bar graphs

Activity 1.3.1

Table of monthly rainfall of weather station X

Months	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall in mm	250	210	450	800	700	70	70	65	90	60	400	800

Use the data presented in the table above to answer the following questions:

a. To construct different types of bar graphs

b. Research on advantages and disadvantages of each bar graph.

A Bar graphs is one of the statistical methods used to show, portray or represent data. It is a graph constructed using rectangular bars.

Bar graphs differ from line graphs because the lines used under bar graphs join to form single and individual rectangular bars. This means that bar graphs stand for a graphic way of numerical (quantitative) comparison by rectangles with heights proportional to the measure of data in question.

The following are different types of bar graphs:

Simple bar graphs

Compound bar graphs

Divergence bar graphs

Age-sex graphs

Dispersion graphs

Circular graphs

1.3.1. Simple bar graphs

Learning activity 1.3.2

Table showing the population of selected countries of the world ('000,000 people) in 2016

Country	Population in millions
China	1378.67
India	1299.00
Euro Area	341.01
United States	324.30
Indonesia	258.70
Brazil	206.08
Russia	146.80
Japan	126.86

Use the data presented in the table above to answer the following questions:

a. Draw a simple bar graph portraying the above data.

b. Describe the population distribution as portrayed on the graph and the table above.

c. Explain the impact of the population on the physical environment in countries such as China and India.

d. Research on advantages and disadvantages of bar graphs.

A simple bar graph is created following the same procedures as a simple line graph. However, instead of using a line to represent the variables, parallel bars are used. The independent variables are indicated on the horizontal axis and dependent variables shown on the y-axis or vertical line. This form of statistical graph is constructed when a single set of statistical data is used.

Construction of a simple bar graph

The following are the main steps followed to construct a simple bar graph:

1. Create a frame of both vertical and horizontal axes. That is, drawing the X and Y axes. The length of these two lines will be determined by the scales used and the figures to be plotted.
2. Indicate the independent variables on the X axis and dependent variables on Y axis.
3. Select appropriate scale: Both vertical and horizontal scales. This is determined

as studied while dealing with line graphs.

4. The horizontal scale will automatically determine the size of the bars. It is recommended that the size of each bar should not exceed 1 cm or go below 1cm in width. Too small and huge bars make the graph lose its primary appearance.
5. While plotting points, use tiny dots to mark the required points. This is because with bar graphs, dots are not supposed to be seen.
6. The volume, percentage or value of the dependent variable is represented by the height of each independent bar.
7. A reasonable small space should be left to separate the bars from the vertical axis.
8. There should be uniformity in terms of the size of bars, separating space existing between bars.
9. The bars should be attached only when a single or similar dependent variable is being dealt with. But this is not a golden ruling. For example, Rainfall, production of coffee or any other variable.

Worked example

Table 1. 9. Table of annual mean rainfall at Kanombe weather station

Months	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall mm	71	101	120	158	93	22	11	32	72	103	126	85

The data displayed in the table above were used to construct the following simple bar graph:

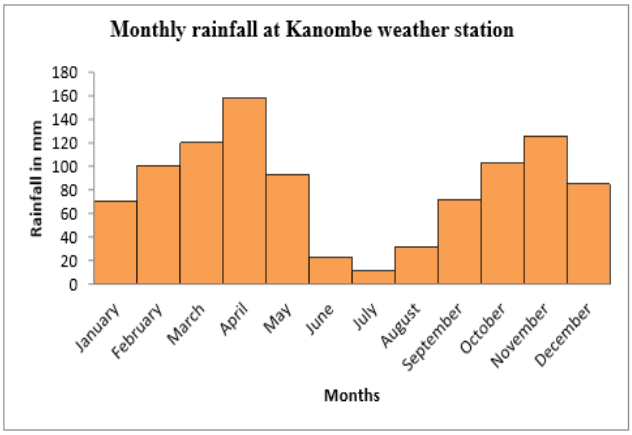


Figure 1.7: A simple bar graph showing annual mean rainfall (dependent variables) at Kanombe weather station

The data used to construct the above simple bar graph deals with single dependent variables like rainfall and that is why the bars are attached to each other. However, the separated bars are used to represent independent variables as shown on the figure below.

Table 1.10: Table showing the profits made in a period of 5 years by Umubanomwiza company

Years	2012	2013	2014	2015	2016
Profit in million Rwf	10	12	18	25	42

The above data are used to construct a simple bar graph for independent variables as shown below:

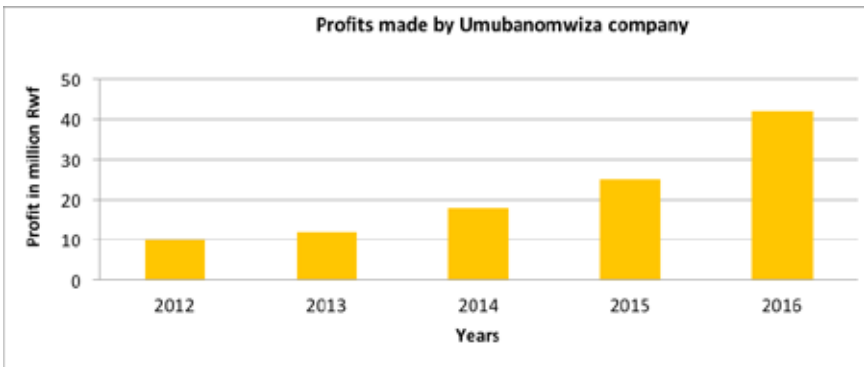


Figure 1.8: A simple bar graph showing profits made by Umubanomwiza Company (independent variables)

Advantages of simple bar graphs

1. The following are advantages of simple bar graphs:
2. They are easy to interpret.
3. They summarize a large amount of data in a visual form.
4. They display trends easier to highlight or notice than simple line graphs.
5. They can be super-imposed on other statistical diagrams. That is, they can be used together with other methods.
6. They are easy to construct.

7. They do not involve complicated calculations.
8. They represent each data category in a frequency distribution.
9. The several bars constructed provide a chance of comparative analysis and expression of differences existing between variables. For example, rainfall received within 12 months.
10. They provide a compact way of presenting statistical data.
11. They are suitable for showing data with different units such as years, months among many others.

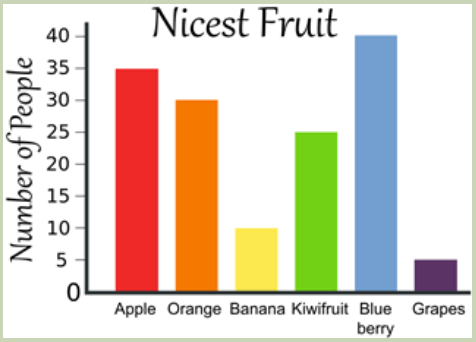
Disadvantages of simple bar graphs

1. They can easily be manipulated to provide false impressions.
2. When large figures are used, determining a suitable scale is more challenging.
3. Time consuming especially when several variables are dealt with.
4. They do not provide an adequate explanation. Therefore, for them to be rewardingly understandable, an additional explanation is required.
5. Simple bar graphs do not show key assumptions, causes, impacts and patterns.

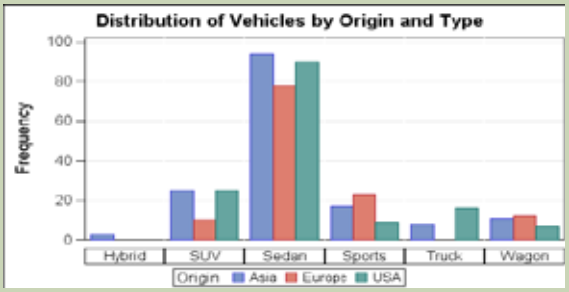
1.3.2 Group bar graph

Learning activity 1.3.3

The following are graphs representing different items



A



B

Examine the graphs provided above to answer the following questions:

a. Explain the differences and similarities existing between graph A and B.

b. Discuss the advantages and disadvantages of graph B.

Group bar graphs also known as multiple bar graphs. Group or multiple bar graph, is a statistical technique used to represent data that is made up of several dependent variables, that can hardly be shown using simple bar graph. A group of bars is constructed following the steps involved in the drawing of a simple bar graph. The only difference is that group bar graph is constructed by attaching a set of bars representing individual variables.

Construction of a group bar graph

The following are the main steps involved in construction of a group bar graph:

1. The way of constructing a group bar graph is the same as that of simple bar graph.
2. The bars are drawn in the form of a set and touching each other for each independent variable. This implies that bars are grouped but separated from another group by a space.
3. The bars are drawn in a vertical manner.
4. The independent variable that has the largest values should be started with and drawn on the left and continuing in a descending order towards the right.
5. The arrangement of the first group should be maintained throughout.
6. The width of all bars must be similar. That is, ensure that all bars display equal size.
7. Shade differently each individual bar and maintain the same shading or colouring up to the last group of bars.
8. A suitable title as adapted from the title of the table used should be indicated on the top of the graph. In the title, the type of the statistical method used must be stated.

Worked example:

Table 1. 11: Table of Irish potatoes production in '000 tons in selected areas

Year / Regions	2015	2016	2017
Gatare	894	1360	1430
Gasozi	1900	1700	1700
Giraneza	520	500	500
Girimpuhwe	4110	3700	3750

The above data are used to construct a group bar graph as shown below:

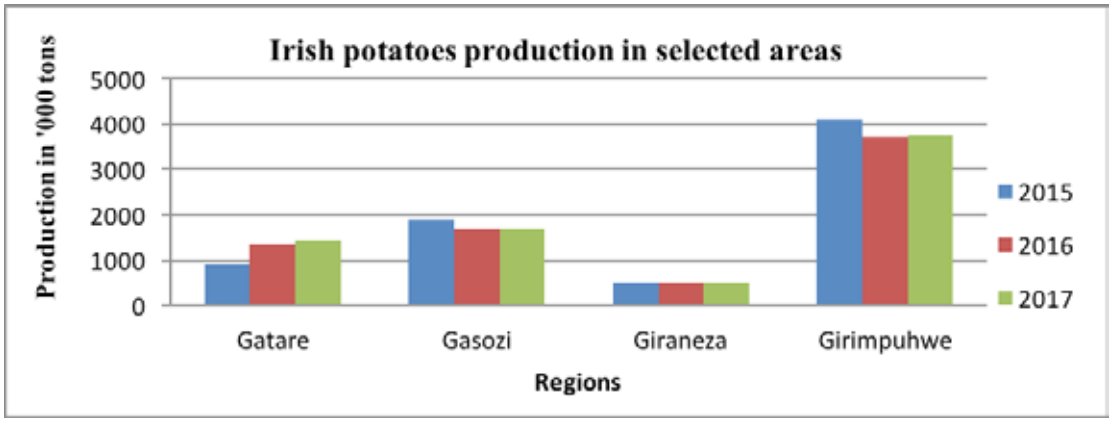


Figure 1. 9: Group bar graph of Irish potatoes production in '000 tons in selected areas

Advantages of group bar graph

1. It is easy to interpret.
2. It favours comparative analysis of the statistical data being dealt with.
3. It is simple to draw.
4. The calculations involved are simple and easy.
5. It provides a wonderful visual impression when it is coloured.
6. It can be used together with other diagrams in a super-imposed way.
7. It is suitable for a wide range of variables.

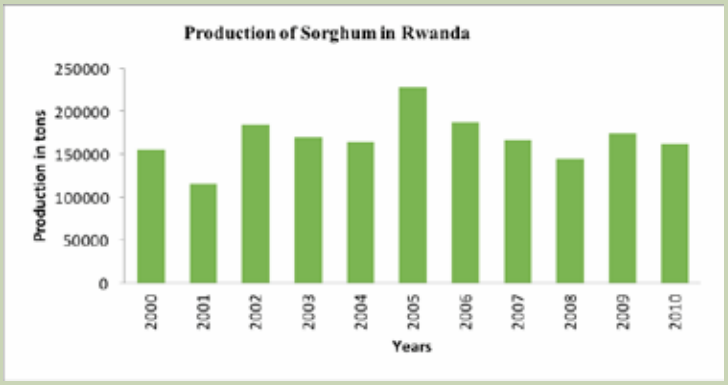
Disadvantages of group bar graph

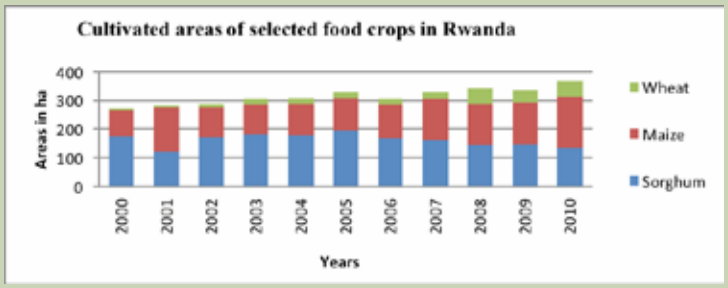
1. It requires a large space.
2. It is challenging while determining the scale.
3. It may be difficult to interpret when it is congested.

1.3.3 Compound bar graph

Learning activity 1.3.4

The following are graphs representing different items





Examine the graphs provided above to answer the following questions:

a. Explain the differences and similarities existing between graphs showing the production of Sorghum in Rwanda and that of cultivated areas of selected food crops in Rwanda.

b. Research on the advantages and disadvantages of the graphs showing cultivated areas of selected food crops in Rwanda

Compound bar graphs are also called cumulative or divided bar graphs. This form of statistical graph is used to show how the total in any one bar is divided up between several subtotals basing on the calculated cumulative totals. This implies that the totals used to plot the variables are progressive in nature.

A compound bar graph used when there is more than one variable and a variety of the items are to be portrayed using one bar. Basing on cumulative totals as calculated depending on the raw data on the table provided, a given bar can be divided into segments. The size of each segment depends on the value of variable

being represented.

Construction of a compound bar graph

The following are the main steps followed to construct compound bar graph:

1. It is constructed by using cumulative progressive totals.
2. It requires selecting a suitable scale that can favour the plotting of both big and small values.
3. The plotted data are displayed in percentages by starting with the greatest value and ending with the smallest figure.
4. The width of each bar is determined basing on the scale used.
5. The number of bars will be determined by the number of variables to be represented in each set of bars.
6. The varying sheds or colors are used for each individual segment or component of every bar.

Worked example

Table 1. 12: Coffee and tea production in '000 tones for selected regions in 2017

Cash crops / Regions	Coffee	Tea
Girubuntu	2206	2535
Ubumwe	786	708
Ubusugire	1295	1928

The above data are used to construct a compound bar graph as shown below:

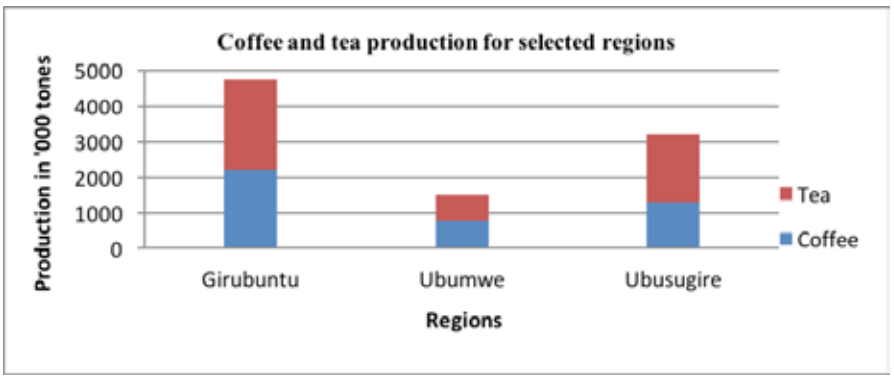


Figure 1. 10: Compound bar graph of coffee and tea production for selected regions

1.3.4. Divergence bar graphs

Learning activity 1.3.5

Table showing mineral exports of country Z from 2000-2008 in USA Dollars

Year	Amount in Million $
2001	790
2002	689
2003	900
2004	850
2005	680
2006	500

Use the data presented in the table above to answer the following questions:

a. Draw a divergence bar graph.

b. Suppose you are asked to explain to your friend the steps involved in drawing a divergence bar graph, list down the main points you would tell her/him.

The primary purpose of the divergence bar graph is to represent the way values of various variables deviate from the average/mean value. Therefore, this statistical method shows the fluctuation of the variables.

Construction of divergence bar graphs

1. The steps to be followed while constructing divergence bar graph are:
2. Construct the two vertical axis lines.
3. Join the two vertical lines with the horizontal line at the base line.
4. Draw the average line which is known as a zero line at the center of the two vertical lines. Write the average against this line at the end points where "0" is indicated.
5. Find the total of all the value of the variables and divide it by the number of the items to get the average. Subtract the average obtained from each value, to get the divergences or deviations.
6. Select the suitable scale basing on the divergences calculated.
7. Plot the negative values below the average line and the positive ones

above the same line.

Worked example

Table 1. 13: Coffee production in '000 tons for country X from 2010 to 2017

Year	Coffee production in '000 tons
2010	500
2011	600
2012	900
2013	700
2014	800
2015	700
2016	560
2017	600

Calculate the average value

$$\frac{600+560+700+800+700+900+600+500}{8} = 670$$

Table 1. 14: Divergences from the mean

Year	Value	Average value	Divergences from the mean
2010	500	670	-170
2011	600	670	-70
2012	900	670	+230
2013	700	670	+30
2014	800	670	+130
2015	700	670	+30
2016	560	670	-110
2017	600	670	-70

The following divergence bar graph shows the country's coffee production in '000 tons from 2000-2008 which is drawn using the data presented in Table 1.14 above.

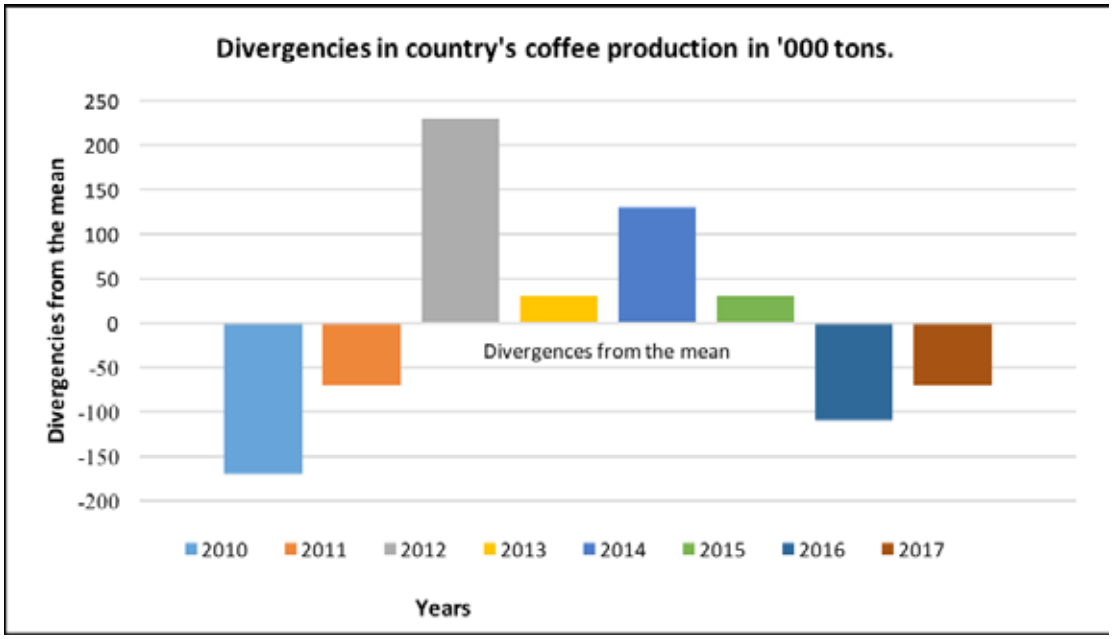


Figure 1. 11: A divergence bar graph showing divergences in the country's coffee production

Advantages of divergence bar graphs

1. The following are advantages associated with divergence bar graphs:
2. They provide a good visual impression.
3. They are appropriate for comparison purposes.
4. They are easy to construct.
5. They are less complex therefore, easy to interpret.
6. They use limited space.

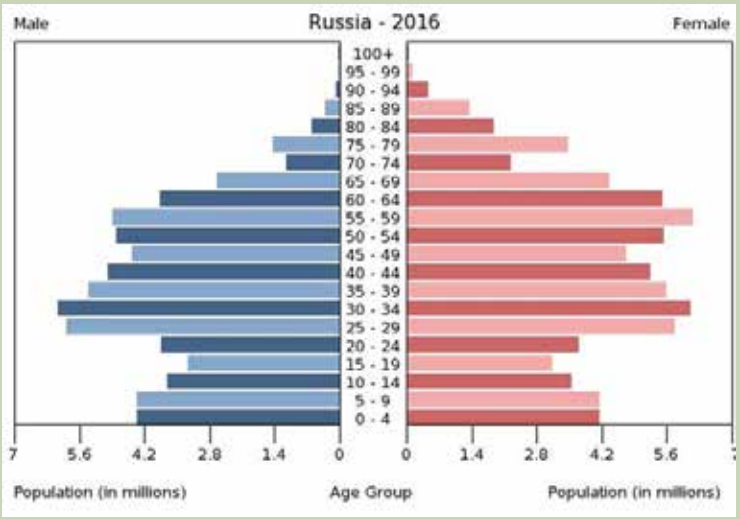
Disadvantages of divergence bar graphs

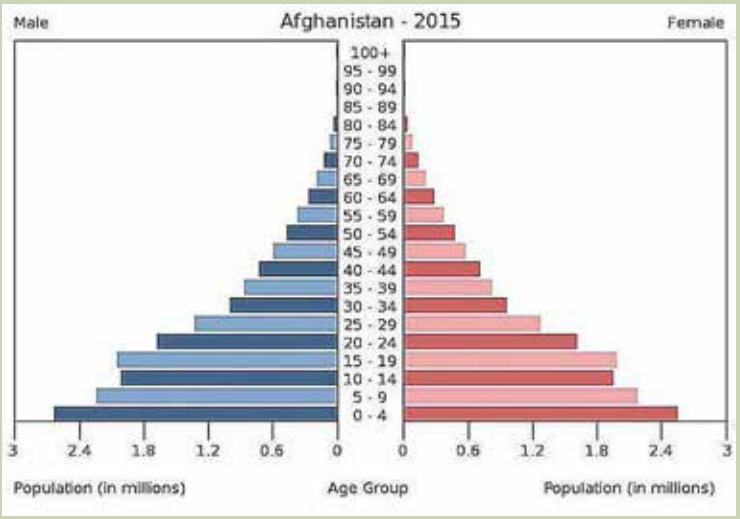
1. There are several calculations involved.
2. The method is only limited to a single item or commodity.
3. Determining the scale especially when the values have a wider amplitude is challenging.
4. The plotting of values is only based on divergences. Therefore, the actual values are not seen.

1.3.5. Age and sex graphs

Activity 1.3.6

Statistical diagrams showing population structure in two different countries:





Refer to the figures presented above to answer the following questions:

a. Name the diagrams indicated above.

b. Differentiate the two diagrams represented above based on their structure.

c. Research on the advantages and disadvantages of such diagrams.

An age-sex graph is also known as a population pyramid. It is a type of bar graph that represents the structure of the population of a country or area basing on age and sex. An age-sex graph forms a structure of pyramid as the population grows.

It is a graphical drawing that displays the distribution of several age groups in each population of a country or part of the world, which makes the shape of a pyramid as the population grows. It typically involves two back-to-back bar graphs, with the population plotted on the horizontal line and age on the vertical line. The left side of the population pyramid should indicate the Male and the right for Females. It is usually in age groups of five years for example 0 - 4 years; 5 - 9 years; 10 - 14 years and so on. The age groups are indicated or plotted in the middle.

Therefore, the primary purpose of the population pyramid is to portray the population structure and age groups. The number may be in a raw form or converted into percentages. Population pyramids are often regarded as the most actual way to graphically represent the age and sex distribution of a population. This is so, because of its clear visual interpretation and direct display of the true picture of the real structure of the population.

Construction of an age-sex graph

When drawing an Age-sex pyramid, the following steps should be observed:

1. It is constructed on two X- axis; one to portray male and another for females.
2. Males are represented on the left and females on the right. The bars representing each sex are separated by a space. It is in this space that age groups are indicated in a progressive manner.
3. The data provided should be grouped using the interval of 5 years as follows; 0 - 4; 5 – 9; 10 – 14; 15 – 19; 20 – 24; 25 – 29; 30 - 34 and so on.
4. After forming the age groups; the lowest group which forms the youngest is indicated on the base of the graph.
5. The left horizontal line should have figures for males and the one on top right showing the figures for females.

Worked example:

Table 1.15: Population Structure (age-sex) of country X

Age	Male	Female
0-4	4500	4780
5-9	4280	4400
10-14	3980	3050
15-19	3400	3000

20-24	2540	2300
25-29	2050	1809
30-34	1940	1920
35-39	1800	1750
40-44	1500	1670
45-49	1200	1300
50-54	1050	1290
55-59	800	900
60-64	500	700
65-69	450	656
70-74	300	478
75-79	120	140
80-84	87	130
85+	40	80

The following age-sex bar graph of country X is drawn using the data presented in the table above.

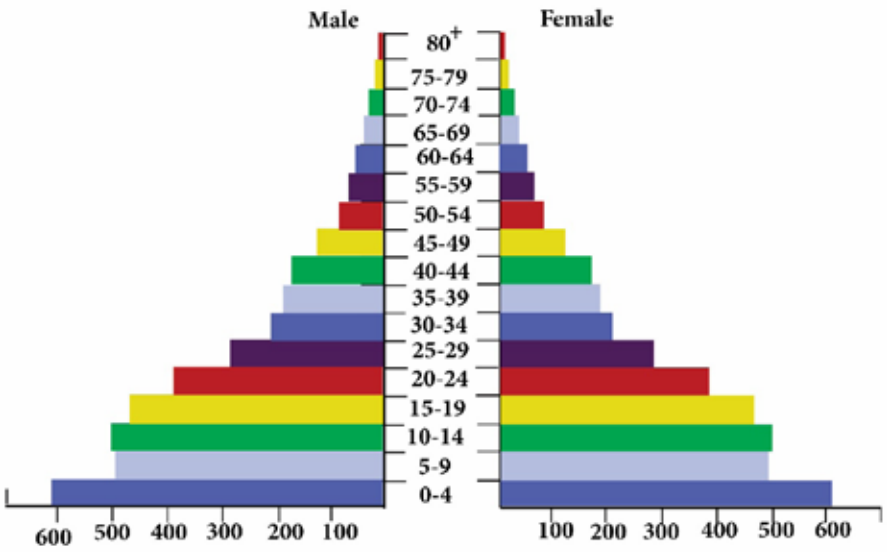


Figure 1. 12: Age-sex graph of country X

Advantages of an age-sex graph

The following are the main advantages of an age-sex graph:

1. It provides instant display of the composition of the population being portrayed with consideration of the age and sex.
2. It portrays the general shape of the population structure that facilitates analytical purpose.
3. The features associated with the age-sex pyramid can indicate factors affecting an area or region it presents.
4. It gives a good visual impression that captures the attention of the reader or interpreter.
5. It is easy to interpret
6. It has limited or sometimes no calculations involved, therefore, it is easy to draw.
7. Age-sex pyramid is suitable for comparison purposes. For example, the number of females and males in each area.

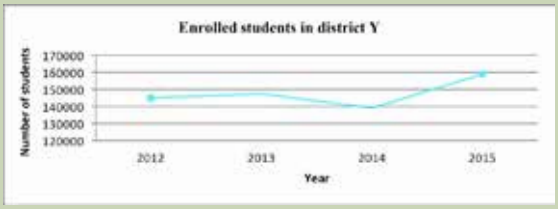
Disadvantages of an age-sex graph

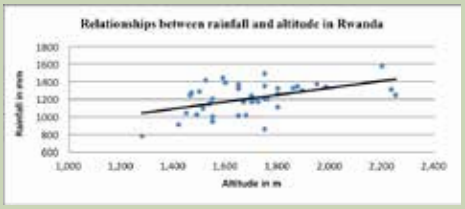
1. It is only used to represent the population structure.
2. It is only used alone and hardly super-imposed on other methods.
3. There is loss of important information due to the use of figures that are in age-cohorts.
4. It cannot show the population distribution (does not describe or show the trend of the population growth).
5. It is only used in population geography.
6. The actual figures may not be seen since in most cases percentages are used.
7. It takes a lot of time to construct.
8. It takes a lot of space.
9. It is challenging to determine a suitable scale.

1.3.6. Dispersion graph

Learning activity
1.3.7

The following diagrams represent various items





Referring to the figures above answer the questions that follow:

a. Name and describe the above presented diagrams.

b. Research on the advantages and disadvantages of dispersion graphs using the internet and text books available.

The dispersion graph is a statistical representation method that displays the tendency of data scattered over a range. It is also called scatter graph. It shows the distribution of the dependent variables in relation to independent variables. Hence, it is used to show the relationship existing between two variables.

Construction of a dispersion graph

Below are the main steps followed while constructing a dispersion graph:

1. Draw the vertical axis and horizontal axis.
2. Select the suitable scale for both axes.
3. Determine the variable that qualifies to be independent variable and the dependent variable.
4. Indicate the dependent variables along the vertical axis and the independent variables on the horizontal axis.
5. Plot the points using visible dots that are thickened.

Worked example:

The table below shows the examination scores in Dihiro G.S in Bugesera District in relation to the hours assigned.

Table 1.16: Examination scores in Dihiro G.S in Bugesera District

Hours of studying	2	5	6	7	3	19	9.5	11

Examination scores	35	60	72	75	53	99.5	78	85

The above data are used to construct a dispersion graph as shown below:

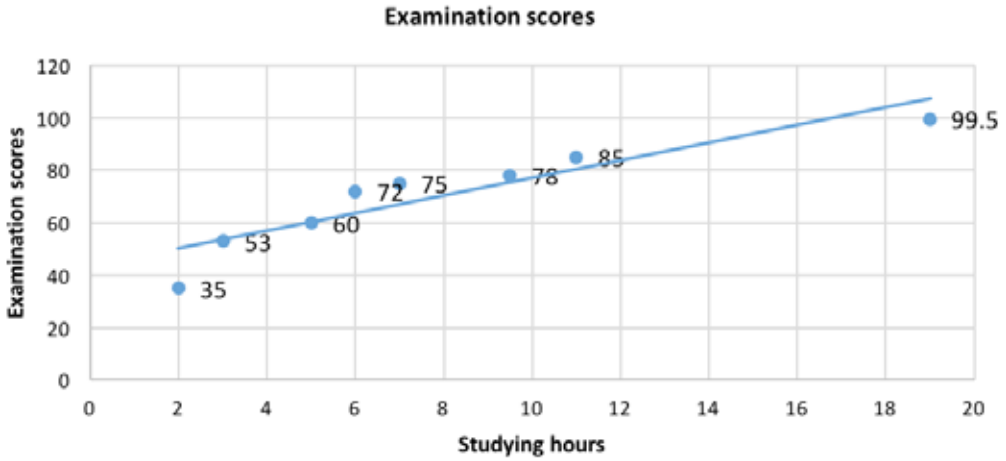


Figure 1.13: a dispersion graph showing the relationship between studying hours and examination scores

It is important to mention that dispersion graphs can display both negative and positive correlations. For instance, there is a positive correlation between studying hours and students' examination scores because the students' examination scores increase with an increase of the hours of studying. However, the following graph shows a negative correlation between altitude and temperature.

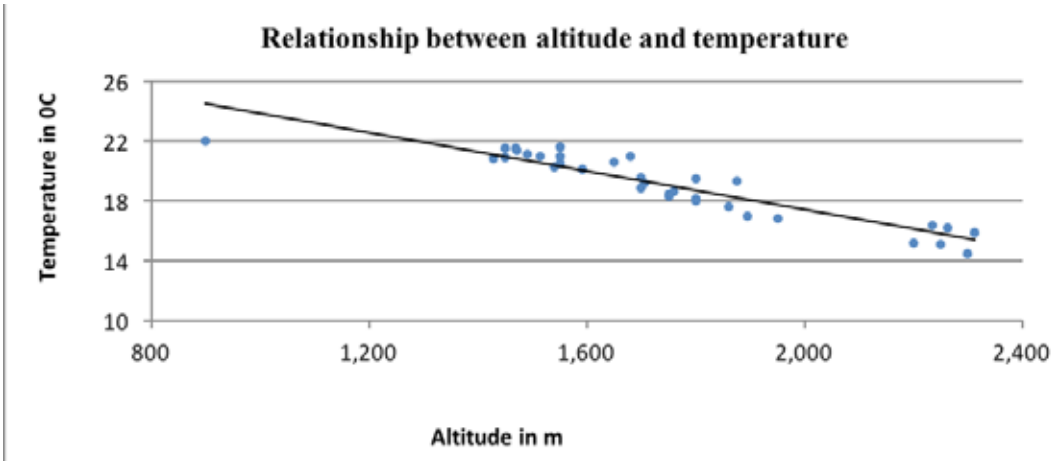


Figure 1.14: Dispersion graph showing the relationship between altitude and temperature

The figure above shows that there is a negative correlation between altitude and temperature as far as the temperatures decrease with altitude.

Advantages of a dispersion graph

1. A dispersion graph displays the relationship between two variables;
2. It tests how reliable the data collected is;
3. It is easy to draw;
4. It provides a good visual impression;
5. It easily portrays the anomalies associated with data.

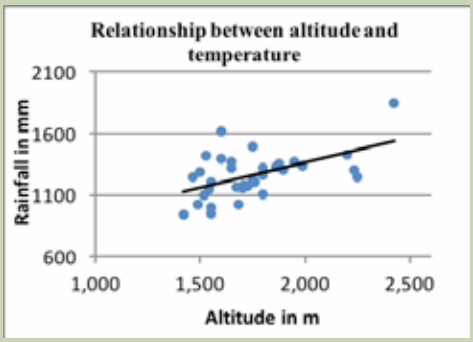
Disadvantages of a dispersion graph

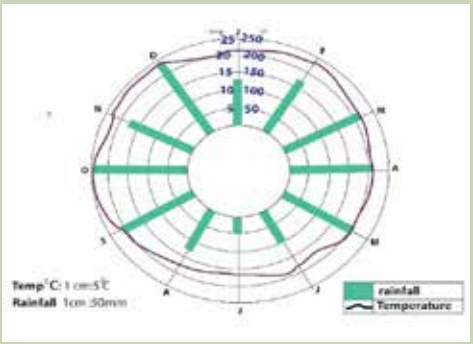
1. Some information that may be important is not displayed.
2. It is more reliable when a wide data is used but when the data used is small, the conclusion may not logically be reliable.
3. Much time is required when huge information is used.
4. It is easily constructed using ICT (Excel) and hard to construct manually.

1.3.7 Circular graph

Learning activity 1.3.8

The following diagrams represent altitude and temperature; rainfall and temperature respectively.





Referring to the figures above answer the questions that follow:

a. Note down and describe the differences existing between the two diagrams presented above.

b. Research on the advantages and disadvantages of circular graph / polar graphs.

Circular graphs are known as the polar graphs. These are statistical and graphical diagrams that take a circular shape as the face of a clock. They are called polar graphs because they display the layout as the one made by the longitudes radiating from

the poles.

Construction of a circular/polar graph

1. Construct a circle of a convenient size. It is advisable to use large circles to avoid congesting the graph with information.
2. In the middle of the bigger circle, draw a small circle where additional information such as activities carried out can be portrayed.
3. Partition the big circle into 12 equal angular parts all touching on the inner small circle. Make sure that each segment represents 30 degrees. To get these 30 degrees, 360 degrees are divided by 12 segments.
4. Labeling of the circular graph begins from twelve o'clock which marks the month of January. Thereafter, other months follow, taking the clock wise order up to December.
5. The scale is determined in degrees centigrade for temperature and bars are plotted basing on the radii portraying rainfall totals or amounts.
6. Plot points for temperature and join each with a continuous curve.
7. Avoid writing words that are upside down or sharply tilted. The writing on the graph should enable the reader not to tilt or turn around the graph.
8. Indicate all the characteristics of a good statistical diagram such as title, key, accuracy and neatness among many others.

Worked example:

Table 1. 17: Table showing agricultural activities through the year and received rainfall

Months	Rainfall (mm)	Planting	Harvesting
January	32	Land clearing	Land clearing
February	56	Sorghum	Wheat
March	89	Weeding	Weeding
April	345	Beans	-
May	345	Millet	
June	200	Millet	
July	208	-	
August	312	Maize	
September	213	-	
October	278	-	
November	100	-	Sorghum

December	190	-	

The data presented in table 1.17 above are used to construct a circular graph presented below.

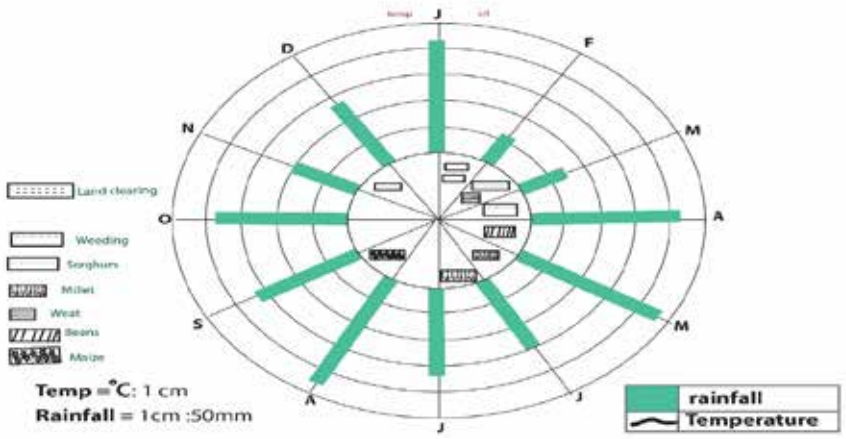


Figure 1.15: Circular graph showing agricultural activities through the year and received rainfall

Advantages of a circular graph

1. They have a good visual impression.
2. Compared to the information dealt with, little space is used.
3. It portrays a wide range of items such as rainfall, temperature, and agricultural activities.
4. They do not involve complicated calculations.
5. Displays the relationship or influence of climate on human activities.

Disadvantages of a circular graph

1. Sometimes it is very difficult to label the graph because of its circular nature.
2. They consume a lot of time especially when many items are to be represented.
3. It is sometimes hard to compare some items such as rainfall values since they are displayed apart and hardly lie on the same baseline.
4. They are more challenging while drawing.

Application Activity 1.3

There is cutting down of trees in Ubwiyunge village. Then senior five students conducted a field work study in the area and they got the following findings:

1000 trees were cut down

549 trees were just recently planted.

1400 tree seedlings

290 trees had reached maturity.

After gathering the information from the farmers and local authorities, they passed a word of thanks to everyone that had assisted them. The respondents were so happy to see students of such high respect and values. Use the information presented above to answer the following questions:

a. Identify the environmental concern associated with Ubwiyunge village.

b. Explain the environmental conservation measures you would teach the citizens of the above village.

c. Give a description and interpretation of the constructed graphs.

1.4. Statistical charts

Learning activity 1.4.1

Sincere smiles describe the happiness of teachers and students at school X. This is because of the significant improvement and success registered in the students' performance in Geography subject. Below is a mark-sheet of the four students.

Names	Score
X	95
Y	85
Z	75
K	70

a. Use the data presented in the table above to construct different types of divided statistical charts.

b. Comment on the performance of the four students.

c. Research on the advantages and disadvantages of each divided statistical chart mentioned in (a) above.

Divided statistical charts may either be divided circles or rectangles. Divided circles

are also known as Pie charts. These are graphs that have a shape of a circle, with varying segments that portray a percentage, value or degree of a given component in relation to the general total to be represented.

The chart is called a 'Pie' chart because when looked at, each segment that forms it, displays a shape of piece of 'Pie'. It is constructed basing on the degrees that are skillfully measured to partition or divide a circle into various sections with correspondent angle. This implies that each segment or portion represents a given quantity, or value, amount or percentage of the statistical data represented.

Divided rectangles are a statistical graphic representation of data, using rectangle that is equaled to the general total of the variable. However, even though the area of the rectangle represents the total, it is partitioned into segments each representing an individual variable. The subdivision of the rectangles in this case stands for individual components (variables).

The following are the main types of divided circles:

1. Simple divided circles
2. Proportional divided circles
3. Simple divided rectangles
4. Compound divided rectangles

1.4.1 Simple divided circles

A circle is drawn to represent statistical total data given. The circle is then divided according to the value of the variables.

Construction of a simple divided circle

The following are steps that are followed in constructing a simple divided circle:

1. Draw a circle of a reasonable size. Avoid using small or very big circles.
2. Determine the degrees proportional to the quantity, value, amount, of the item or component to be portrayed.
3. Start with the component with the biggest degree. Place this to the right of 12 o'clock.
4. Arrange the smallest portions or segments to be plotted in one part. That is, start from the biggest to the very tiny segment.
5. Labeling on a pie chart should take a horizontal order. Where need be, write the words or names outside the chart using a pointing arrow for the small segments.
6. Shed each segment differently and use the key for referral purpose. If colours are available, use them.

7. The segments or components should not go beyond 8 in number. Beyond this figure, the chart becomes over crowded or jam-packed.

Worked sample:

Table 1.18: The exports of country X (1)

Items	Exports ('000 tons)
Yellow banana	894
Pineapple	456
Cereals	286
Beans	189
Vegetables	105

The data presented above can be used to construct a simple divided circle. The presentation of the data displayed in table 1.18 above is done using a simple divided circle. This requires calculating the values of each data in degrees. These calculated degrees can be also converted into percentages.

1) $Yellow\ banana = \frac{894}{1930} X360 = 166.75$

2) $Pineaple\ = \frac{456}{1930} X360 = 85.05$

3) $Cereals = \frac{286}{1930} X360 = 53.34$

4) Beans $= \frac{189}{1930} X360 = 35.25$

5) Vegetables $= \frac{105}{1930} X360 = 19.58$

Table 1.19: The exports of country X (2)

Items	Exports ('000 tons)	Degrees
Yellow banana	894	166.75°
Pineapple	456	85.05°
Cereals	286	53.34°
Beans	189	35.25°

Vegetables	105	19.58°

The above calculated degrees are used to construct the simple divided circle as shown below.

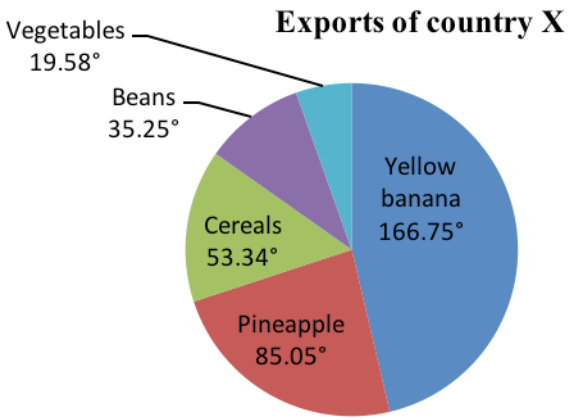


Figure 1.16: A pie chart showing exports of country X in'000,000 tons

Advantages of a simple divided circle/pie chart

Simple divided circles or pie charts are increasingly becoming a common tool used in the representation of statistical data. This is because of their advantages as shown below:

1. When the wedges /portions are clearly shaded or coloured, they provide a good visual impression.
2. They are effective and reliable when two or more variables are to be comparatively analyzed.
3. When well-labeled, they are easy to interpret.
4. They don't require specific skills to be understood as it is the case for dispersion graphs or divergence graphs, among many others.
5. They involve simple calculations which make them easy to draw.
6. Pie charts can be super-imposed on other statistical methods such as maps.
7. They can be used for a wide range of purposes in geography and other disciplines.
8. Pie charts are used as a summarizing tool, where vast data is set in a visual way.

9. The divided circles require minimal additional explanation or description.

Disadvantages of a simple divided circle/pie chart

1. They deal with degrees and sometimes percentages. Therefore, exact figures may not be easily noted by the reader.
2. Pie charts are not suitable for tracking the trend of a given variable. This implies that several pie charts must be used.
3. Pie charts can easily be maliciously manipulated or intentionally altered, therefore, displaying incorrect information. Hence, the reader may make erroneous conclusions.
4. They are constructed without basing on a specific scale, this leaves a gap in the exactness of the method.
5. They provide errors due to lack of accuracy, especially when tiny degrees are plotted. The thickness of the pencil affects the perfection of the method.
6. Labeling the pie chart sometimes is challenging especially when small degrees are plotted.
7. Pie charts or divided circles take a lot of time to construct. This is because of the calculations, measuring, drawing, and shading.
8. Large wedges/portions for bigger values tend to over shadow the small values.
9. In case there are several portions of almost matching size, it is challenging and confusing or difficult to interpret and assimilate the data.
10. The reader may find it challenging to comparatively analyze non-adjacent segments. That is, the reader will keep twisting and turning the chart to have a suitable angle of observation.

1.4.2. Proportional divided circles

Learning activity: 1.4.2

Use internet, text books and other sources of information to research on the following:

a. Description of proportional divided circles.
b. How proportional divided circles are constructed.
c. Advantages and disadvantages of proportional divided circles.

Proportional divided circles are also called comparative divided circles. They are used when more than one variable is dealt with. They are used for comparison purpose.

Construction of proportional divided circles

The techniques involved in the construction of proportional divided circles are like those of a simple divided circle especially how the varying segments are being portioned. However, the proportional divided circles are constructed using circles of varying sizes which are used once their totals are not uniform.

Steps involved in the construction of comparative divided circles are described here under:

1. The number of the circles to be constructed will depend on how many variables are being dealt with. For example, if one is comparing imports and exports, then the comparative divided circles will be two.
2. In case the totals of the independent variables are the same, therefore, the circles to be drawn will be of the same size.
3. The circles will have varying sizes, if the totals of the independent variables differ.
4. Circles should be constructed near each other to facilitate the comparison.
5. Find the square root of each total of the independent variable.
6. The size of each circle should be proportional to the totals. Therefore, determine the radius of each circle that is obtained by use of the square root of each total.
7. While dividing each circle into wedges or portions, follow the steps involved in drawing a simple divided circle.
8. There must be uniformity in the arrangement of the segments for all the circles.

Worked example:

The table below shows the exports and imports valued in Rwandan francs for selected regions

Table 1.20: The exports and imports in FRW for selected regions

Regions	Exports ('000 Rwf)	Imports ('000 Rwf)
Y	630,500	8000
Z	15,000	800,500
K	6,000	22,000
J	36,000	7,000
Totals	687,500	837,500

The proportional divided circle was constructed below using the data provided in table above.

The variation of totals implies that the proportional divided circles will be of differing sizes. Therefore, the radius for each circle is determined as follows:

Calculation for exports:

Area = the totals of exports

Formula A = πr2

Therefore, total exports = 687,500

$= 3.14$ or $\frac{22}{7}$

Total (Area) = 3.14r2

678,500 = 3.14r2

$r2 = \frac{678,500}{3.14} = 218,949.044$

$r = \sqrt{218,949.044}$

r = 467.92

Since the figures indicated in the table are in thousands of Rwandan francs, it is then advisable to multiply it by 1000

Therefore, $467.92X1000 = 467,920467.92X1000 = 467,920$

Calculation for imports

Therefore, the total imports = 687,500

Area (A) = πr2

3.14 r2 = 837,500

$r2 = \frac{837,500}{3.14} = 266,719.74$

$r = \sqrt{266,719.74}$

r = 516.44

Therefore, the totals in the table are in thousands

R = 516.44X1000

R = 516,440

Exports = 467,920

Imports = 516,440

As such a radius is too huge, it is advisable to reduce it proportionally by dividing each by uniform figure of convenience.

1cm: 100,000

Exports = $\frac{467,920}{100,000} = 4.6792$

Imports = $\frac{516,440}{100,000} = 5.1644$

The figures calculated are still too big for the radius. This means that if they are used, the circles will be too big. Therefore, they must further be divided by 2.

Exports = $\frac{4.6792}{2} = 2.335$

Imports = $\frac{5.1644}{2} = 2.59$

Therefore, the final radius for each:

Exports=2cm

Imports=3cm

At this stage, calculate the degrees for each region for all the independent variable (exports and imports).

Table 1. 21 Degrees for each region for all the independent variables

Country	Exports ('000 Rwf)	Degrees	Imports ('000 Rwf)	Degrees
Y	630,500	$\frac{630,500}{687,500} X360 = 330.15°$	8000	$\frac{8000}{837,500} X360 = 3.43°$
Z	15,000	$\frac{15,000}{687,500} X360 = 7.85°$	800,500	$\frac{800,500}{837,500} X360 = 344.09°$
K	6000	$\frac{6000}{687,500} X360 = 3.14°$	22,000	$\frac{22,000}{837,500} X360 = 9.45°$
J	36,000	$\frac{36,000}{687,500} X360 = 18.85°$	7,000	$\frac{7000}{837,500} X360 = 3.00°$

Table 1.22 Calculated degrees

Regions	Calculated degrees for exports	Calculated degrees for imports
Y	330.15°	3.43°
Z	7.85°	344.09°
K	3.14°	9.45°
J	18.85°	3.00°

The above calculated degrees were used to construct the following proportional divided circles. As the totals of both imports and exports differ; the radius used to represent the data will vary proportionally to their totals.

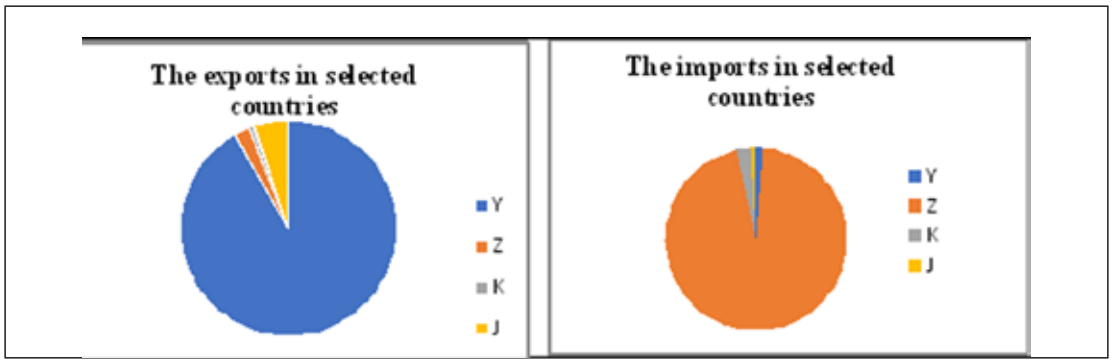


Figure 1. 17: Proportional divided circles showing exports and imports of selected countries

Advantages of proportional divided circles

1. Comparative divided circles capture the attention and interest of the reader because of the wonderful visual impression they offer.
2. They are suitable statistical graphical methods for the data that require comparative analysis and interpretation.
3. They provide an instant visual interpretation of the data represented.
4. Once the segments are determined in terms of degrees, the method is easy to draw.
5. There are simple calculations involved.

Note: This statistical method shares directly most of the advantages of a simple divided circle as earlier studied.

Disadvantages of proportional divided circles

1. They are not constructed on a scale which affects the effectiveness and exactness of the data.
2. Small degrees sometimes are hard to plot, and such provides erroneous effects in the interpretation of data.
3. When small degrees are involved, writing or labeling becomes hard and over-crowding of the chart occurs.
4. The determining of the radius, degrees and finding the totals, makes the method time consuming.

1.4.3. Simple divided rectangles

Learning activity 1.4.3

Use internet, text books and other sources of information to research on the following:

a. Description of divided rectangles.
b. How simple and compound divided rectangles are constructed
c. Advantages and disadvantages of simple and compound divided rectangles.

Divided rectangles are a statistical graphic representation of data, using rectangle that is proportional to the general total of the variable. However, even though the area of the rectangle represents the total, it is partitioned into segments each representing individual variables. Two methods can be used; these include the following: simple divided rectangle and compound divided rectangle. A rectangle is subdivided to indicate the constituent parts. The simple divided rectangle represents the total value or area of the components.

Construction of simple divided rectangle

Simple divided rectangles are constructed in the following ways:

1. A rectangle is drawn whose area is proportional to the quantity or value of all parts.
2. The rectangle is then divided into strips of uniform height.
3. The variation in the values of the constituent parts are represented by making subdivisions along the horizontal scale.
4. The vertical axis shows a constant of any convenience, but most suitably

and commonly recommendable is 100%.

5. The quantity or values are indicated along the horizontal axis. The height is determined by using a given scale of any choice.
6. Divide the rectangle into segments each representing a given value or quantity. But at the end all should add up to make a complete rectangle.
7. The portions or wedges should be shaded differently or coloured in a varying manner.

Worked example:

The table below shows crop production in country X per province.

Table 1. 23 showing crop production per province in a country X

Province	1000 tons
Northern	150
Southern	80
Western	90
Eastern	180

The data displayed in table 1.23 were used to construct the simple divided circle as shown below:

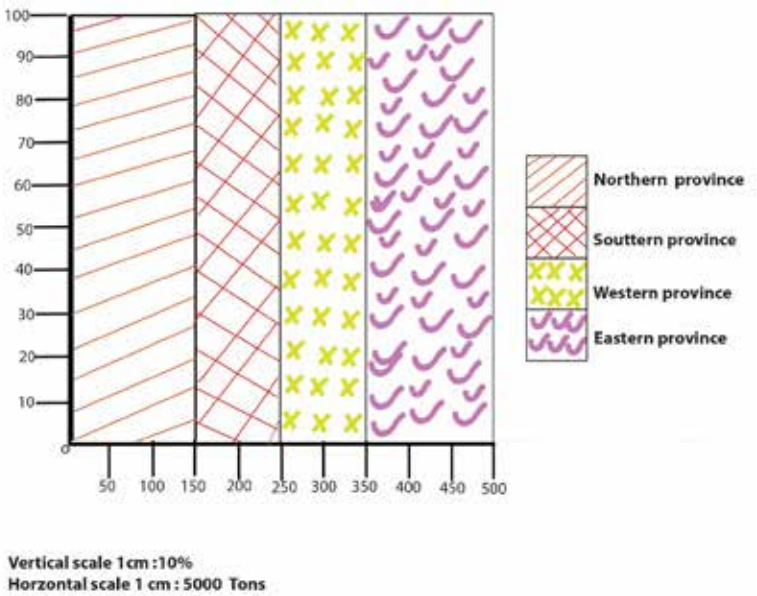


Figure 1. 18: Simple divided rectangles showing crop production in country X

Advantages of simple divided rectangles

The following are some of advantages of simple divided rectangles:

1. When the rectangles are clearly shaded or coloured, they provide a good visual impression.
2. They are effective and reliable when two or more variables are to be comparatively analyzed.
3. When well-labeled, they are easy to interpret.
4. They involve simple calculations which make them easy to draw.
5. They can be used for a wide range of purposes in geography and other disciplines.
6. They require minimal additional explanation or description.

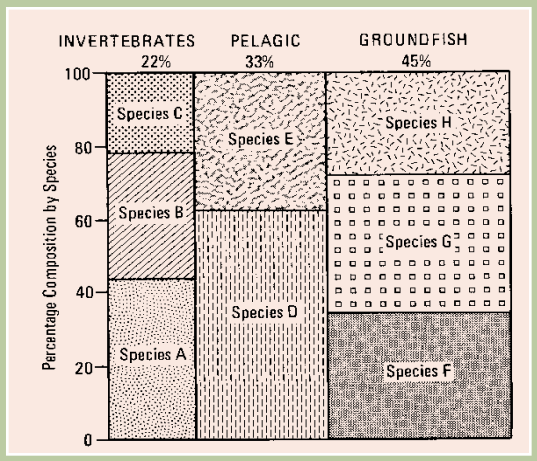
Disadvantages of simple divided rectangles

1. They deal with sometimes percentages. Therefore, exact figures may not be easily noted by the reader.
2. Simple divided rectangles can easily be maliciously manipulated or intentionally altered, therefore, displaying incorrect information. Hence, the reader may make erroneous conclusions.
3. They are constructed without basing on a specific scale. Such leaves a gap in the exactness of the method.
4. They may provide errors, due to lack of accuracy; especially when tiny degrees are plotted. The thickness of the pencil affects the perfection of the method.
5. Large wedges/proportions for bigger values tend to over shadow the small values.

1.4.4. Compound divided rectangles

Learning activity 1.4.4

The chart showing the distribution of selected animals living in water bodies



Examine carefully the chart above to answer the following questions:

a. Name and describe the above presented chart.

b. Research on the advantages and disadvantages of simple divided rectangles.

This statistical method is like a simple divided rectangle. The difference is that, with compound divided rectangle, each segment is partitioned basing on the general total, it is further sub-divided to represent the sub-divisions of the segments as illustrated by the practical example.

Construction of compound divided rectangle

Steps taken for the construction include:

1. Get the data to be represented and calculate the total value. This is where there is the addition of all the absolute values given.
2. Draw a rectangle which is proportional to the total quantity calculated in step 1 above.
3. Estimate the vertical scale and this should be constant. This is usually given in percentages to simplify data presentation.
4. Subdivide the rectangle into strips of uniform heights but with different subdivisions using the horizontal scale which must be proportional to their values.

Worked example

The table below shows how the land is used in country X.

Table 1. 24 showing how the land is used in country X

Countries	Area (000) km2	Land use % of total area		
		Uncultivated land	Farmland	Forestry
Z	267	80	05	15
Y	35	40	47	13
K	426	31	0	69
J	22	21	35	44

The data displayed in table 1.24 were used to construct the simple divided rectangle as shown below:

It should be noted that, in this case the total area (000) km2 is used to determine the suitable horizontal scale, while the % against each independent variable, will be used to portion the segments.

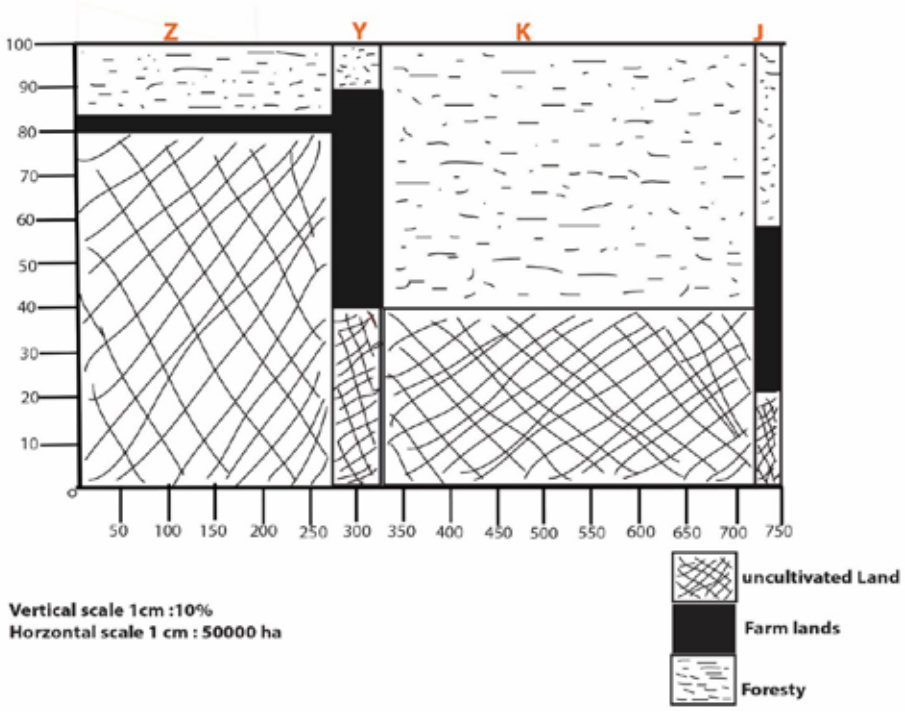


Figure 1.19: A compound divided rectangle showing the % of how land is used in country X

Advantages of compound divided rectangles

Compound divided rectangles are very important statistical methods of data representation as it is explained below:

1. It conveys much more statistical information when compared with other graphs like compound bar graphs;

2. It occupies little space compared to circular graphs;
3. It gives clearly the total values of an entity in question;
4. It is very simple to construct because it does not involve a lot of mathematical calculations compared to divided circles;
5. It gives a good visual impression when well-drawn and shaded.

Disadvantages

1. It is challenging to find a convenient scale;
2. They are not applicable to the representation of statistical data that are locational in nature;
3. This method does not give absolute individual values.
4. Shading consumes a lot of time if many subdivisions are involved.
5. It is limited to the use of location purposes.

Application Activity 1.4

The table showing land use in place Y

Land use	% of the land cultivated
crop growing	**60**
irrigation	**05**
Plantation	**10**
Livestock	**25**

Use the above presented data in the table to answer the following questions:

a. Construct different types of divided charts.
b. Interpret the constructed divided charts in (a) above.
c. Assess the effects of the land mentioned above on the physical environment.

1.5. Repeated symbols

Activity 1.5.1

Using various sources of geographical information research on:

a. Repeated symbols used in statistics to represent geographical information on charts.
b. Advantages and disadvantages of each method used to represent geographical information on charts using repeated symbols.

Repeated symbols are a form of statistical method used to represent the data that emphasizes locational aspects. That is, some geographic information may require representing symbols of the same size and nature on a map and clearly locating the symbol in its almost exact place. Such symbols are repeated all over the map being super-imposed in relation to where they are intended to be located.

For example, when dealing with livestock, one may say, one symbol of cow (🐄) represents 260 cows. Therefore, the total number of the symbols of a cow will be equal to 260 X total number of symbols. Suppose, on map X, there are 100 symbols of a cow, the reader will count them to get the number:

100 symbols indicated on Map X

One symbol of a cow = 260 cows.

The actual number of cows represented will be **100 X 260 = 260,000 cows.**

There are different kinds of charts which are represented using repeated symbols. These include: proportional circles, squares, cubes and spheres.

1.5.1 Proportional circles

Circles of different circumference are drawn based on the quantity of the item supposed to be represented. It involves mathematical calculation, and the use of square roots is required to obtain the radii of the circles required. It is constructed like the proportion squares diagram.

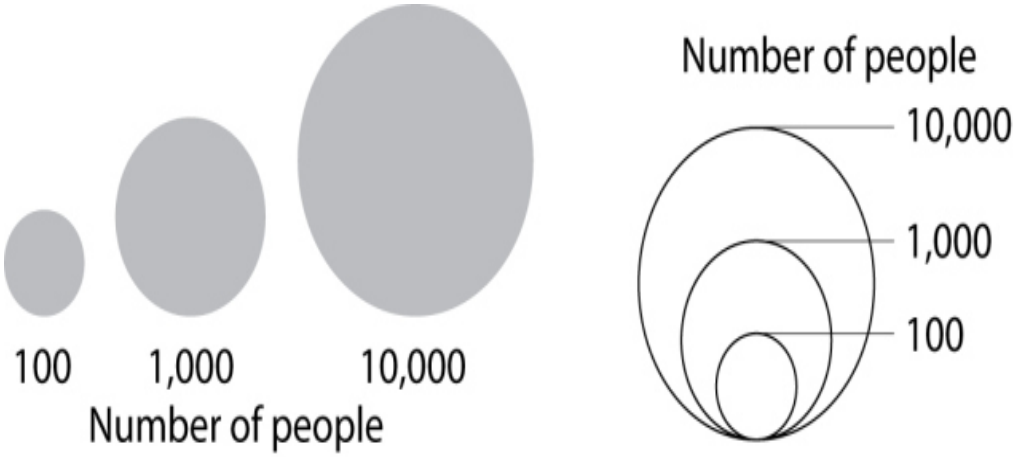


Figure 1.20: Proportional circles showing number of people

Advantages of proportional circles

1. They display relative proportions of multiple classes of data;
2. The size of the circle can be made proportional to the total quantity it represents;

3. They summarize a large data set in visual form;
4. They are visually simpler than other types of graphs;
5. They permit a visual check of the reasonableness or accuracy of calculations;
6. They require minimal additional explanation.

Disadvantages of proportional circles

1. They do not easily reveal exact values.
2. Many proportional circles may be needed to show changes over time.
3. They fail to reveal key assumptions, causes, effects, or patterns.
4. They may be easily manipulated to yield false impressions.

1.5.2. Proportional squares

Learning activity: 1.5.2

Table showing crop production in selected regions

Area	Crop Production in "000 tons
A	1572
B	1360
C	12340

1. Use the data presented in table above to answer the following questions:
   a. Construct a proportional square representing the data shown in the table above.
   b. Comment on the distribution of crop production in selected region.
2. Research on the advantages and disadvantages of proportional squares.

The proportional squares are almost used in equivalent manner as proportional circles. The general total is equivalent to the area of the square. This implies that the quantity in question will be directly represented equivalently by the size of the square, whose length will be determined by the square root of the total.

Construction of proportional squares

There are mainly five steps followed while drawing proportional squares. This requires remembering the skills acquired in drawing squares. These steps include the following:

1. Find the length of the sides of squares. This is obtained by calculating the square roots of the totals of variables.
2. Draw the squares for each variable. This means use the square roots to determine the length in centimeters.
3. If the proportional squares are to be super-imposed on maps or any other statistical diagram, the south-west corner of the square must touch the point of location or representation.
4. Proportional squares can be drawn alone without being super-imposed on maps.
5. The location or the position of the area being represented can be read by looking where the south-west corner connects or touches.

Worked example:

Use the table1.25 below to answer the questions that follow:

Table 1.25 showing the crops product in '000 tons in selected areas

Areas	Crop production in '000 tons
X	162
Y	200
Z	340

The data presented in table 1.25 above were used to construct proportional squares shown below following the recommended steps.

Calculation made to determine the square root and length in cm of each crop is presented in the table below:

Table 1.26 showing square root and length in cm of each crop derived from the data shown in table 1.25

Areas	Square root	Length in cm
X	$\sqrt{162}\sqrt{162}$ = 12.72 X 1000 = 12,720	If cm= 10,000 cm 12,720/10,000 = 1.27= 1.3 cm
Y	$\sqrt{200} = 14.14\ X\ 1000 = 14{,}140$	14,140/10,000 = 1.41 cm
Z	$\sqrt{340} = 18.43\ X\ 1000 = 18{,}430$	18,430 /10,000= 1.8 cm

The square roots are multiplied by 1000 because the raw data in the table are reduced by '000 in tons.

The square roots after being multiplied by 1000 each, the figures become big. However, they are reduced by a uniform figure of 1cm: 10,000; to get at least simple figures that are easily measurable.

Areas	Length in cm
X	1.3 cm
Y	1.4 cm
Z	1.8 cm

The following are proportional squares constructed based on the above length in Cm:

Figure 1. 21: Proportional squares showing crop production in selected areas

Advantages of proportional squares

1. Easy to construct;
2. They promote a good visual impression;
3. They can accommodate several figures;
4. They can be used together with other diagrams such as maps;
5. They involve few calculations.

Disadvantages of proportional squares

1. They are sometimes difficult in interpretation due to over-lapping.
2. It is hard to analyze small figures reflected between totals.
3. It shows directly the figures on the square, if a slight difference exists between figures it is hard to tell the accuracy of the figures.
4. They occupy large space, hence are less economical.

1.5.3. Proportional cubes

Learning activity 1.5.3

Table showing cultivated areas in selected regions

Regions	Cultivated ares in '000 ha
Beans	**572**
Sorghum	**360**
irish potatoes	**123**

Use the data presented in the table above to answer the following questions:

a. Construct a proportional cube representing the data shown in the table above

b. Comment on the cultivated areas in selected regions.

c. Research on the advantages and disadvantages of proportional cubes.

They are representing quantitative distribution of the objects. The side of the cube is directly related to the cube root of the quantity.

Construction of proportional cubes (cuboids)

The following are the major steps to be followed while constructing proportional cubes:

1. Calculate the cube root of the value or quantity or total to be represented by the cube.;
2. Place the drawn cubes along the same straight for the purpose of comparison. This is applicable where they are not placed to the base map.
3. Show the key and all elements of a good statistical diagram.
4. Once used on the base map, maintain the same pattern of constructing the individual cubes.
5. Indicate the quantity in terms of cube roots along the cubes (on the face of the cube).

Table 1.27showing crop production in tons

Crops	Crop production in tons
Banana	256,000
Beans	360,000
Peas	200,000

Sweet potatoes	100,000

The data presented in the table above are used to construct a proportional square

The cube roots for each variable to be used in the construction of a proportional square are calculated below:

Suppose 1cm: 20cm

Banana $\sqrt[3]{256,000}$= 63.49 =63

Beans $\sqrt[3]{360\ 000}$= 71.13= 71

Peas $\sqrt[3]{200\ 000}$= 58.480

Sweet potatoes $\sqrt[3]{100,000}$ =46.41= 46

These cube roots are too big but can be used when they are reduced using the scale indicated above (1cm: 20 cm). The reduced centimeters are now used to construct the cubes.

Beans= 4 cm

Bananas = 3.2 cm

Peas= 2.9 cm

Sweet potatoes 2.3 cm

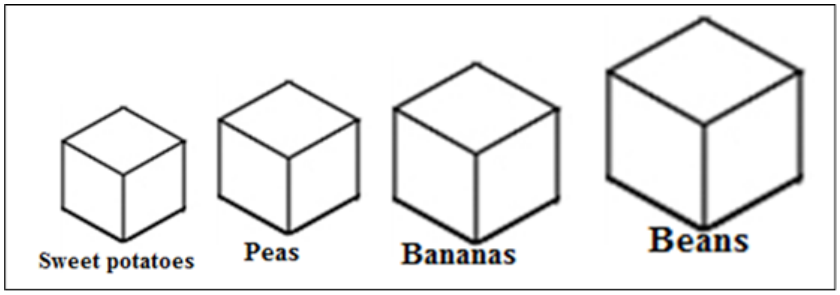


Figure 1. 22: Proportional cuboids

Advantages of proportional cubes

1. They are easy to construct.
2. They promote a good visual impression.
3. They can accommodate several figures.

4. They can be used together with other diagrams such as maps.
5. They involve few calculations.

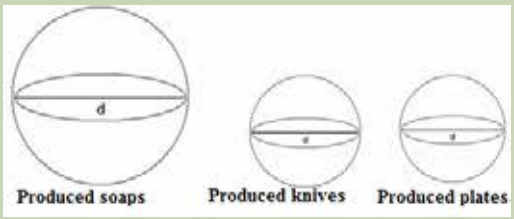
Disadvantages of proportional cubes

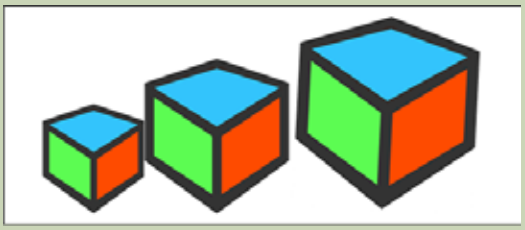
1. They are sometimes difficult in interpretation due to over-lapping.
2. It is hard to analyze small figures reflected between totals.
3. It shows directly the figures on the cubes, if a slight difference exists between figures it is hard to tell the accuracy of the figures.
4. They occupy large space, hence are less economical.

1.5.4. Proportional spheres

Activities 1.5.4

The following diagrams represent different items





Referring to the figures above answer the questions that follow:

1. Note down and describe the differences existing between the two diagrams presented above.
2. Research on the advantages and disadvantages of proportional spheres.

Proportional spheres serve the same purpose as the cubes. The volume of the spheres should be proportional to the quantities they represent. The radius of the sphere is determined by calculating the cube root of the quantity to be represented (the volume of a sphere is 4/3/r3). The sphere is then drawn in its correct position on the map. Proportional spheres are not normally used except on a locational basis.

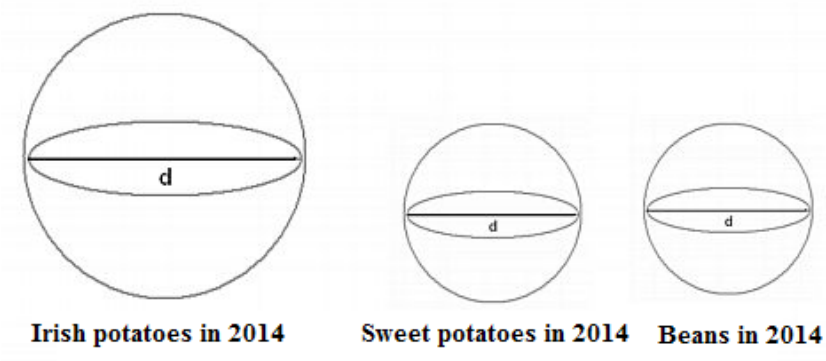


Figure 1. 23: Proportional spheres

Advantages of proportional spheres

1. Easy to construct.
2. They promote a good visual impression.
3. They can accommodate several figures.
4. They can be used together with other diagrams such as maps.
5. They involve few calculations.

Disadvantages of proportional spheres

1. They are sometimes difficult in interpretation due to over-lapping.
2. It is hard to analyze small figures reflected between totals.
3. It shows directly the figures on the spheres, if a slight difference exists between figures it is hard to tell the accuracy of the figures.
4. They occupy large space, hence are less economical.

Application Activity 1.5

The table showing enrolled students at selected schools

Schools/Years	2012	2013	2014	2015
Ineza	124	160	160	206
Ubworoherane	97	255	202	246
Kwigira	151	245	343	175

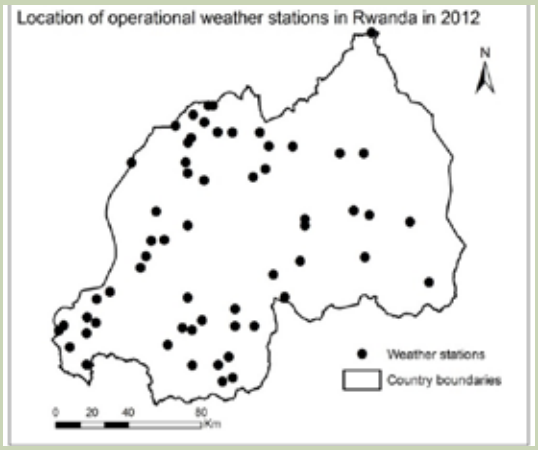
Use the above presented data in the table to answer the following questions:

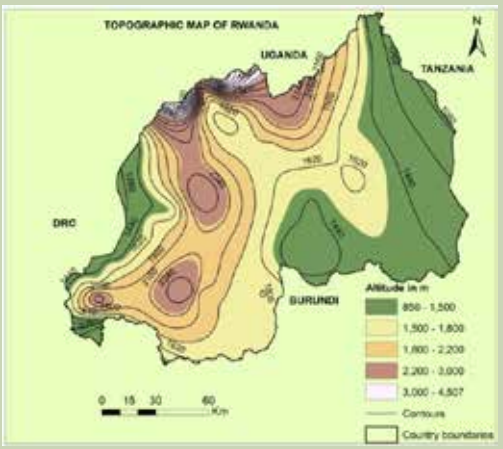
1. Construct different types of charts using repeated symbols.
2. Interpret the constructed charts in (a) above.
3. Suggest how peace and different Rwandan values may be promoted at Ineza, Ubworoherane and Kwigira schools.

1.6. Statistical diagrams

Activity: 1.6.1

The following are maps representing different aspects on Rwanda maps





Study the statistical maps shown above, and use them to find solutions to the following questions:

a. Explain the similarities and differences existing between the two maps.
b. Identify two African countries with the highest population.
c. Examine the impact of such high population on physical environment of any one country mentioned in b above.

Statistical maps are used in a situation where the data represented need to reflect the distribution of the variable being portrayed. Therefore, maps are used since it is easier for the reader to see directly the location in relation to the variable represented.

There are four main types of statistical maps, namely:

1. Dot maps.
2. Isoclines maps.
3. Shading maps or choropleth maps.
4. Flow maps.

1.6.1. Dot maps

A dot map is a map type that uses a dot symbol to show the presence of a feature or phenomenon found within the boundaries of a geographic area. In addition, with dot maps, there is an attempt to show the pattern of distribution within the area by placing the dots where the phenomenon is most likely to occur.

In a one-to-one dot map, each dot represents a single recording of a phenomenon. Care must be taken to place the dot in its correct position on the map.

Construction of dot maps

There are several conditions that must be put into consideration while drawing the dot maps. These include the following:

1. Determine the value of each dot. Take note of the nature of quantity. The value of dots on the maps will depend on the smallest quantity (value) or the biggest figure.

   If the lowest figure on the table is 2500 for Z and highest 5000 (K) then the value of dot can be:

   5000 = 5 dots (K)

   1000

   2500 = 2.5 dots = 3 dots (Z)

   1000

   Therefore, in area K there were five dots and 3 dots in place Z.

   It is very important to note that, the dot value should not be unnecessarily exaggerated. Too big or too small dot value provides wrong impression which interrupts with the analytical results of the data.

2. In case there are halves or fractions, it is necessary to round off that whole number of dots. For example, if you calculated and found that there are 3.5, 4.6, and 5.1 dots, then it is advisable to round up these figures to read 5 instead of 4.5.

3. The size of a dot should be reasonable. Not too big or very tiny. It should be able to enable the reader to be able to use his/her eyes to count the dots.

4. All dots used on the map should have equal size.

5. Plot all dots using a pencil so that in case of a mistake, it becomes easy to correct it.

Worked sample

Table 1.28. Population density of Rwanda in 2012 by district

Nr	Districts	Population density	Nr	District	Population density
1	Bugesera	282	16	Ngoma	390
2	Burera	522	17	Ngororero	493
3	Gakenke	481	18	Nyabihu	556
4	Gasabo	1237	19	Nyagatare	243
5	Gatsibo	275	20	Nyamagabe	314
6	Gicumbi	480	21	Nyamasheke	326
7	Gisagara	475	22	Nyanza	481
8	Huye	565	23	Nyarugenge	2127
9	Kamonyi	523	24	Nyaruguru	290
10	Karongi	334	25	Rubavu	1041
11	Kayonza	179	26	Ruhango	514
12	Kicukiro	1918	27	Rulindo	509
13	Kirehe	288	28	Rusizi	422
14	Muhanga	492	29	Rutsiro	279
15	Musanze	695	30	Rwamagana	455

The data presented above are used to construct a dot map of the population density of Rwanda in 2012

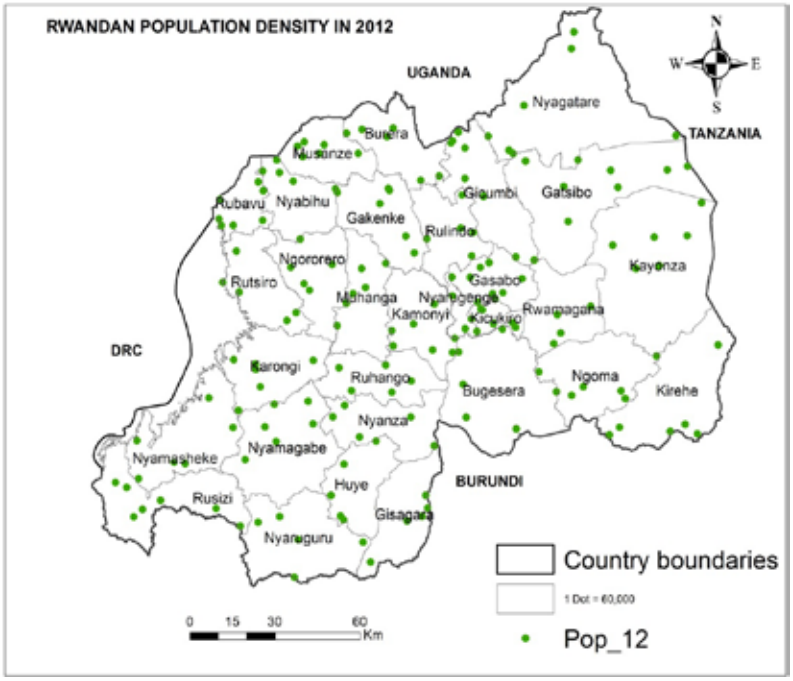


Figure 1.24: Dot map showing the population density of Rwanda in 2012

Advantages of dot maps

1. Dot maps provide a good visual impression.
2. They are suitable for the representation or portrayal of the data of spatial distribution such as population distribution.
3. They don't involve difficult or challenging calculations.
4. It is very easy for the reader to immediately compare the distribution of what is represented, e.g. population distribution.
5. It can be conveniently used for the portrayal of a varying range of items such as distribution of crops, population, volume, area, etc.

Disadvantages of dot maps

1. There is a risk of giving false impression especially when dots are evenly spread.
2. It involves more calculations such as determining the population density, dot value, etc.
3. They provide unclear impact due to the congestion of data in densely populated areas.
4. Drawing with free hand dots of equal size is difficult and challenging.
5. Identifying and locating are exposed to personal subjective decision.
6. In areas where there are many dots near each other, it is difficult to find the number without making errors.

1.6.2. Isoline maps

Learning activity 1.6.2

The table showing different lines that join places of equal values

Element	Line
Clouds	Isonephs
Rainfall	.....
Atmospheric Pressure	.....
Height	Contours
Salinity	Isohalines
Ocean Depth	.....
Equal value	.....

Use the information presented in the table above to answer following questions:

a. Fill in the missing information.

b. Describe how isoline maps are drawn and used in geography.

An isoline or isopleth map is a map with continuous lines joining points of the same value. For instance, the lines joining equal altitude (contour lines), temperature (isotherms), barometric pressure (isobars), wind speed (isotachs) and wind direction (isogon), etc.

Construction of isoline maps

The construction of an isopleth map is done as follows:

1. Obtaining an outline base map and the appropriate necessary geographical data.
2. Marking in the points and their values on the map.
3. Deciding on a suitable interval of units.
4. Drawing curved lines joining all places with equal values; always starting with the highest value.
5. Making sure that the lines do not cross or touch each other.
6. Numbering the isopleth lines.

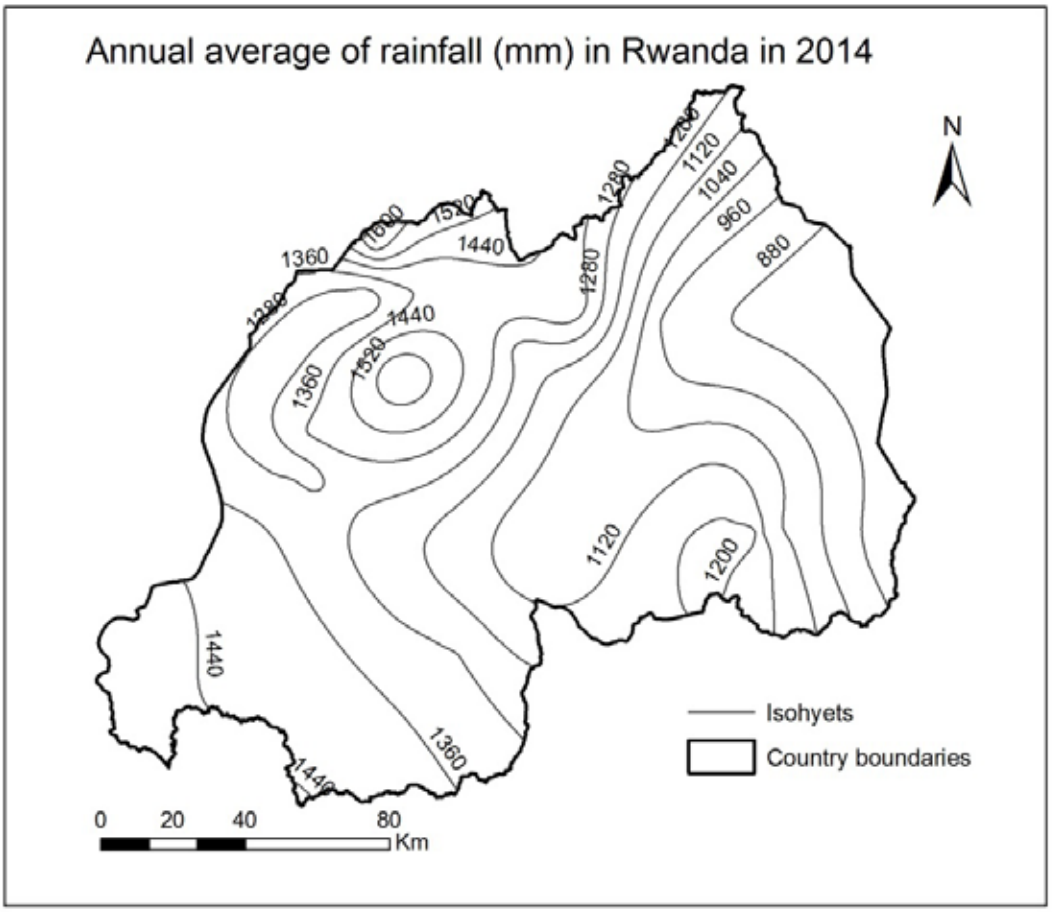


Figure 1. 25. An isopleth map (Isohyets)

Advantages of isoline maps

1. They are useful in showing the distribution of geographical phenomena at a large scale.
2. They are useful in illustrating the distribution of even and uneven phenomena.
3. It is easy to obtain values on any point of the map.
4. Isoline maps are used for comparing variables.
5. They provide a clear impression of population density.
6. They can be used together with other statistical diagrams in a super-imposed way.
7. They don't involve calculations.
8. There are easy to construct and easy to interpret.
9. They provide a good visual impression.

Disadvantages of isoline maps

1. With isoline maps, the interpretation may not be easy especially when the isopleth lines are not clearly shaped.
2. It may be difficult to calculate isoline interval on the map.
3. Isopleth maps are not suitable to present the population distribution.
4. In drawing isoline maps; the administrative boundaries are not taken into account.
5. Isopleth lines may be difficult to draw, especially where there are points to join.
6. Isoline maps provide unreliable impression, on assumption that the gap between two adjacent isoline lines is uniform.
7. It is very hard to determine the distance area on isoline maps.

1.6.3. Shading or choropleth maps

Learning activity 1.6.3

Using internet, textbooks and other sources of geographical information research on:

a. The difference existing between choropleth and isoclines map.
b. Description of how choropleth maps are constructed.
c. Advantages and disadvantages of choropleth maps.

Choropleth maps are thematic maps in nature described by a series of varying shading patterns, each representing proportionally the measurement of a given statistical variable being portrayed on the map. The choropleth map provides an easy way to visualize how a measurement varies across a geographic area or it shows the level of variability within a region. A choropleth map is a map which shows regions or areas with the same characteristics.

Construction of choropleth maps

A choropleth map is made as follows:

1. Drawing a base map showing administrative units such as provinces or districts.
2. Calculating the average densities, ratios or percentages for each administrative unit.
3. Choosing and drawing grades or scales of densities to be used.
4. Indicating on the map the grade of shading or coloring to be used for each administrative unit.
5. Shading or coloring the map but leaving boundary lines
6. Dividing the range of values into groups.
7. Including a key showing individual boxes.
8. Showing increases or decreases in population density, average crop yields, etc.

Worked example:

Table 1.29: Population density of Rwanda in 2012

Nr	Districts	Population density	Nr	District	Population density
1	Bugesera	282	16	Ngoma	390
2	Burera	522	17	Ngororero	493
3	Gakenke	481	18	Nyabihu	556
4	Gasabo	1237	19	Nyagatare	243
5	Gatsibo	275	20	Nyamagabe	314
6	Gicumbi	480	21	Nyamasheke	326
7	Gisagara	475	22	Nyanza	481
8	Huye	565	23	Nyarugenge	2127
9	Kamonyi	523	24	Nyaruguru	290
10	Karongi	334	25	Rubavu	1041
11	Kayonza	179	26	Ruhango	514
12	Kicukiro	1918	27	Rulindo	509
13	Kirehe	288	28	Rusizi	422
14	Muhanga	492	29	Rutsiro	279
15	Musanze	695	30	Rwamagana	455

The data presented above are used to construct a choropleth map showing the population density of Rwanda in 2012

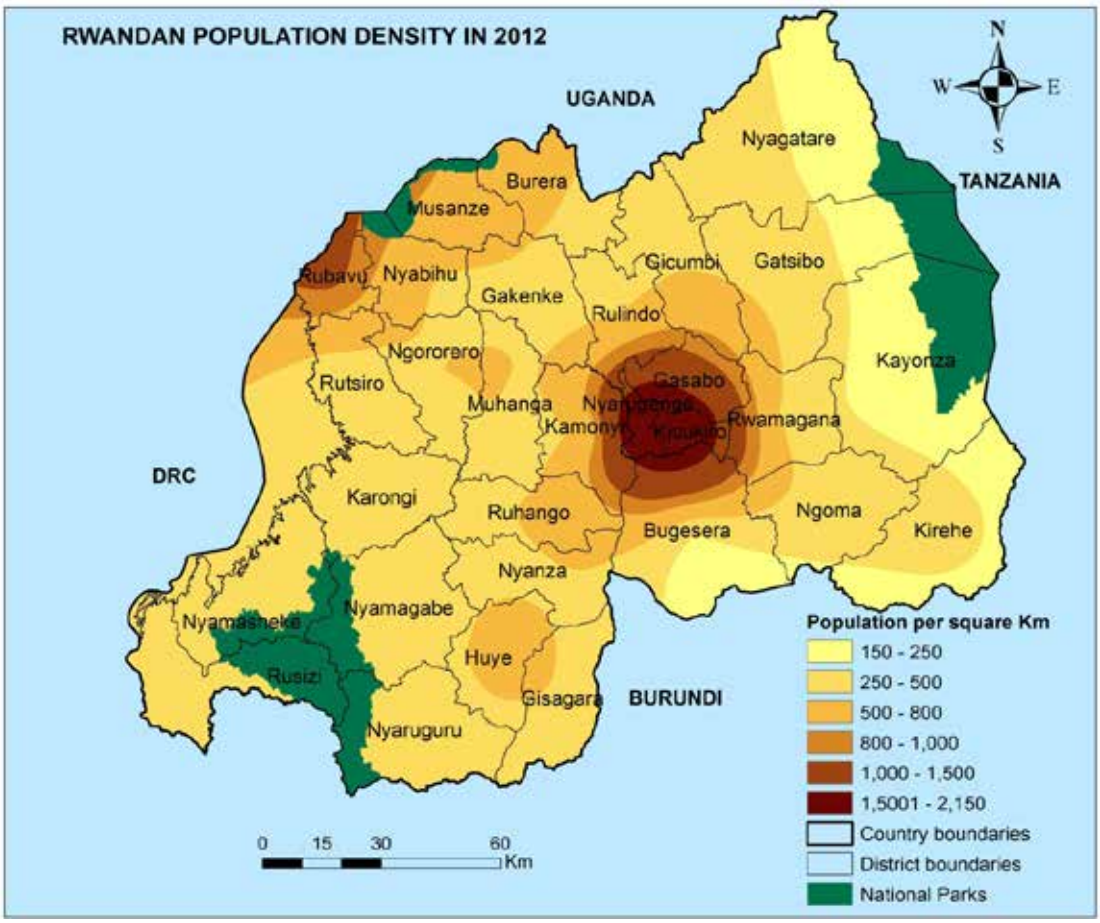


Figure 1.26: Choropleth map showing the Rwandan population density in 2012

Advantages of choropleth map

1. Most often choropleth maps represent the typical value for the region not spread uniformly within the region.
2. Choropleth maps are used for phenomena that have spatial variation that coincide with the boundaries of the spatial area used for map.

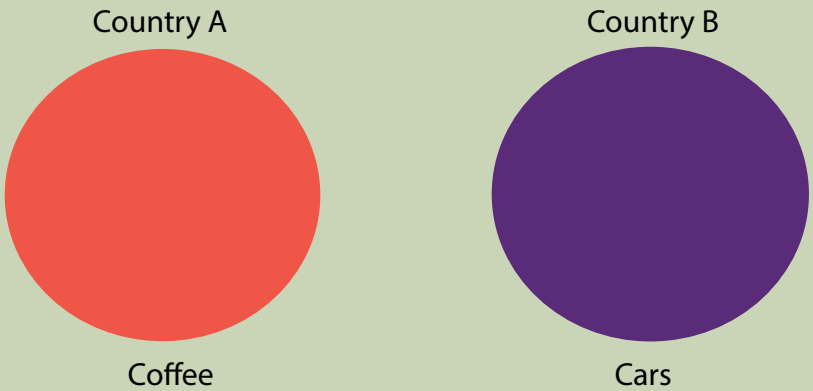
Disadvantages of choropleth map

1. Choropleth map is suitable for mapping discrete phenomena.
2. In most cases it is not easy to use absolute numbers in choropleth map.
3. To make phenomena comparable for administrative units it should be quite often standardised.

1.6.4. Flow maps

Learning activity 1.6.4

Examine the two illustrations drawn here below and answer the following questions:



a. Explain what the illustration above mean

b. Identify the items:

   i. Imported by B

   ii. Exported by B

   iii. Imported by A

   iv. Exported by A.

Flow maps are statistical methods used to represent diagrammatically the movement of goods from one area to another.

They are commonly used to represent the flow of imports and exports. They are again used in other ways, such as the flow of traffic by water, air or rail.

Construct of a flow map

1. The line drawn show the direction of flow.
2. The width of the line represents the quality of goods imported or exported.
3. Write the amount of goods directly on/alongside the line of lines.
4. The drawn lines are colored to avoid congestion. In this case, a key can be of a good help.
5. Determine the width of the lines by using a suitable scale.
6. Lines should not be too big or small. It is advisable to use a scale expressed in millimeters but not in centimeters.

7. Show all elements of a good statistical diagram, namely, Title, Scale, and Key among many others.

Worked example

Study the table below showing exchange of agricultural products in '000 tons from one district to other districts in Rwanda.

Table1.30 showing exchange of agricultural products in '000 tons from one district to other districts in Rwanda.

Producing district	Receiving district	Products
Musanze	Nyagatare	Irish potatoes
Nyagatare	Bugesera	Maize
Kamonyi	Bugesera	Sweet potatoes
Bugesera	Kamonyi	Cassava

The data presented in table 1.30 above are used to construct a flow map representing trade between Rwandan districts

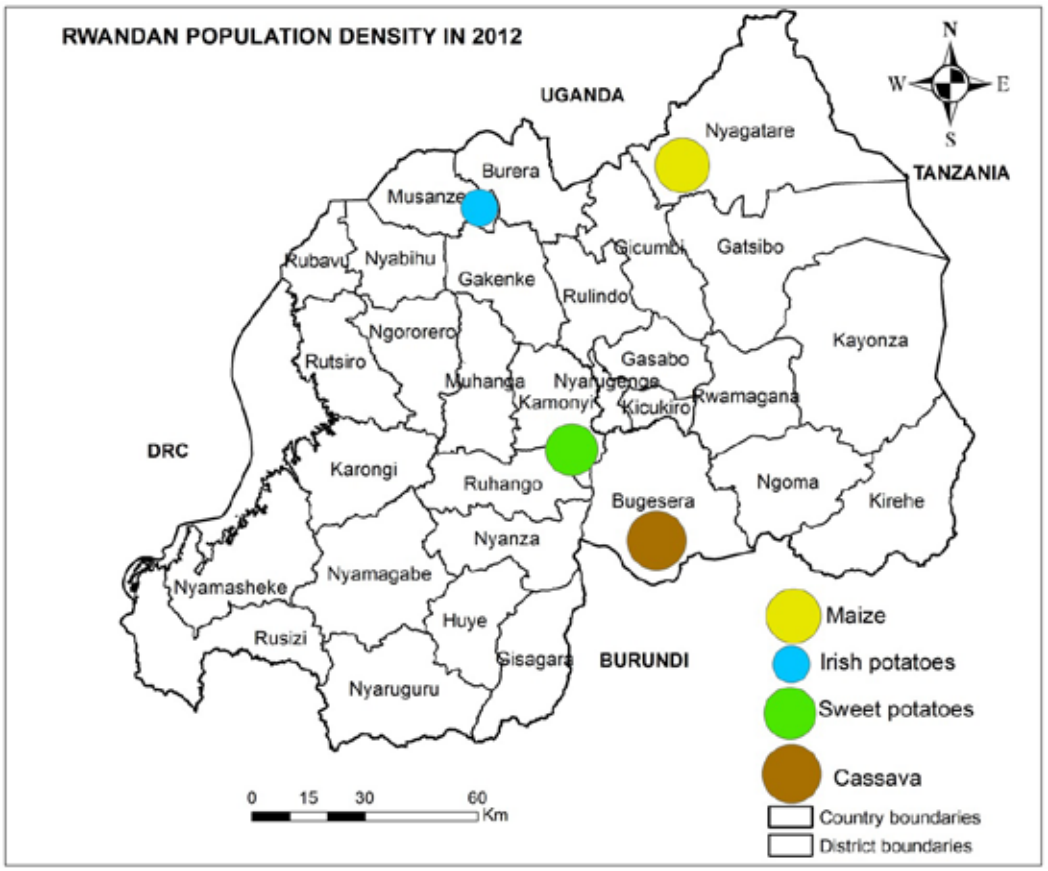


Figure 1. 27: A flow map representing trade between Rwandan districts

Advantages of flow maps

1. They are the only suitable method for portraying the movement of goods.
2. They are easy to interpret.
3. They can be used together with other maps and statistical diagrams.
4. They provide a good visual impression.
5. They are suitable for comparison purpose.
6. They do not involve difficult calculations.

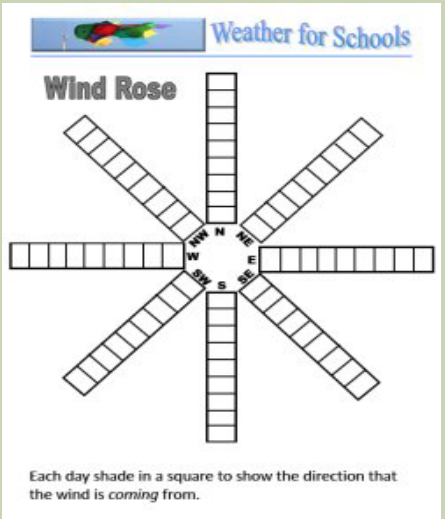
Disadvantages of flow maps

1. They take a lot of time to draw.
2. They hardly provide immediate interpretation.
3. They are more challenging to draw.

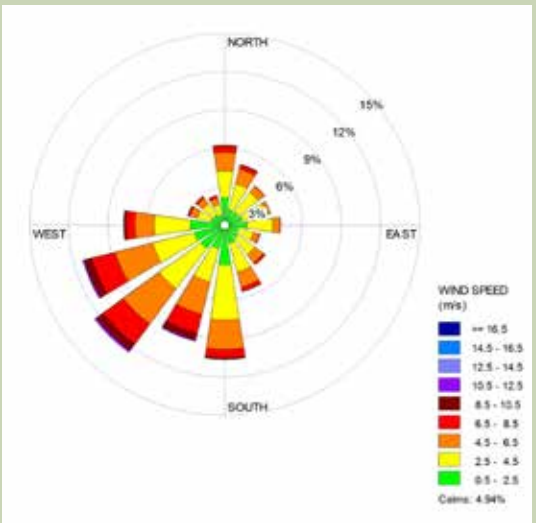
1.6.5. Wind rose

Learning activity: 1.6.5

Analyze and examine the pictures provided below and use them to answer the question that follow:



A



B

a. Identify the similarities and differences existing between the two statistical diagrams presented above.

b. Comment on the data information represented by diagram A and B.

A wind rose is another statistical tool used to portray diagrammatically the average occurrence and direction of wind associated with a specific area. The wind rose is used by meteorologists to summarize data about the wind in relation to specific

speed, location, and time. There are two types of wind rose namely simple and compound wind roses.

It is important mentioning that there are two types of wind rose namely simple and compound wind rose.

Construction of a wind rose

1. Draw a circle of any convenient size. This marks the central point of wind rose.
2. Show or indicate the calm days inside the circle.
3. Construct a wind rose following the main 8 points of a compass can also be applied.
4. The days are indicated by the length of the columns commonly known as arms.
5. Determine a suitable scale of your convenience.

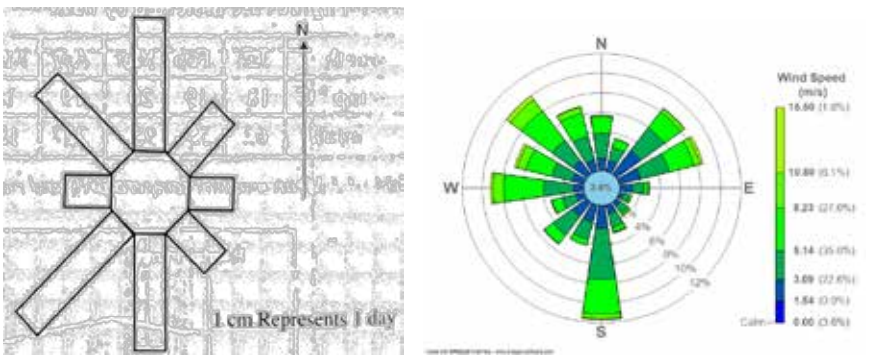


Figure 1. 28: A simple Wind Rose and A Compound Wind Rose

Construction of compound wind rose

1. Apply all the steps involved while constructing a simple wind rose.
2. The width of the columns represents the speed of the wind. When there is a rise in the speed of wind, the width of the column is expected to increase too.
3. Divide the columns into segments following the Beaufort Scale.
4. Draw a key to represent the different segments of each column.

Advantages of wind roses

1. They are easy to interpret.
2. They provide a good visual impression because of the way they display polygon shape and colours.
3. The reader can have clear and faster information replaced.

4. They portray a wide variety of aspects such as, wind direction, speed, and frequency.
5. They facilitate the central comparison of the climatic data.

Disadvantages of wind roses

1. There are challenges involved while determining the scale for the columns.
2. They do not emphasize seasonal patterns and the movement of winds.
3. They require the reader to have skills and specialty in interpretation.

Application Activity 1.6

The table showing wind speed in Km/hour

Area	Direction	Wind speed in km per hour
A	North	332
B	South	29
C	East	78
D	West	67

a. Select a suitable statistical diagram to statistically portray the above data.
b. Which area is more likely to have challenges with fierce winds?
c. Assess the impact of the wind on the environment in the area mentioned in (b) above.
d. Suggest precautionary measures that can be taken by people living in the area mentioned in (b) above.

End unit assessment

Landslides and floods hit several parts of Rwanda between 7 and 8 May 2016 after a period of heavy rainfall. Government officials say that at least 49 deaths have been recorded so far. Some of the victims drowned in flood water, others died after houses collapsed under the heavy rain and landslide.

The worst hit areas are the districts of Gakenke and Muhanga. As many as 34 people have died in Gakenke, 8 in Muhanga, 4 in Rubavu and 3 in Ngororero. Around 26 injuries have also been reported. Reports from the Ministry for Disaster Management and Refugee Affairs reported that over 500 houses have been destroyed. Therefore, use the statistical information presented above to do the following:

a. Extract statistical raw data mentioned in the story.

b. Use appropriate statistical diagrams, graphs and charts to display the portrayed data in (a) above.

c. Identify and describe the geographical phenomena that are highlighted in the news print.

d. Explain how you would use the data collected and statistical diagrams, graphs and charts constructed to advise the people and the government on the environmental challenges to be addressed.

e. Assess the environmental challenges to be addressed in the area and show measures of controlling them.

UNIT 2

BEARINGS, DIRECTIONS, DISTANCES AND AREAS ON A MAP

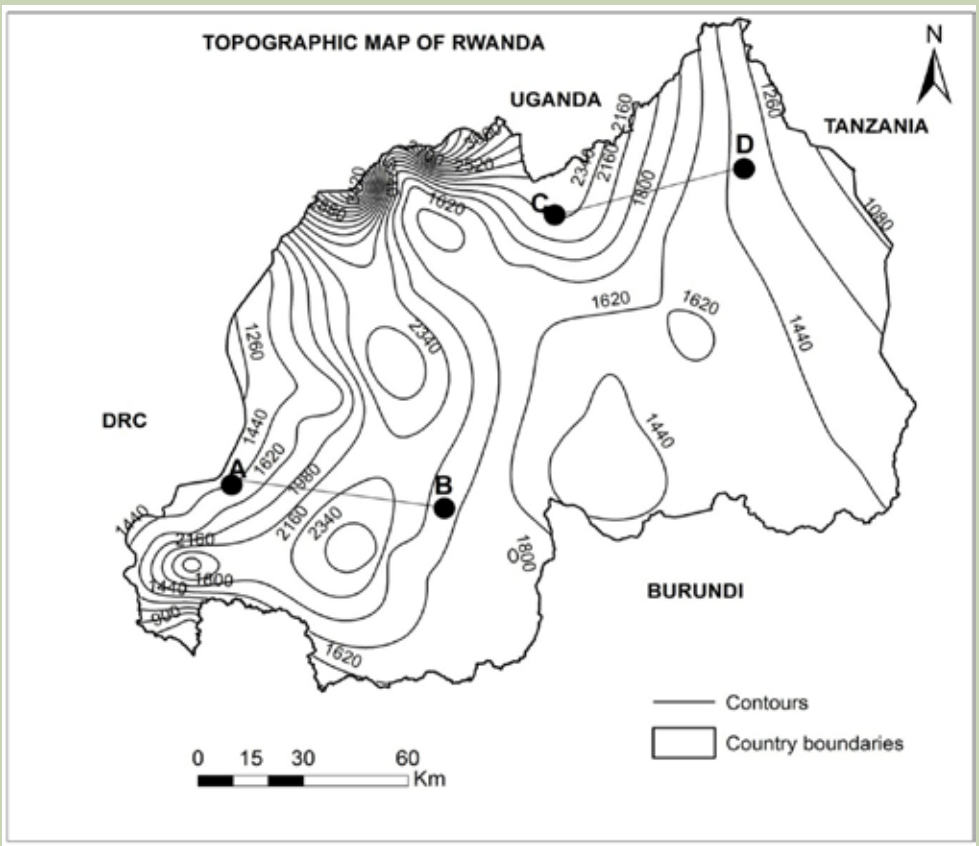
UNIT 2: BEARINGS, DIRECTIONS, DISTANCES AND AREAS ON A MAP

Key unit competency:

By the end of this unit, I should be able to measure the bearings and the directions, calculate distances and areas on a map.

Introductory Activity

Study the topographical map of Rwanda provided below and answer the questions that follow.



a) Maps are very important in showing location of places. How do we locate places on maps using grid references?

b) How can you determine the distance from point A to B and C to D?

c) Identify the steps one can follow to determine the bearing of B from A.

2.1. Location of places using the grid reference

Activity 2.1

a) A map has several lines printed on it. Identify the names given to the vertical and horizontal lines printed on the map.

b) What does grid reference mean?

A grid is a series of straight lines drawn vertically and horizontally on topographical maps. Where the lines cross each other to form squares of equal sizes. The lines running from north to south (vertical lines) are called **Eastings.** This is because their numbers increase towards the east from the south western corner. This corner is known as the grid origin and it is from it that all readings start. There are those drawn horizontally, and their numbers increase towards the north. These are called the **Northings.**

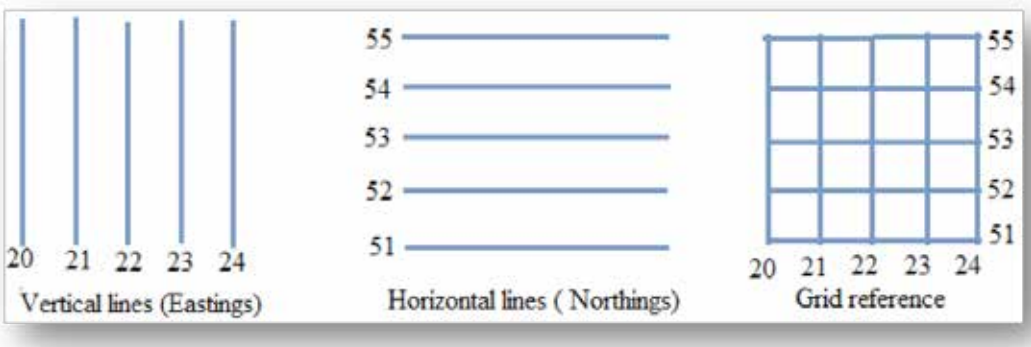


Figure 2. 29. A grid reference system

The lines shown on the illustration above, intersect forming grid squares. These are formed by both vertical lines (Eastings) and Horizontal lines (Northings). These are called grid references or geographical coordinates. They are the ones that are used to locate places and features indicated on the map. This is illustrated hereunder:

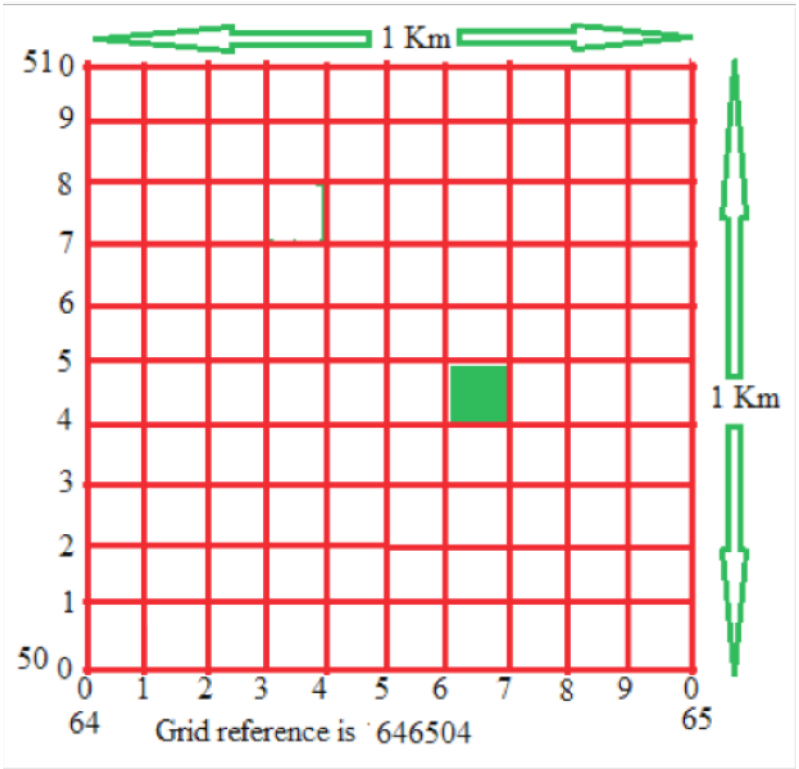


Figure 2. 30: Subdivision of Eastings and northings into rows and Columns of little boxes

The value of the easting (vertical gridline) is read first, followed by the value of the northing (horizontal Gridline). The values of the Eastings and northings are known as **coordinates**. The coordinates are expressed as a single continuous figure without decimal points or commas, for example, 646 504 and not 64, 65, 04. They are plain numbers, without units of measurement.

The coordinates are given in two ways:

- Four figure grid reference
- Six figure grid reference

2.1.1 The four-figure grid reference

The four-figure grid reference has four digits. It gives the grid square in which a position is found. The four-figure grid reference of Yellow Square in figure 2.31 below is found as follows:

- Read the easting first and record its value. In this case it is **11.**
- Next, read the northings and record its value. In this case it is **81**.
- Put the two values together.
- The four-figure grid reference for the yellow square is **1181.**

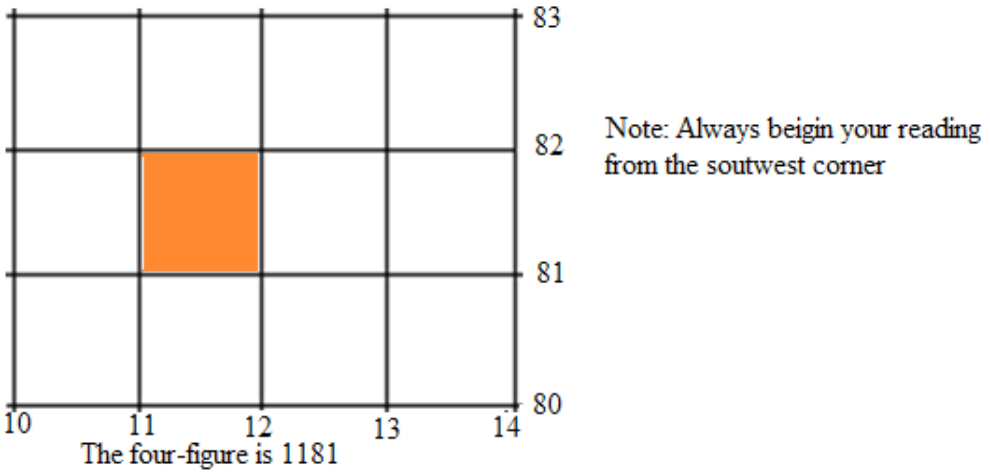


Figure 2. 31. Four-figure grid references

2.1.2 The six-figure grid reference

This reference has six digits. It is more exact than the four-figure grid reference. To get the six-figure grid reference for red square in figure 2.32 below, the following is done:

- Read the easting first and record its value. In this case it is 62.
- Subdivide the area between easting 62 and 63 into 10 equal parts.
- Record the value of red square out of 10 from easting 62. In this case, it is 5. This forms the third digit of the easting.
- The value of the easting for red square is therefore 625.
- Read and record the northing. In this case, it is 33.
- Subdivide the area between northing 33 and 34 into 10 equal parts.
- Record the value of red square out of 10 from northing 33. In this case, it is 3. This forms the third digit of the northing.
- The value of the northing for the red square is therefore 333.
- The six-figure grid reference for red square is therefore **625 333.**

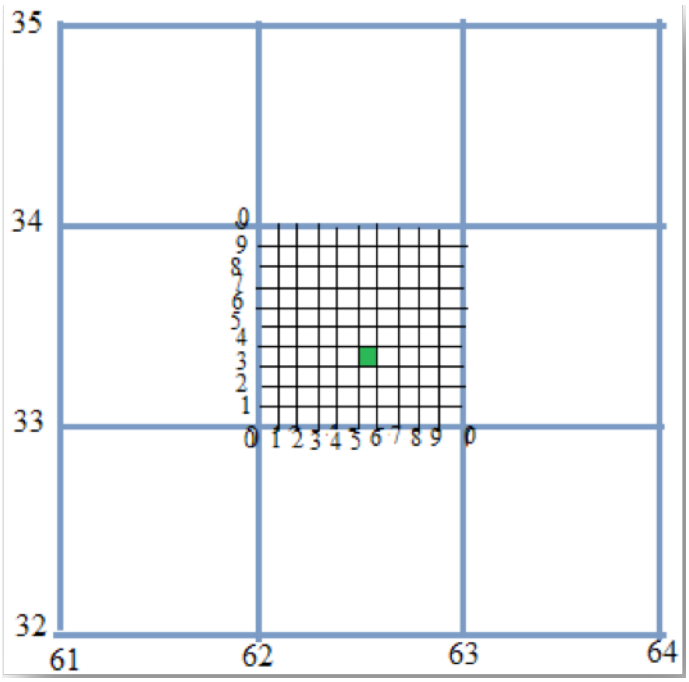
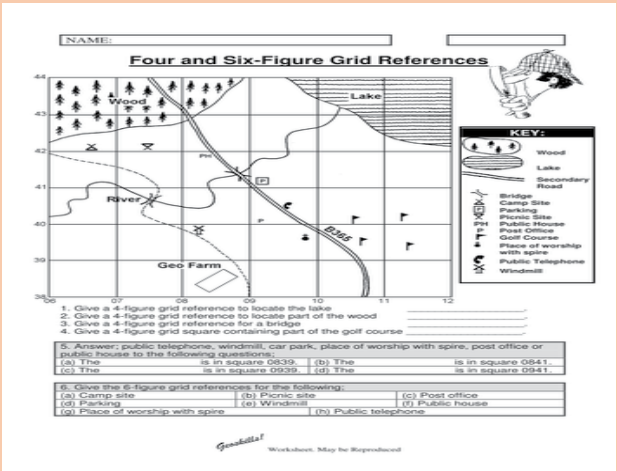


Figure 2. 32. Six-figure grid references

Application activity 2.1

Study the extracted map below and answer the questions that follow

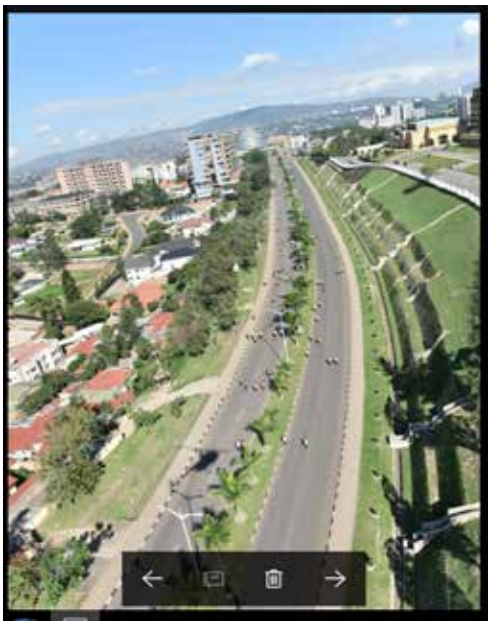


Source: https://www.tes.com/teaching-resource/4-and-6-figure-grid-references-6373196

1. Give the four-grid reference of the Geo farm.

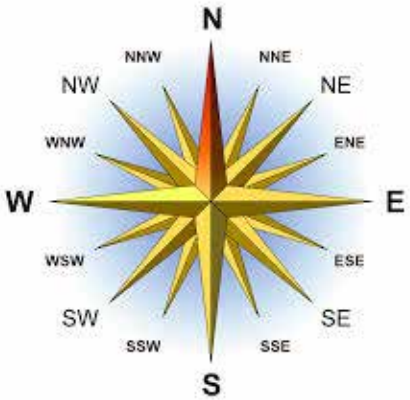
2. Identify the six-grid reference of two bridges shown on the map.

2.2: Stating directions and bearings on topographic map



2.2.1. Direction

Direction or orientation is important for finding the way and its relative position or direction of something. All directions are based on the cardinal points of the compass shown below:



Source: https://fa.wikipedia.org/wiki/لام‌ش

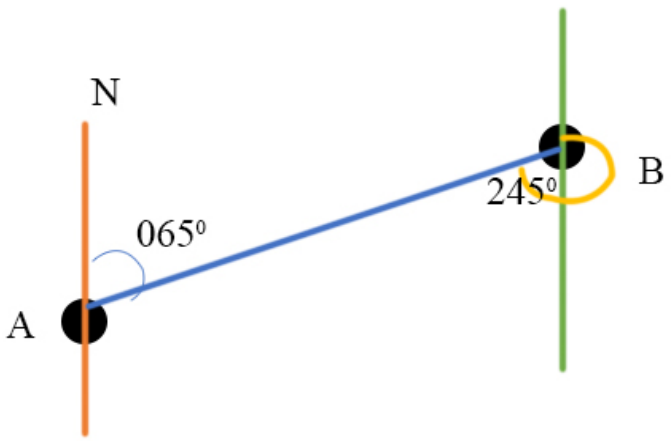
Figure 2. 33. Compass showing 16 cardinal points

Direction is the relative position of a place from another using the points of the compass. The main cardinal points of a compass are north, east, south and west. The first letters of these directions (in capital) are used in place of the full names. These are N—North, E—East, S—South and W—West.

2.2.2. Bearing

Bearing is an accurate way of giving the direction of one place in relation to another. It is more accurate than direction because it has 360 points compared to the 16 points of a compass. Instead of saying, for example, that place A is north east of place B, we use degrees. So, we would say that place B is situated at 045° from place A.

The bearing of a point is the number of degrees in the angle measured in a clockwise direction, from the North line to the line joining the centre of the compass with the point. This is illustrated below :



A bearing is used to represent the direction of one-point relative to another point. For example, the bearing of A Form B is 245˚. The bearing of B from A is 065˚.

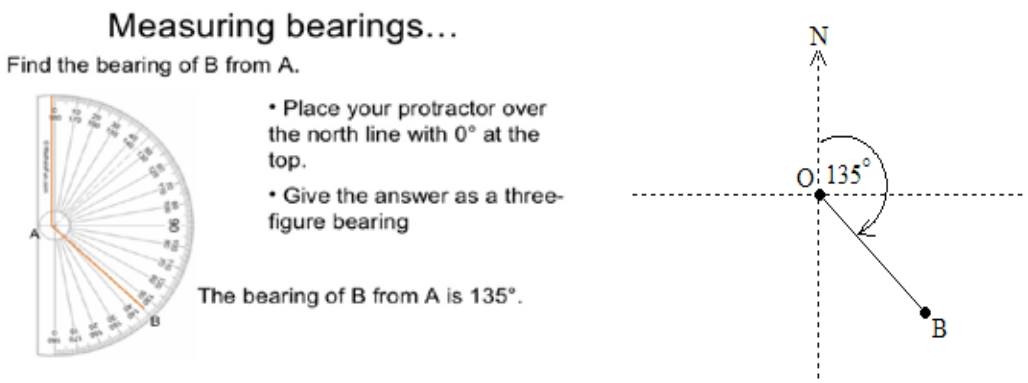
Bearing is also the direction to something measured as an angle relative to the north. It increases towards the East, with North=0 degrees, East=90 degrees, South=180 degrees, and West=270degrees.

2.2.3. Measuring true bearing

True bearing (TB) is a bearing where the true-north line is taken as 0˚. It is the measurement of the angle between the true-north line and the line joining the two places in question.

A true bearing is measured using a protractor from True North, as shown below:

- Draw a north-south line through the starting point.
- Use a straight line to join the two places given.
- Draw an arrow from the True North line to the line joining the two places in a clockwise direction. Then measure the angle with a protractor.



A *B*

Figure 2.34: Protractor (A) *Measuring Bearing of point (B)*

Source: https://myscres.com/collection/maths-worksheets-on-bearings.html

In this case, the bearing of B from A is 135 degrees. It is therefore, very important to understand how to use the protractor.

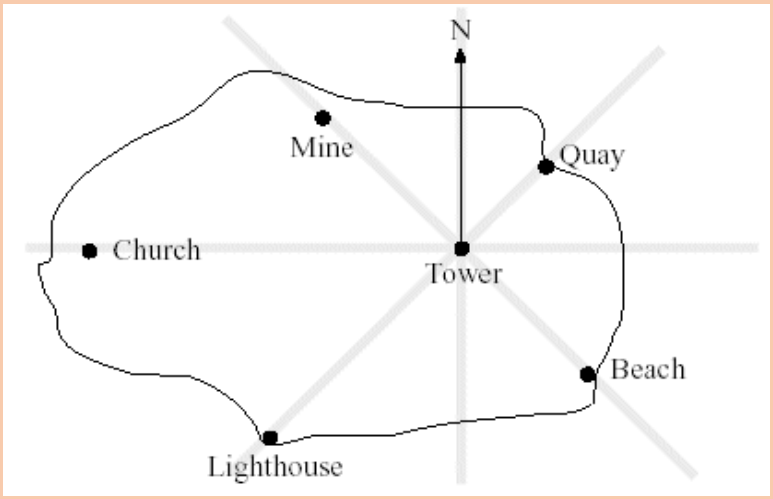
i) Centre the protractor over the starting point and orient 0˚with true north.

ii) Draw a line on the map from the starting point towards the destination.

iii) Read the bearing where the line intersects the protractor. Remember that line is the direction of travel to your destination.

Application Activity 2.2

Study the illustration shown below and answer the questions that follow.



Source: http://www.cimt.org.uk/projects/mepres/book8/bk8i11/bk8_11i3.htm

Determine the bearing of:

a) The Beach from the Tower.

b) The Tower from the Church.

b) The Mine from the Tower.

c) What is the direction of the church from the Quay?

2.3: Measure the distance on the maps: straight line and curved line

Learning activity 2.3

Read this conversation between Paul and Sarah students in S1 A and answer the questions:

Paul: Let us visit my uncle at Kayonza district.

Sarah: Can we walk from GS St Aloys Rwamagana to Kayonza?

Paul: I don't know, let us look at our map. It has a ratio scale of 1:50 000. On the map, it is about 30 cm from our school to Kayonza district.

Using your map reading skills that you have acquired in your previous studies:

a) Calculate the actual distance on the ground

b Can Sarah and Paul walk within two hours from GS St Aloys Rwamagana to Kayonza? Support your answer.

A map is a representation of the actual ground on a piece of paper. It is usually drawn to scale. Distance on the map is measured between two points, e.g. between a school and the museum or any other feature. Then, the distance measured on the map is converted into the actual distance on the ground. The distances can either be straight or curved. To measure the distance requires:

- To identify the two places and then calculate the length between them in either centimetres or millimetres;

- To convert the length into the units required such as Kilometres or miles of the actual area (ground) referring to the map scale.

A map scale refers to the relationship (or ratio) between distance on a map and the corresponding distance on the actual ground. The map scale tells you about the comparative size of features and distances displayed on the map.

The following methods show how distance can be measured.

2.3.1. Straight line distance

The shortest distance between two points is sometimes known as "the crow flies'.

- Use a ruler and measure the distance between two points in centimeters.

- Convert the centimeter reading to kilometers by multiplying by 0.5 km if the map scale is (1:50 000) to obtain the kilometers on the ground.

- For example, the distance as the crow flies from A to B is 9.5 cm on a map; therefore 9.5 cm x 0,5 km = 4.75 km on the ground.

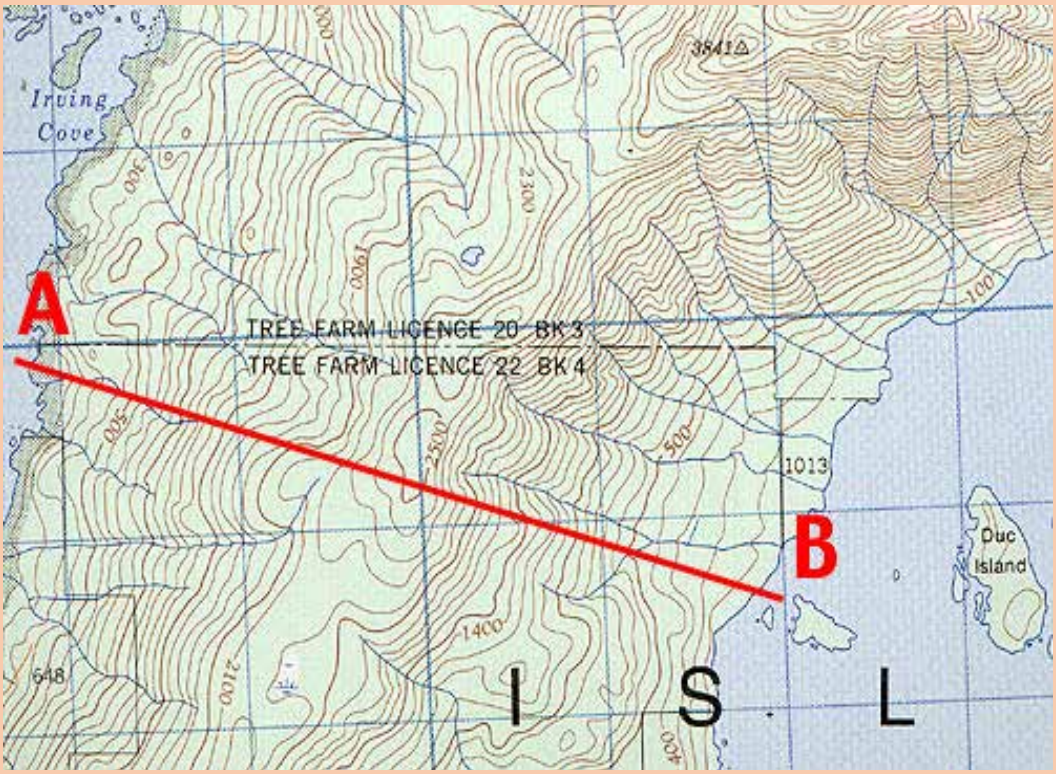
2.3.2 Curved Distances

In map reading, there are times when curved or straight areas are used while determining the distance. Below are the explanations of how curved distances can be determined or calculated:

- Place the straight edge of paper along the feature to be measured e.g. road;
- Make a mark where the paper intersects the road;
- Hold the paper steadily with the point of a pair of dividers.
- Rotate or swivel paper following the line/road being measured.
- Mark where paper insects with the line/road.
- Write down the reading after measuring the line/ road.
- Check the scale of the map.
- Now multiply the distance between the two points by the scale on the map.
- The answer above needs to be converted to the unit for the actual ground distances (km).

Application activity2.3

Observe carefully the map provided below and calculate the distance from A to B using the scale of 1:50 000



NB – An alternative method is where a piece of string is used to measure the curved / winding line. Make sure that the string is not elastic.

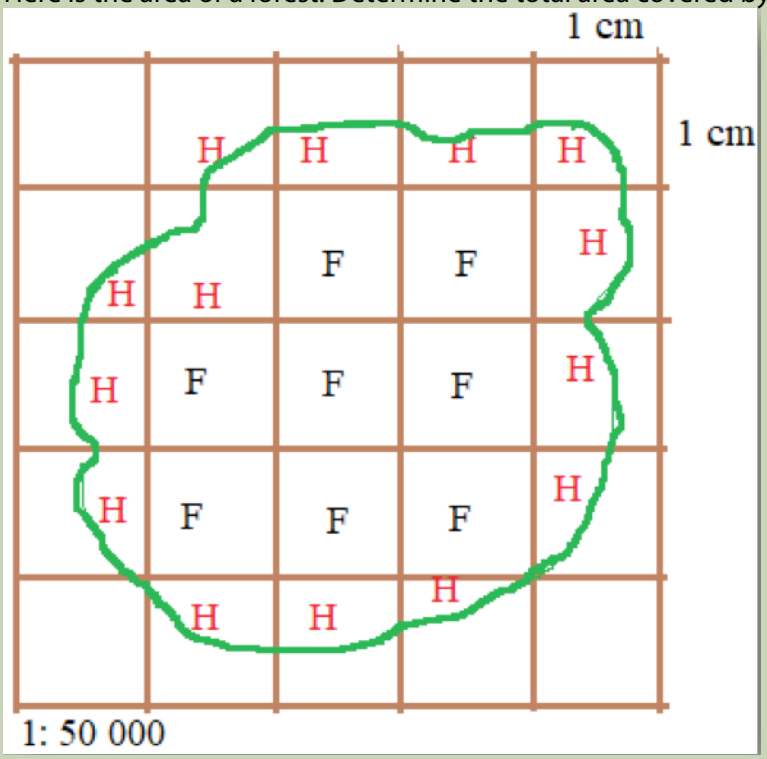
Formula: Actual Distance on the ground = Map distance/Scale.

Source: http://www.juddtrump.com/index-contour

2.4. Calculate the areas on topographic maps: regular and irregular shape

Learning activity 2.4

1. Here is the area of a forest. Determine the total area covered by a fores



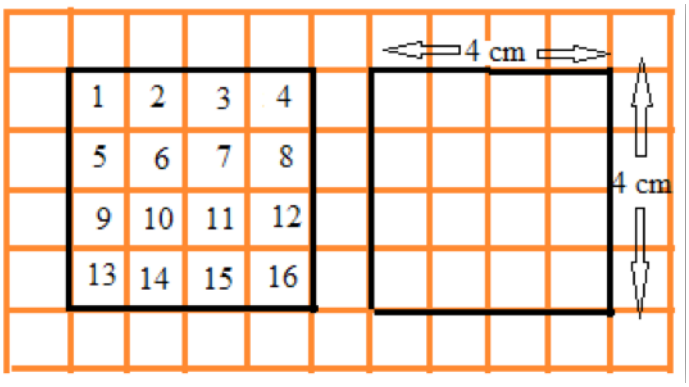
2. Identify methods used to calculate features of regular shape on the map

An area is calculated to determine the actual (size on the ground) of a feature / region / demarcated area. The area of a feature can be regular or irregular in shape.)

2.4.1. Calculate areas of regular shapes

Getting the area of a regular body on maps is simple. This is because the body may be a square, rectangle, triangle or a circle. Once the distances are obtained, the formulae used in mathematics are used.

- Square and rectangle: multiply the length by the width.
- Triangle: half base multiplied by height.
- Circle: Pi multiplied by square of radius.



Area = 16 cm2 *Area= 4×4 = 16 cm2*

Figure 2. 35. Squared figure measurement

2.4.2. Calculate areas of irregular shapes

The following methods are used to calculate the irregular shapes:

a. The use of grid squares

On topographical maps of the scale 1:50,000, there are grid squares measuring 2 cm by 2 cm. On the ground, these measure 1 km by 1 km. This means that they have an area of 1 km2. To calculate the area of irregular shapes, the following steps are done:

- Count all the full squares inside the irregular body.
- Count all the half squares inside the irregular body
- and divide them by two.
- Add the total of the full squares and the half squares.

For example,

Formula: $Sum\ of\ whole\ squares + (sum\ of\ partial\ squares \div 2)\ X\ map\ scale$

Full squares= 20

Half Squares=26

Get 26 halves divide by 2 =13 full squares

20 +13=33 full squares X the area of one square

33 x1 square km

=33 km Squared.

b. The use of strip method

Here, strips of equal width are drawn on the irregular body. The length of the strips differs from strip to strip. Follow the method used to find the area of regular shapes. Calculate the area of each strip. Add the areas of the various strips. This gives you the area of the irregular shape.

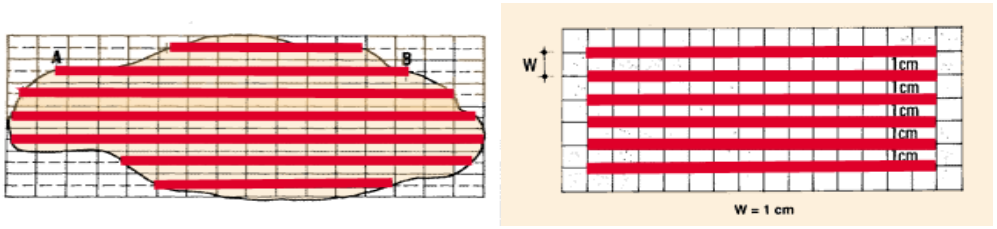


Figure 2. 35. Calculating an area using the strip method

c. Use of rectangles and triangles

The irregular body is divided into a rectangle and triangles as shown below. Their measurements are taken. The formula for finding the area are used (known). Then get the totals of these areas.

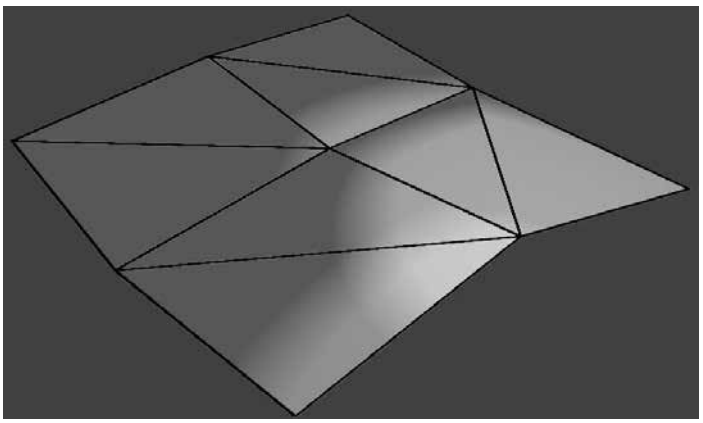


Figure 2. 36. Calculating an area using rectangles and triangles

Application activity 2.4

Using your knowledge, identify how you can calculate the area of a farm if the measurement got are 45 m length, and 34 m width.

2.5: Representation of relief on the map

Learning activity 2.5

Look at the maps below and answer the following questions:

1. What is a relief?
2. Give difference between elevation and height
3. Identify different methods to represent relief features on the map

Source: https://www.worldmapsonline.com/europe-raised-relief-map.htm

Source: http://www.vidiani.com/large-detailed-relief-map-of-rwanda/

The surface of the earth is not flat. It has such features as mountains, valleys, gullies, hills, plateaus and plains. In Geography, this form of landscape is called relief. In other words, relief is the general appearance of the land's surface. It does not include the aspects covered in human geography. The following are the most common techniques used to represent relief features:

2.5.1. Altitude

Altitude is the height above sea level. It is the height of a point in relation to the seal level.

Elevation is the vertical distance above the sea level while Height is the vertical distance from the base to the top. The figure below shows how relief is determined.

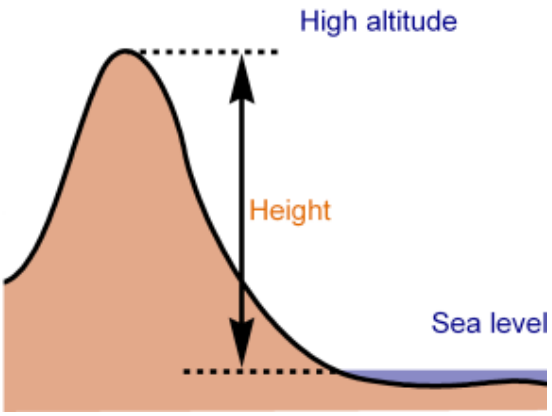


Figure 2.37. The altitude of a given area

2.5.2. Contours

a. Contour lines

Contours are lines that join places of the same height above the sea level. A contour is represented in brown lines on the topographical maps. The height of the contour is indicated on each contour line. The difference between one contour line and the next is called contour interval.

If only certain contours are numbered, one must find how many contours lie between the numbered contours and work out the contour interval. A contour interval is given on the legend on the topographical maps. From the below illustration, the contour interval is 20 m.

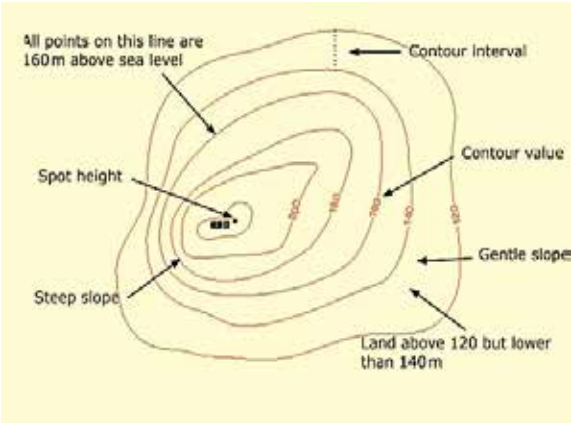


Figure 2. 38. Contour lines

b. Uses of contours and identifying the shape created by the patterns of contours

i. Contours help to recognize land features

By recognizing land features, we understand our natural environment. This is useful and helpful for a wide range of activities including:

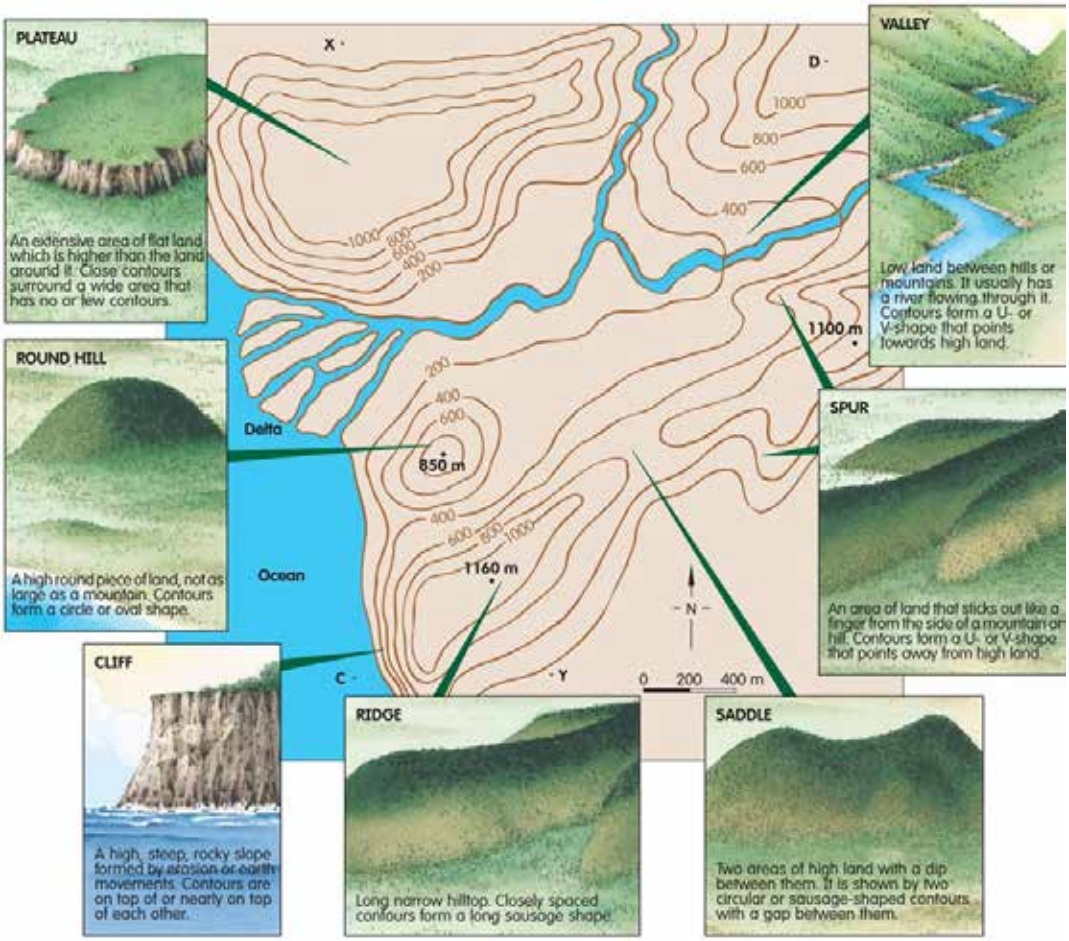
- Planning housing estates, freeway routes and reservoirs;
- Organizing outdoor recreational pursuits;
- Managing hazards such as flooding, landsides, etc.

ii. Contours help to recognize the shape of the land

By reading the contour lines an understanding of the shape of the land is obtained. Land features are identified from the contour lines as follow:

- spacing (density) of the contours indicates the slope (gradient) of the land;
- contour lines that are close together denote steep slopes;
- contour lines that are far apart denote gentle slopes;
- when there are no contour lines, it means the land is almost flat;
- when the contour lines spaced further apart as the height of the slope increases, the
- Slope is convex; when the contour lines spaced closer together as the height of the slope increases, the slope is concave (broad spacing to narrow spacing).

iii. Recognizing land features on a map involves identifying the shape created by the patterns of contours



Source: http://sskalski2014.weebly.com/recognising-landforms.html

Figure 2.39. Patterns of contour lines

2.5.3. Hill shading

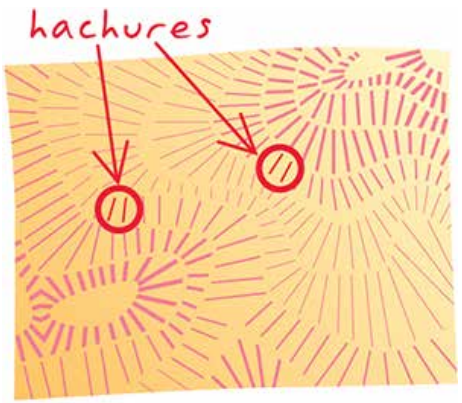
Hill shading is the method of adding light and dark area or shading to a map to highlight the location of hills or mountains. When light is shone from a given direction, areas with steep slopes are hidden. Such parts can be clearly shown by shading. The thickness of the shade depends on how steep the slope is. Steep relief has darker shading compared to gentle slopes. This method does not show the exact height of the relief feature. Refer to the figure below.

Source: https://www.berniejenny.info/terrain/

Figure 2.40. A shaded relief

2.5.4. Hachures

Hachures are short lines on a map that indicate the direction and steepness of a slope. Hachures that represent steep slopes are short and close together while hachures that represent gentle slopes are longer, lighter, and farther apart.



Source:https://www.suport.esri.com/en/other-resources/gis-dictionary/term/5952b013-599e-4a34-9903-80eee0bff14b Figure 2.41. Hachures structure

2.5.5. Pictorial representation

In this method, certain symbols are used to show relief on maps. It does not give the heights above sea level. Only a small variety of landforms can be shown using it. The pictures may further hide important details. See the figure below.

Figure 2.42. Pictorial representation

2.5.6. Colouring/ Layer Tinting

Colouring or layer tinting is a method of showing relief by colour. A different colour is used for each band of elevation. Each shade of colour or band, represents a definite elevation range. A legend is printed on the map margin to indicate the elevation range represented by each colour. However, this method does not allow the map user to determine the exact elevation of a specific point; only the range is identified.

Source:https://www.123rf.com/photo_10768866_cambodia-shaded-relief-map-colored-according-to-elevation-with-major-urban-areas-includes-clip-path-.html

Figure 2.43. Colored relief

Application activity 2.5

Make your own research and find an extract of the topographic map of Rwanda, and describe its relief basing on different representation signs used.

2.6. Calculation of the vertical interval and the amplitude of relief /spot heights

Learning activity 2.6

What is the vertical interval on this map?

Identify the steps to carry out the vertical interval.

2.6.1. Vertical interval and amplitude of relief

The dark lines with reading are index contour lines while thin lines represent intermediate contours. The difference in height or altitude between two places is known as the vertical rise or the vertical interval (V.I.).

How to calculate the vertical interval?

There are several steps that are followed when the vertical interval is being determined. These include the following:

2. Locate 2 index contour lines that are labeled with a specific elevation.
3. Now calculate the difference between the two-selected index contour line selected from a map. To take the difference, subtract the higher elevated line with the lower elevated line reading.
4. Now count the number of non-index lines contour lines between the 2 index contour lines selected for the contour interval calculating in the 1st step.
5. The number of lines obtained in the above step is taken and added with 1. For example: if the number of lines between 2 index lines are 4. Then add 1 to 4 that becomes 5.

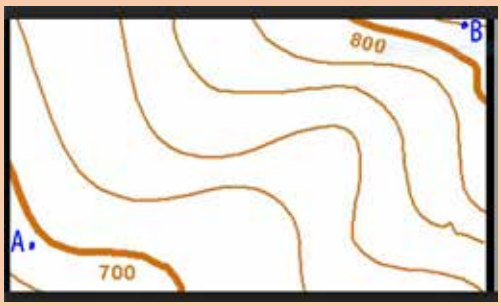
6. The final step is the measure of the difference between 2 index lines (step 2) and the number of lines in between two index lines plus 1 (step 4).
7. The final answer we get after dividing is the contour interval of the specific topographical map.

2.6.2. Spot heights and trigonometrical stations

A spot height is shown as a dot and the actual height in metres. Spot heights are mainly used where drawing of complete contours is difficult. This happens on such features as mountain peaks and hilltops. Trigonometrical stations are also known as triangulation points. Surveyors mark those using triangles or circles with a dot at the centre.

Application activity 2.6

Study and analyze the map below and answer this question: suppose that you have to walk from a place A to B, Calculate the vertical interval between the two places.

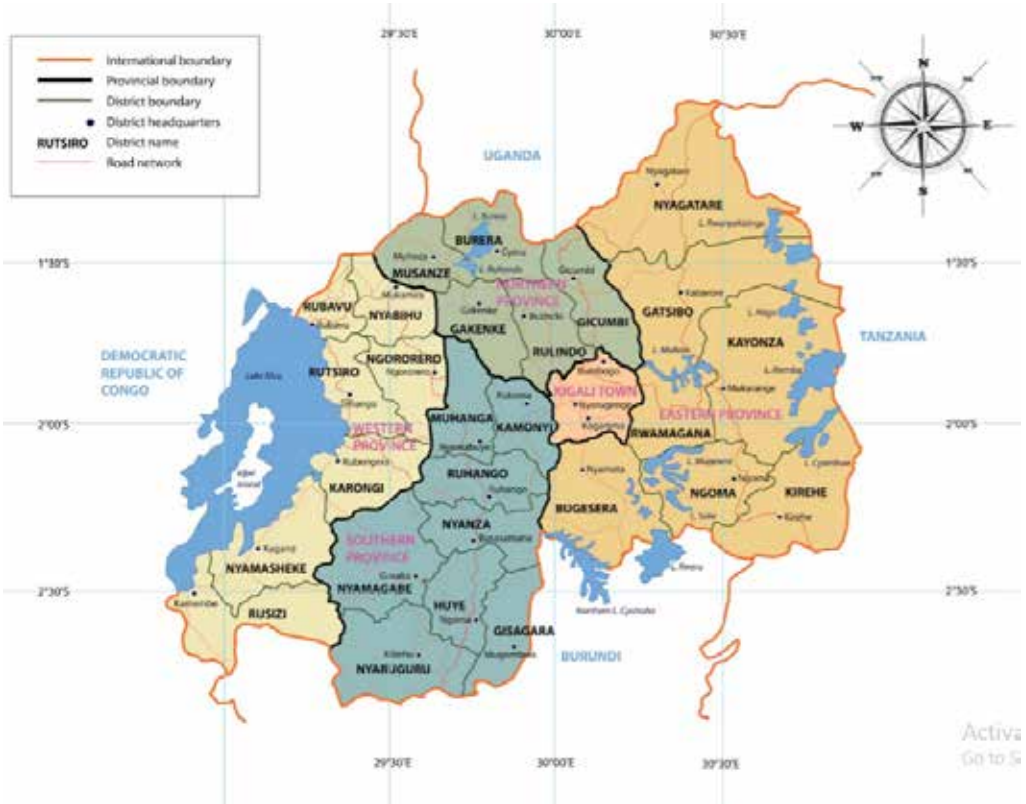


End unit assessment

Mugisha and Mucyo are traders in Kigali and they export goods made in Rwanda and import some missing commodities not locally produced. Sometimes goods delay as they are being transported from Mombasa port. Suppose you want to travel with these traders, explain how you would use a map to find out the distance from Kigali to Mombasa.

Imagine someone comes from Europe to visit Rwanda, specifically in Muhoza sector, Musanze district (see the map below). At Kigali airport someone gives him a map with a scale of 1:50 000. He/ she needs to know the bearing of Muhoza from Kigali.

1. Show how you would find the bearing of Muhoza if this visitor asked for guidance.
2. What is the relative position of Muhoza from Kigali?
3. Basing on your general knowledge describe physical features that make Musanze to be known and hence attracting many people all over the world. In addition, explain the environmental hazards that use to happen in its area of northern part of Rwanda.



Source: https://www.tes.com/teaching-resource/map-skills-resources-11280466

UNIT 3

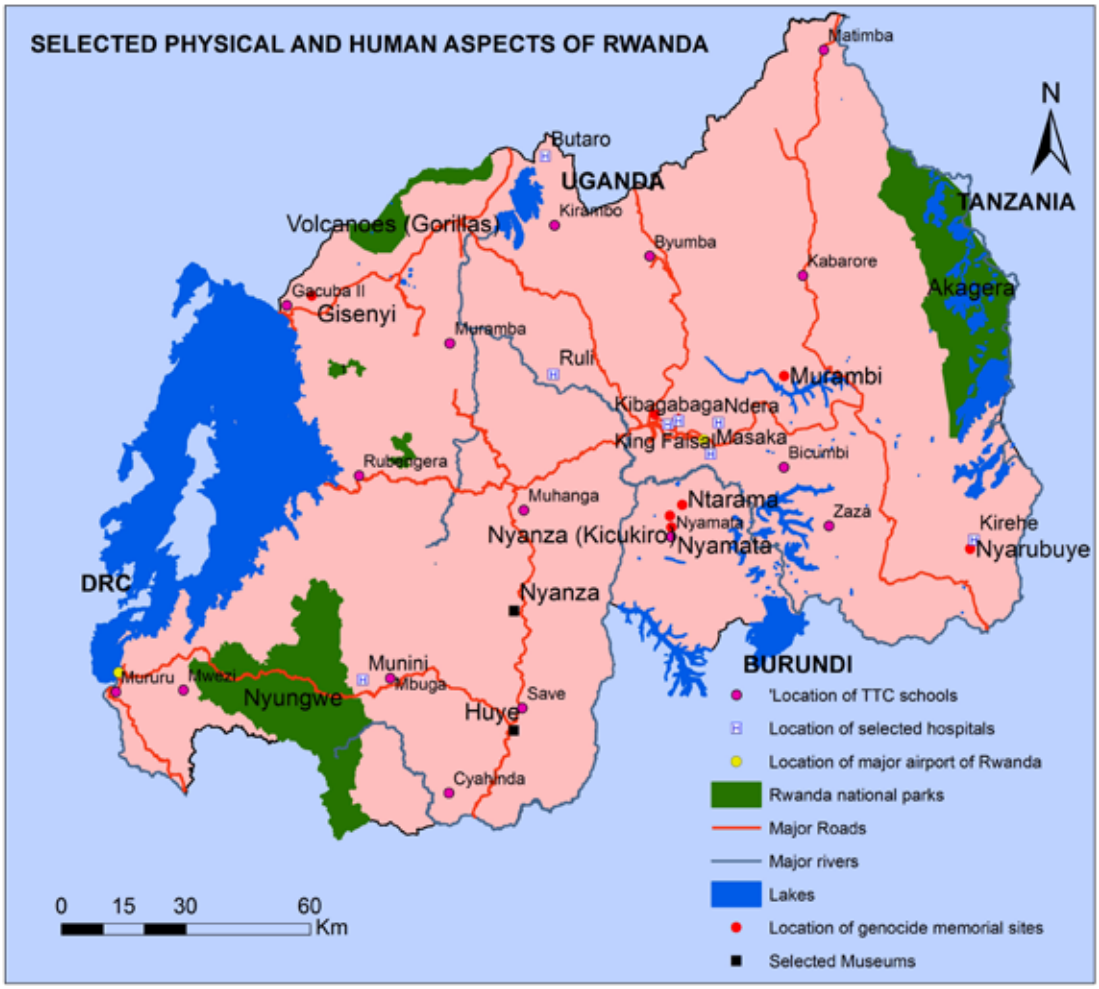
MAP WORK INTERPRETATION

UNIT 3: MAP WORK INTERPRETATION

Key unit competence

By the end of this unit, I should be able to explain the relationship between the physical and human activities on maps

Introductory activity:



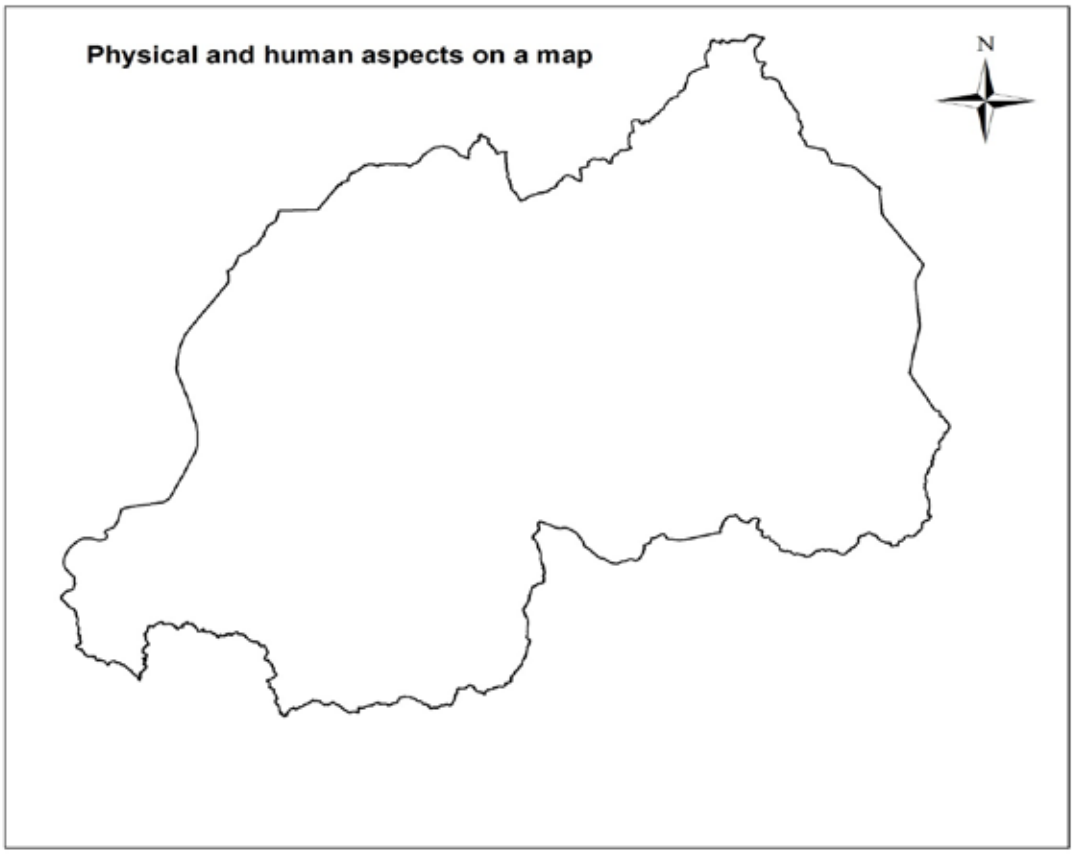
A map is a representation of all or part of existing things on the earth surface on a flat surface. A photograph is a picture of an object or environment taken by a camera at a particular time in a given place. Maps and photographs represent both physical and human features. The aspects represented on map/photographs are shown using several types of signs and symbols. This helps map /photograph users to extract the needed information from a given map /photograph.

Referring to the map above and the definition above;

a. Identify the main physical features represented on the map.

b. Identify the human features represented on the map.

c. Use the following map to represent approximately the same features as those represented on the map above.



d. Take a photograph of the environment around your school and then identify all physical and human aspects taken on that photograph.

3.1. Interpretation of physical aspects from maps/photographs

Activity: 3.1

Make a research on:

a. The major physical aspects which may be represented on a map/ photograph.

b. The signs and symbols which may be used to represent physical features on a map/photograph.

Physical features are also called natural features. They include the following:

- Relief which comprises rocks, slopes, soils, valleys, plains, plateau, hills and mountains.
- Drainage features like rivers, dams, lakes, seas and oceans.
- Vegetation cover like forests made of several types of trees, crops and ground vegetation, wetland vegetation.
- Climate which is defined through various parameters like rainfall, temperatures, relative humidity, cloud cover, wind speed and direction, atmospheric pressure, sun shine.

The following are the most commonly used methods to represent the selected physical features:

3.1.1. Interpretation of geological features

The main geological features commonly represented on a map/photography include rocks, cliffs and boulders.

- A rock is a solid matter which is found on the surface or in the interior of the earth.
- A cliff is a vertical or nearly vertical rock face in mountainous and hilly areas. Cliffs are found along the shores of lakes and seas. Cliffs and rocks are shown on topographical maps using contours that are close to each other. Boulders are large pieces of rock. They indicate weathering and mass wasting taking place on the cliff.
- Flat rocks show the eroded and exposed rock on the seabed where the shore is shallow or found the bed of a river or within the dry valley.
- A crater is a bowl-shaped depression, or hollowed-out area, produced by the impact of a meteorite, volcanic activity, or an explosion.
- A quarry is a place from which dimension stone, rock, construction aggregate, riprap, sand, gravel, or slate has been excavated from the ground. A quarry

appears like a place where open cast mining is practiced.

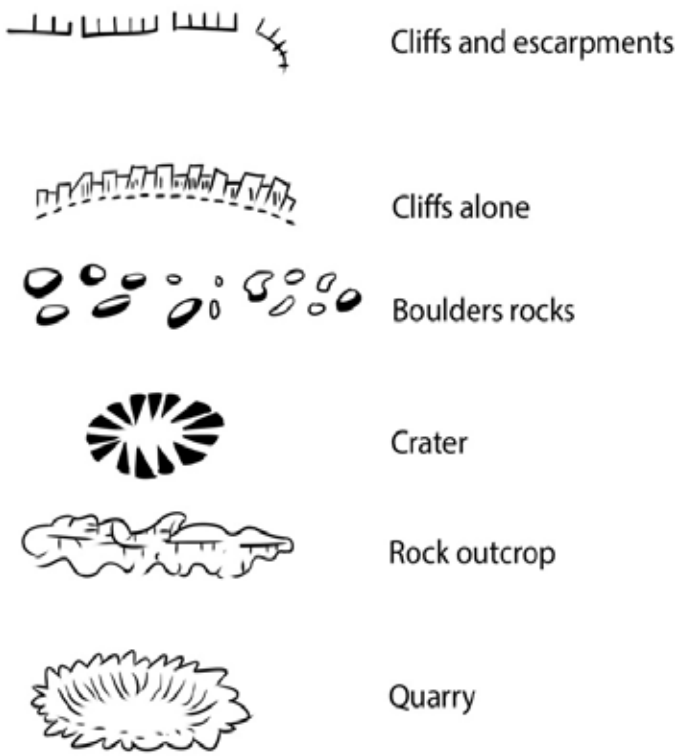


Figure: 3.44. Cliff, rock and boulders

3.1.2. Interpretation of slopes from a map/photograph

The slopes are classified according to their inclination, constancy or shape. The slopes are represented on the map by help of contours. Contours are lines on a map linking places of the same height above the sea level. They are drawn at fixed intervals, known as vertical interval or VI.

Contours are labeled from the lowest to the highest. Where they are too close to each other, the relief is steep. Where they are far apart, the land may be a plain or a plateau. The main types of slopes are: gentle, steep, regular, irregular, convex and concave slopes.

- **Gentle slopes**: Spaced contours are used to indicate gentle slopes. In that case the land may be a plain or plateau.
- **Steep slopes**: Very close contours are used for steep slopes. The closer the contours, the steeper the slope. In that case the landform may be a mountain.

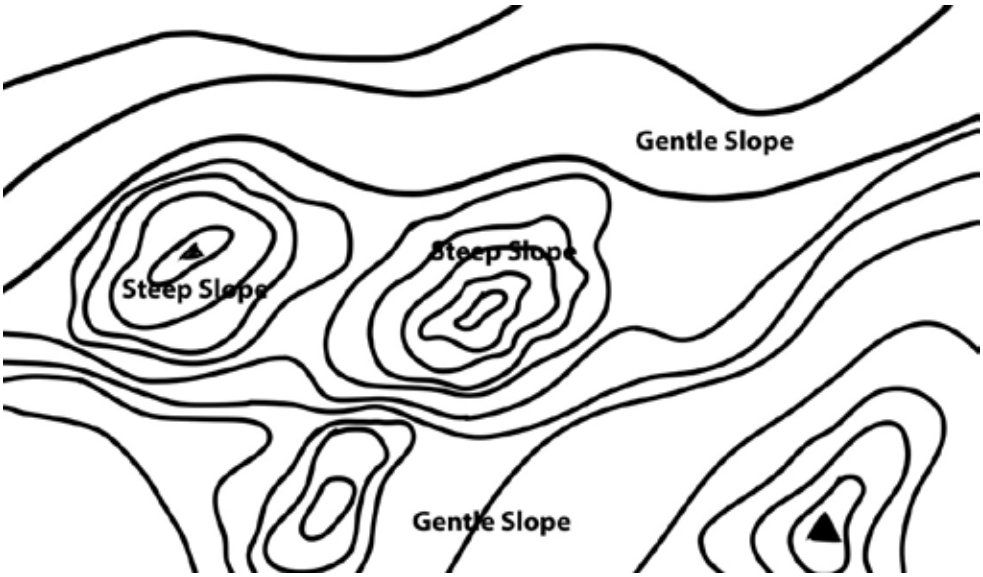


Figure 3. 45 Contours representing gentle and steep slopes

- **Regular slopes:** Regular slopes are also called constant or even slopes. The contours have constant spaces. The slopes can be either gentle or steep slopes.
- **Irregular slopes:** These are uneven or inconstant slopes. They are represented by unequally spaced contours. They can be either gentle or steep slopes. These slopes are found mostly in rugged, mountainous or hilly areas.

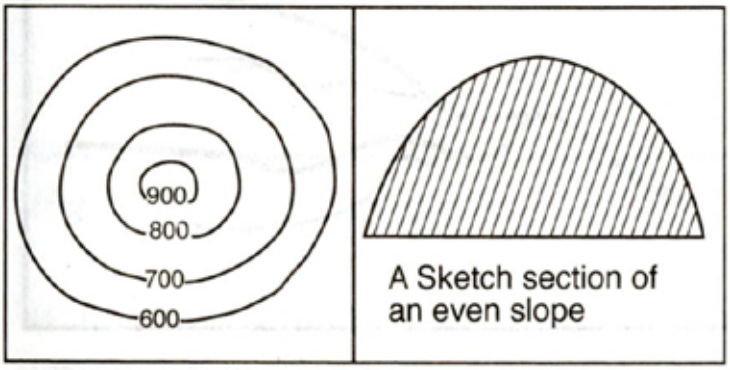


Figure 3. 46. Contours representing by irregular and regular slopes on a sketch section

- **Concave slopes:** They indicate that the land is steeper on the upper part and gentler on the lower part. They are drawn using closely packed contours on the upper part of where the slope is steep. The contours are widely spaced on the lower part where the slope is gentle.

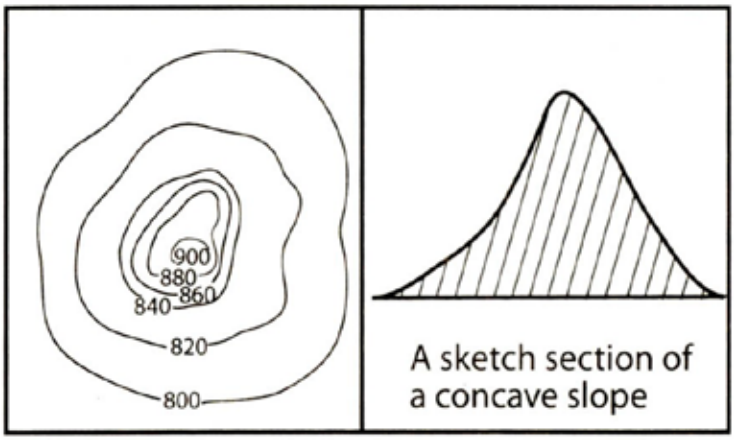


Figure 3.47. Contours representing a concave slope and a sketch of a concave slope

– **Convex slopes:** Convex slopes are gentle at the top and steep at the bottom of the hill or mountain. The contours are closely spaced at the bottom section (steep slopes) and widely spaced at the top section (gentle slopes).

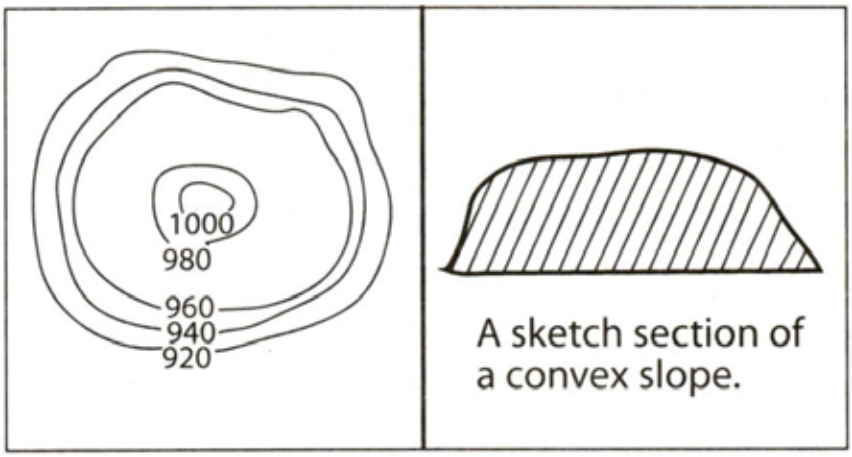


Figure 3.48. Contours representing convex slopes and sketch of a convex slope

3.1.3. Interpretation of drainage and landforms from a map/photograph

i. Interpretation of drainage features from a map/photograph

The lake, sea and ocean occupy a very large area. They are seen in blue color on a color photograph and in dark color on black and white photograph. However other conventional symbols may be applied on a map to represent a lake, sea and ocean; the most important thing is to put in legend/key the used symbols.

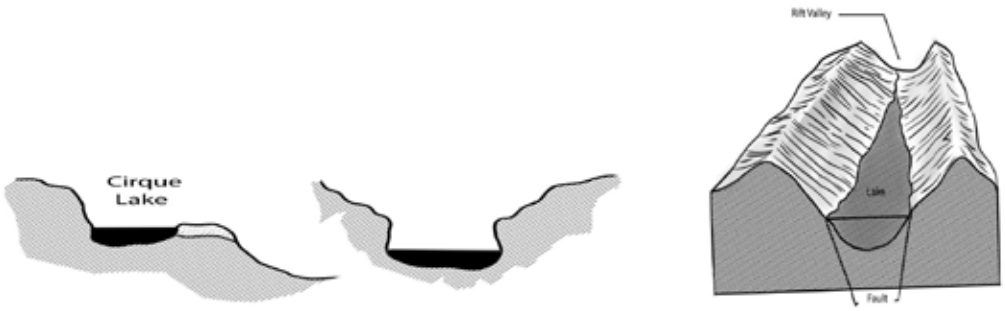


Figure 3.49. Examples of a representation of a lake

The rivers originate from mountains or hills and flows on steep slope to end in the depression that are usually found in valleys or low-lying areas. The streams and rivers are seen on a photograph/map as lines and they have different patterns or arrangements which can be detected easily on a map or photograph.

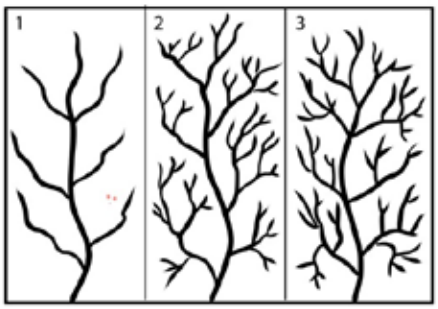


Figure 3.50. Examples of river patterns

ii. Interpretation of landforms:

– **Valley**: A valley is an elongated depression sloping towards a drainage basin like a sea, lake or swamp and which may contain water or not. The valley is normally represented on a topographic map by using the contours having "V shape".

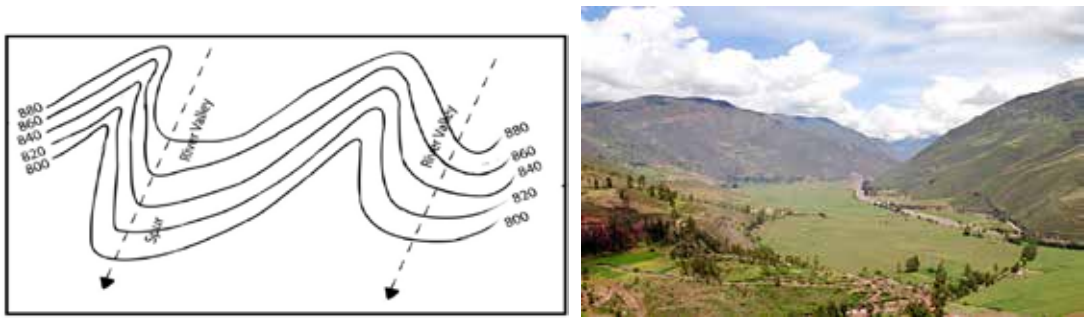


Figure 3.51. A valley passed by a river on a topographic map and a photograph of a valley

– **Plain:** Most of the plains are in low-lying areas but some of them may be raised but the slopes remain gentle. On the topographical maps, a plain is represented by widely spaced contours. The river passing in plain areas may also be shown on the map.

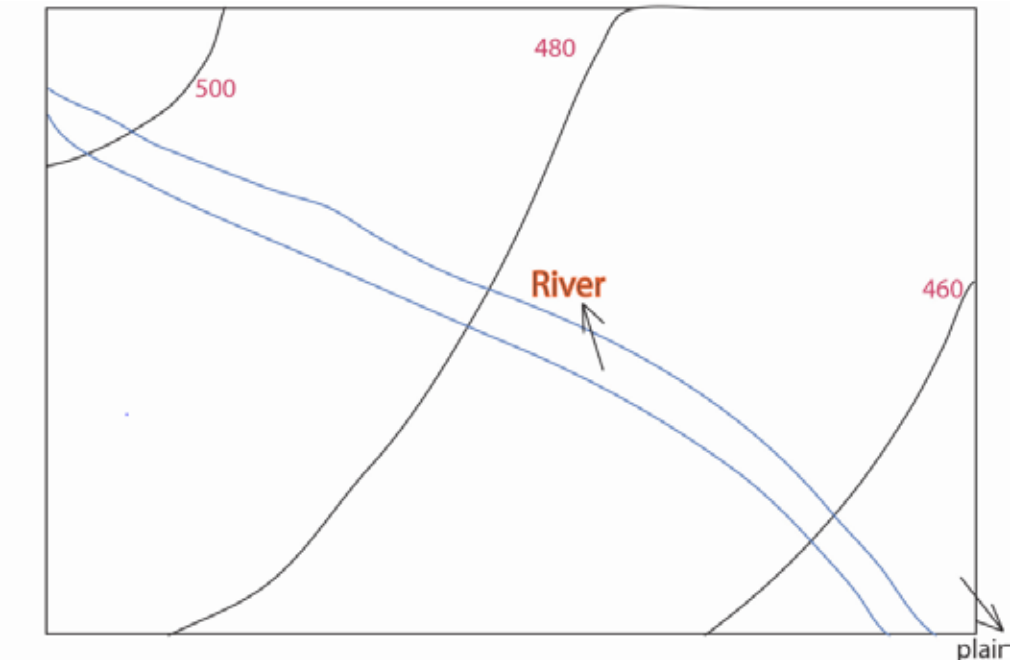


Figure 3.52. A plain on a topographic map

Figure 3.53. A photograph of a plain

– **Plateau**: A plateau is an extended landform which is bordered by steep slopes. On the map, a plateau is shown as a wide area surrounded by one or two contours having the same height on both sides.

Figure 3.54. Contours showing a plateau and a photograph of a plateau

– **Mountain**: A mountain is an extended landform with steep slopes. On the map, a mountain is shown as a wide area with very close contours surrounded by one or two wider contours showing the depression areas surrounding the mountain.

Figure 3.55. Contours showing a mountain and a photograph of a mountain

3.1.4. Interpretation of soils on the map

Assorted colours or symbols are used to show several types of soils on a topographic map. Tiny brown dots called stipples are used to represent a surface covered by sand or mud. The types of soil can be also shown by help of dots having varied sizes according to the texture of the soil. The types of soils can be differentiated on a photograph based on their texture (sizes) and color. Surfaces covered by lava flows are shown by symbols that look like inverted V'S.

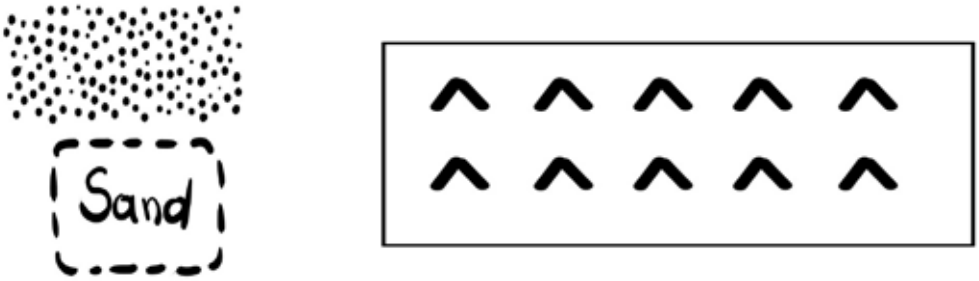


Figure 3.56. Sand or shifting sand and Symbols showing lava surfaces

Application activity: 3.1

a. Identify the physical features in area where you live and describe how they are represented on a topographic map.

b. Draw a sketch of your home area on it name and mark the physical features identified in (a) above.

c. Suggest ways through which the above features can be protected and conserved.

3.2. Interpretation of human aspects on maps

Learning activity: 3.2

Make a research on:

a. The major human aspects which may be represented on a map/ photograph.

b. The signs and symbols which may be used to represent human features on a map/photograph.

Human aspects on a map reflect human activities of a given area represented on a map. These include agricultural development, mining, industry, settlement, etc.

3.2.1. Agricultural activities

Crop plantations are drawn on a topographical map by using light-green shading. A letter may be used over the shade to indicate the name of the crop growing in each area. For example, C for coffee; T for tea.

Figure 3. 57. Symbol for Coffee (CC) and Tea (TT) plantation

Several types of crops may be taken on a photograph and be identified based on their shapes, sizes and colors.

Figure 3.58. Crops in the field

3.2.2. Mining and quarrying activities from a map

Mining refers to all the processes by which minerals are obtained from the earth's crust. Minerals may be in gaseous, liquid or solid form. Quarrying is the digging of stones, sand or soil from the ground. These are used, for example, in construction. Mining and quarrying activities on a map are shown by symbols as represented on the figure below. The mining activities may be taken on a photograph and different types of minerals/quarries may be differentiated based on their colors.

Figure 3. 59. Mining area, quarrying and machine in mining activities

3.2.3. Industrial areas

Industrial area is a geographically localized set of specific industries. Such areas are subject to important production, marketing and other interrelationships.

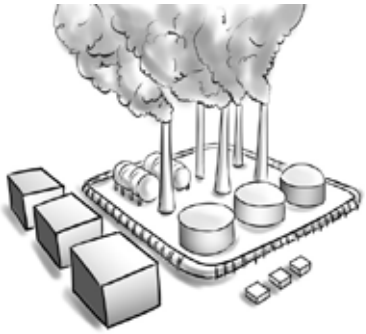


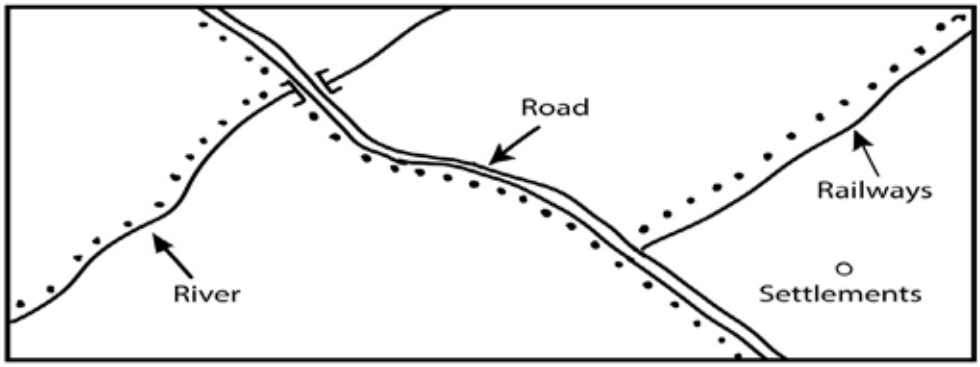
Figure 3.60. Industrial areas

3.2.4. Settlements

Settlement refers to a place where people live. It also means the process of settling in such a place. Settlement on the map can be shown by dots or rectangles which may be black or grey in colour. Dots indicate rural semi-permanent settlements while rectangles show permanent buildings like those built of stone or bricks, with iron or tile roofing.

The dots or rectangles are spaced in relation to the concentration of settlement. Nucleated settlements are represented by the dots and rectangles close to one another while they are much spaced for scattered settlement.

The settlement is also represented according to its shape, for example ring or linear. The shapes of settlement may be influenced by communication networks like roads, railways, landforms like valley, plain, plateau, mountain among others.



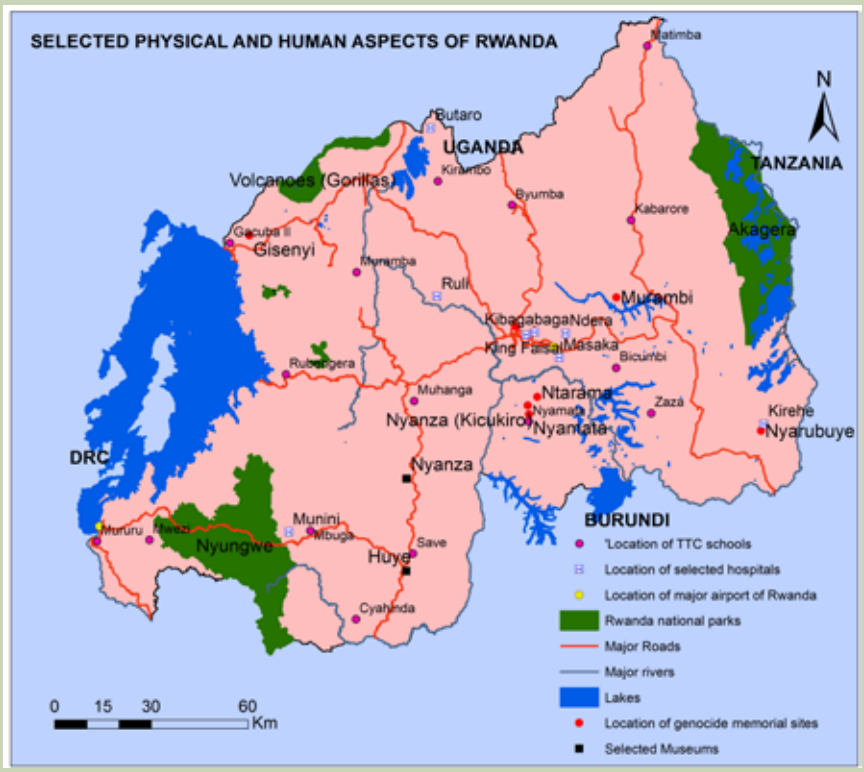
Application activity:3.2

1. Use a photograph/map to identify and describe mining/quarrying areas.
2. Visit the nearest mining/quarrying areas and represent them on sketch map using appropriate signs and symbols.

3.3. Relationship between physical and human aspects on maps photographs

Learning activity: 3.3

The following map represents both physical and human aspects which are interrelated.



In reference to the map above and the knowledge acquired from the influence of relief on the human activities; answer the following questions:

a. Identify the existing relationships between main physical and human features represented on the map.

b. Discuss the existing relationships between main physical and human features available in the environment around your school and your village.

Physical aspect of an area plays a key role in the activities people do. It also has an influence on the number of people who settle in an area. For instance, the relief affects human activities in the following ways:

– Mountainous places are less populated because of steep slopes being unfavorable for settlement and for mechanized agriculture. Such landscape

makes the establishment of social facilities (hospitals, schools, shopping centers) in such places to be difficult.

- Places that are poorly drained like swamps and marshes are also not suitable for settlement.
- Some plains and plateaus have good soils. These allow growing of crops and keeping of livestock. It is also possible to use machines in farming. There is no need to make terraces to stop soil erosion. Therefore, more food is produced, and more people live there.
- The depressions or valleys areas are also suitable for agriculture.
- Fishing is done in seas, oceans and lakes.

3.3.1. Drainage patterns

A drainage pattern is a network formed by rivers and their tributaries on the landscape. The development of the drainage patterns is influenced by the gradient of the slope, nature of the bedrock in terms of hardness, structure of the basement rock. The drainage pattern can also result from human activities which may change the original patterns. Man's activities that have direct impact on the drainage pattern include agriculture, industries, settlements, dam construction, etc.

The main drainage patterns which can be seen on a topographic map/photograph are as follows:

- **Trellised drainage pattern**: Such patterns are developed in simple folds characterized by parallel anticlinal ridges alternated by parallel synclinal valleys.
- **Dendritic drainage pattern:** The dendritic pattern is associated with the areas of similar lithology, horizontal or very gently dipping strata, and rolling extensive topographic surface having extremely low reliefs.

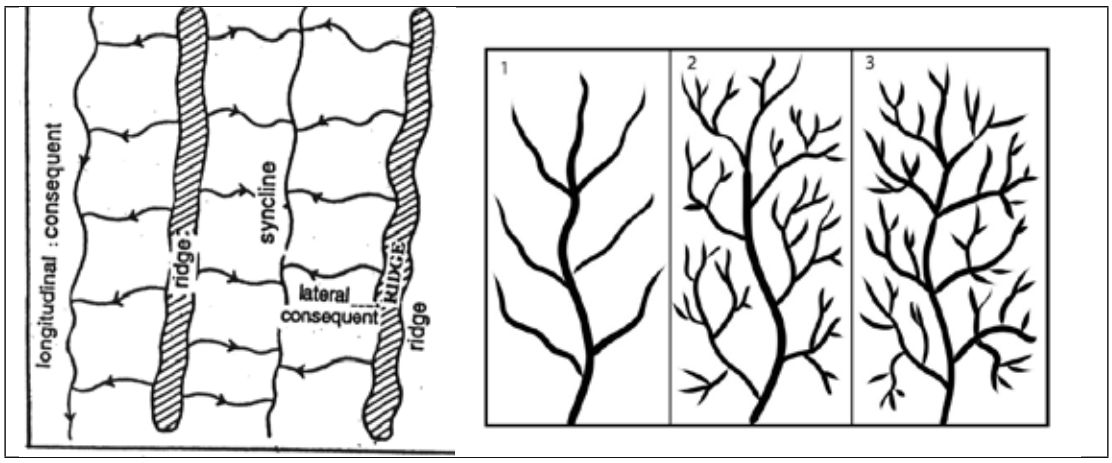


Figure 3.62. Trellised drainage pattern (left) and dendritic drainage pattern (right)

- **The rectangular drainage pattern** is generally developed in the regions where the rock joints form rectangular pattern. The rocks are weathered and eroded along the interfaces of joints, fractures and faults and thus surface runoff collects in such long and narrow cliffs and forms numerous small rills.
- **Radial drainage pattern** also known as centrifugal pattern is formed by the streams which diverge from a central higher point in all directions.

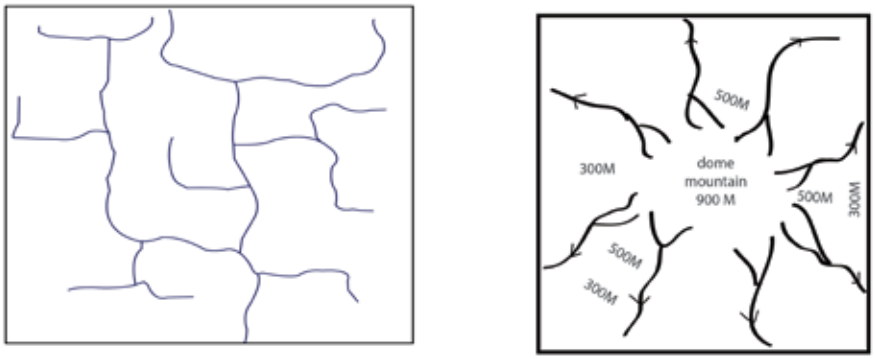


Figure 3. 63. Rectangular drainage pattern (left) and Radial drainage pattern (right)

- **Centripetal drainage pattern:** This pattern is formed by a series of streams which after emerging from surrounding uplands converge in a central lowland which may be a depression/basin/crater lake
- **Annular drainage pattern:** The annular drainage pattern, also known as "circular pattern", is developed over a mature and dissected dome mountain characterized by a series of alternate bands of hard and soft rock beds.

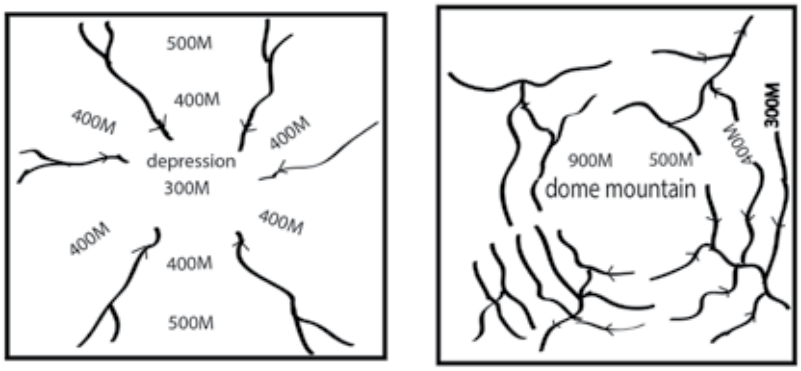


Figure 3. 64. Centripetal drainage pattern (left) and annular drainage pattern (right)

– **Barbed drainage pattern** is formed when the tributaries flow in the opposite direction to their master streams.

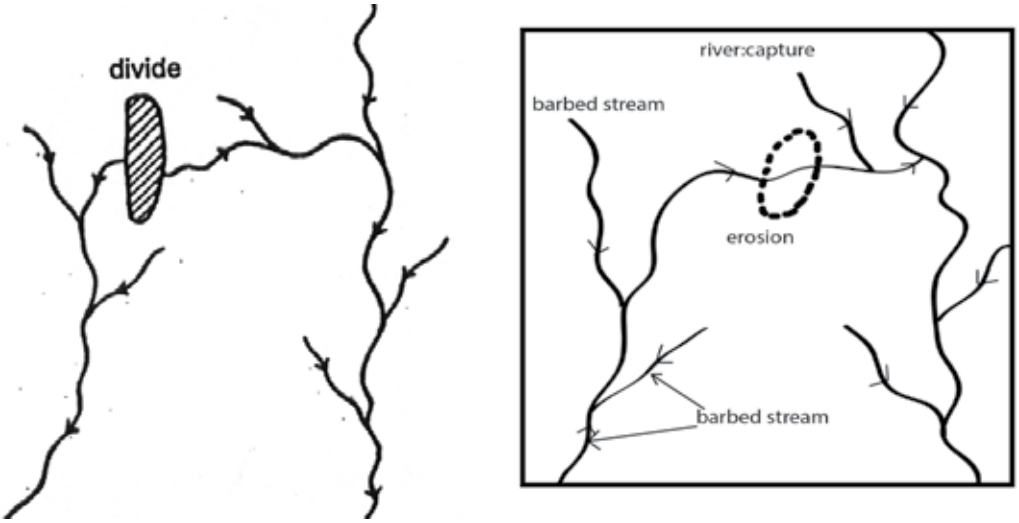


Figure 3. 65. Barbed drainage pattern

– **Pinnate drainage** is developed in a narrow valley banked by steep ranges.

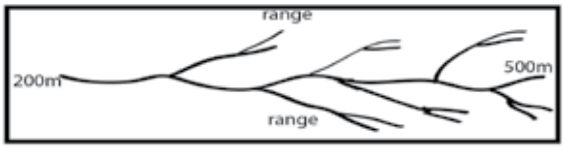


Figure 3. 66. Pinnate drainage pattern

– **Herringbone drainage** pattern also known as rib pattern (like the limbs of human beings) is developed in mountainous areas where broad valleys are flanked by parallel ridges having steep hillside slopes.

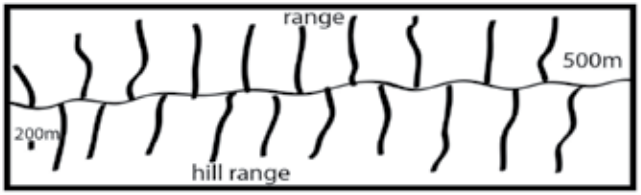


Figure 3.67. Herringbone drainage pattern

– **Parallel drainage patterns** comprise numerous rivers, which are parallel to each other and follow the regional slope. This pattern is more frequently developed on uniformly sloping and dipping rock beds such as cuestas or newly emerged coastal plains.

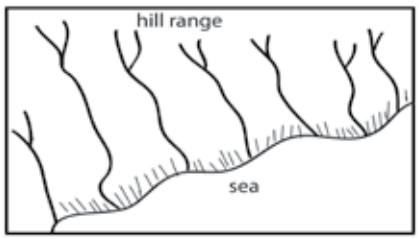


Figure 3.68. Parallel drainage pattern

3.3.2. Settlement patterns

Settlement refers to a place where people live. It also means the process of settling in such a place. The settlement patterns of a given area are influenced by both physical and human factors like topography, road network, community services, cultural and economic factors, etc. This results into several types of settlement patterns as follows:

– **Nucleated settlement**: This refers to the grouping of many houses around a center called nucleus; often around a central feature like a church or a pub. Houses are built close to each other. This type of settlement is mainly influenced by cultural and social factors. For example, the houses in "imidugudu" settlements may have such pattern.

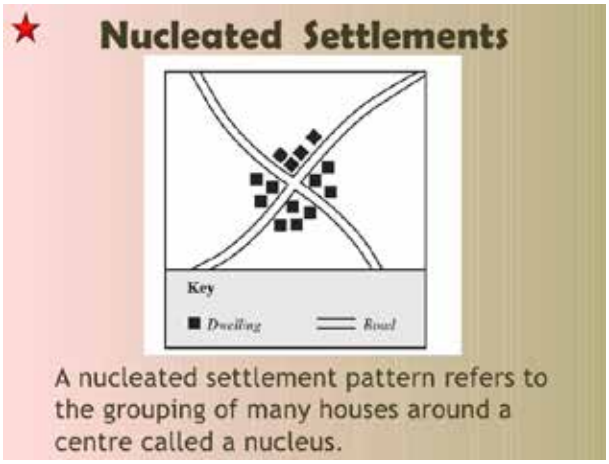


Figure 3.69. Nucleated/Clustered settlements

– **Linear settlement**: This is where houses are well planned. They are built along the road, railway and river or along the coast.

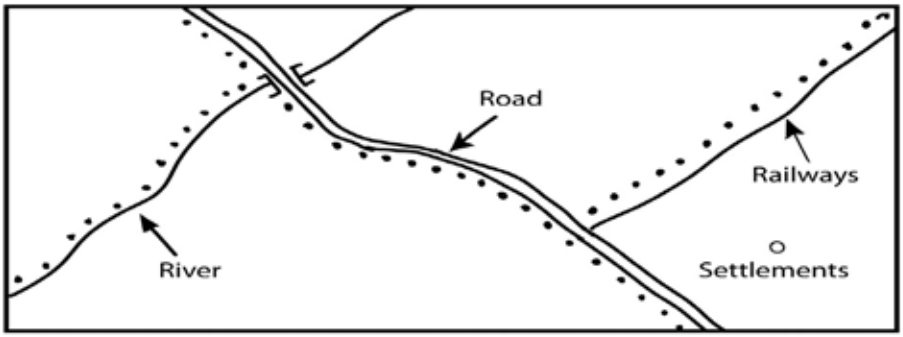


Figure 3. 70. Linear settlement

– **Sparse or scattered or dispersed settlements**: These settlements are associated with houses which spread out over a wide area (houses are built far from each other). They are often the homes of farmers and can be found in rural and mountainous areas.

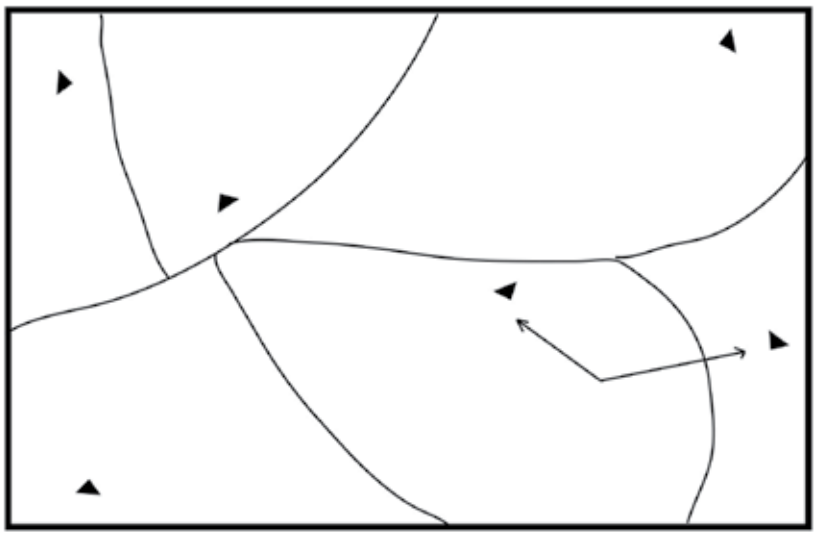


Figure 3.71. Scattered settlements

– **Isolated settlement**: This is where a few people live away from other people. These people could be hunters in a forest.
– **Ring settlement:** In this type of settlements, houses make a circle. There is an open ground at the center.

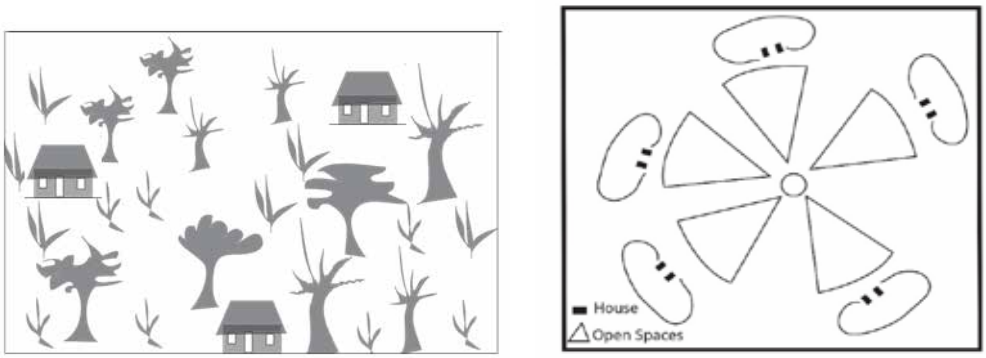


Figure 3.72. Isolated settlements (left) and ring settlement (right)

– **Planned settlement:** This type of settlement is well organized and planned in specific ways as directed for instance by the government.

Source:https://www.google.rw/search?q=planned+settlements+pictures+in+Rwanda&tbm=isch&source

Figure 3.73. Planned settlements

3.3.3. Vegetation

Human activities are related to vegetation. The distribution of vegetation on a photograph/map in each area is linked with human activities taking place in that part/dwelling. Below are some of the examples that show the interrelationship between man and vegetation.

– **In areas with dense forests:** The main activities are timber harvesting. The timber is used to make furniture and paper.

Figure 3.74. Timber harvesting in evergreen forest

– **In savannah grasslands:** the main activities are livestock keeping and agriculture. This is because in these areas soils are fertile.

Figure 3.75. Livestock keeping and agriculture in savannah grasslands

– **Desert vegetation:** Agriculture is only possible in oases. Very few animals can survive in the dry areas like the camels, goats and sheep and reared under nomadic pastoralism.

Figure 3.76. Livestock keeping in desert area

- **In tundra and taiga forests:** The low rainfall and temperature affect human activities. Only hunting, fishing and mining are the main activities done in these regions.

Figure 3.77. Hunting activities in tundra/taiga forest

3.3.4. Communication networks

Communication networks facilitate the movement of people and commodities from one place to another over a given distance. Communication networks may also refer to the physical facilities which help the transmission of information in the form of news and messages. The communication networks represented on map/ photograph are most of time influenced by both physical and human factors. Some of them are discussed below:

- **Relief:** Steep slopes make the construction of roads and railway lines expensive. On the other hand, valleys have swamps; they contain water logged soils that are too soft to allow the movement of heavy objects like trailers, lorries and trains.

Figure 3.78. Construction of roads in swampy and sloppy areas

– **Climate:** Too much rainfall results into floods and landslides and these disturb land transport. On the other hand, accumulation of fog and clouds reduce visibility hence affecting air transport.

Figure 3.79. Landslides blocking the roads an airplane in cloudy sky

– **Vegetation:** Thick vegetation cover makes construction of road and rail networks difficult because it requires uprooting big trunks of trees. Areas with thick vegetation are invested with wild animals that pose danger to the people.

Figure 3.80.Construction of road in dense forest (left)and on a flat area (right)

– **Drainage:** Navigable rivers, lakes, seas and oceans provide natural route-ways used for transportation.

Figure 3.81. A boat in Kivu Lake

– **Topography:** mask towers for communication are usually placed on the top of mountain.

Figure 3.82. mast tower on the top of mountain

– **Economic activities:** The economic activities (mining, agriculture, industries, etc) taking place in given areas influence the construct of communication networks.

Figure 3.83. Road networks in mining areas

Application activity: 3.3

1. Identify several types of communication networks on any map/ photograph.
2. Explain how the identified communication networks are related to physical and human features.
3. Move around your village and identify the existing communication networks and explain their relationships with physical and human features.

End unit assessment

1. "As it is difficult to reach all parts of the world; the photographs and maps help to explore different physical and human features on the earth."
   a. Identify physical features on topographic map of Rwanda.
   b. Identify the human features on thematic maps of Rwanda.
2. Show different signs and symbols to be used in representing physical and human features on maps/photography.
3. Discuss the relationships existing between settlement patterns and physical features in your district and present them on a sketch map using signs and symbols.
4. From the photographs taken at different places in Rwanda, prepare a sketch map of captured physical and human features by using conventional signs and symbols.

UNIT 4

THE UNIVERSE AND THE SOLAR SYSTEM

UNIT 4: THE UNIVERSE AND THE SOLAR SYSTEM

Key unit competency:

By the end of this unit, I should be able to distinguish between the components of the universe and the solar system.

Introductory activity:

One of the students in senior one moved outside one evening and all of sudden saw a running star that disappeared. The moon was fading, being covered by dark clouds. He wondered whether there are moons elsewhere and went back to bed. In the morning, the sunrise with golden rays replaced the dark and starry night.

a. Identify the heavenly bodies mentioned in the passage.

b. Using your experience and the passage above, identify other components of the universe not mentioned in (a) above.

4.1. The universe

4.1.1. Definition of the universe and Components of the universe.

Activity 4.1

Study the photograph provided below and use it to answer the questions that follow:

a. Explain what the above photograph represents.

b. Using the above photograph, explain the meaning of Universe.

c. Identify the components of the universe

The universe refers to all of space and everything in it. It contains everything that exists, from the smallest particles to the largest structures known. The exact size of the universe is not known. Astronomers estimate that it contains about 100 billion galaxies. Astronomers are experts who study bodies in the sky or outer space. A galaxy is a system of stars, together with gas and dust. These are held together by forces of gravity. Each of the galaxies has an average of 100 billion stars. The origin of the universe is explained through the Big Bang Theory, which happened about 13 billion years ago.

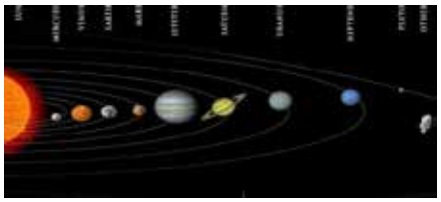
4.1.2. The components of the universe

The Universe contains many components, which vary considerably in size. The smallest components are atomic particles followed by atoms (mostly free hydrogen and helium), molecules, dust, space rocks, comets, asteroids, moons, dwarf planets, planets, solar systems, stars, black holes, nebulae, and galaxies. Among these components the solar system is the most known with certainty.

The table below shows the components associated with the universe.

Table 4.31. Components of the universe

Component	Description
Galaxy 	– Galaxy is a group of billions of stars, with gas and dust held together by the same gravitational force. – The planet Earth is in the Milky Way Galaxy; that displays a spiral arrangement therefore, named spiral galaxy. – There are three types of Galaxy. Namely; Spiral galaxy (e.g. Milky Way), irregular galaxy and elliptical galaxy.
Cluster 	– This is a group of stars which are bound together due to gravitation.
Stars and the sun 	– A star is luminous (gives out light) heavenly body. Stars have high temperature. – The sun is also a star. The sun is the luminous heavenly body that emits its own light and it is at the Centre of the solar system.

Planets and Earth 	– A planet is a heavenly body that revolves around a star. – The Earth is one of the eight planets of the solar system. It is the only planet where life is possible.

Application Activity 4.1:

Study thesimple illustration provided below and use it to answer the questions that follow:

a. Explain why we should love our universe.

b. Suppose you are asked by your friend, to describe and relate the above illustration with the earth, explain what your answers would be.

4.2. Solar system: sun and planets

Activity 4.2.

1. Using the previous knowledge that you have in Geography, explain the meaning of solar system and identify the elements or components that form it, and share your finding in class.
2. Using internet, text books and other sources of geographical information, research on the characteristics of sun and planets.

The term solar system is defined as the arrangement of the sun and planets that revolve around it (Sun). The solar system is therefore made up of the following: the sun, planets including the earth, the moon and other heavenly bodies such as asteroids, comets, meteorites, meteors, etc.

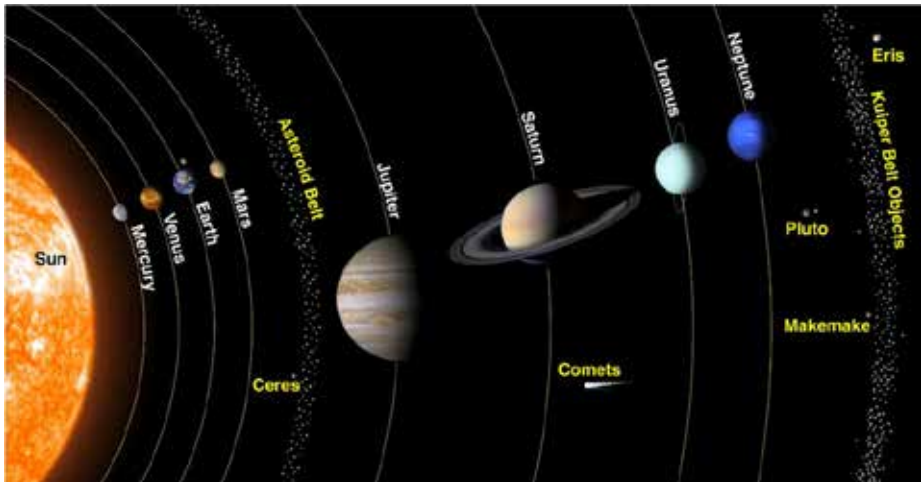


Figure 4.84. Solar system

4.2.1. The sun

The sun as earlier studied, is one of the billions of stars that make up the Milky Way galaxy. It is one of the smallest stars in our universe. However, it is 109 times bigger than Planet earth. It forms the center of the solar system. Its gravitational force keeps planets in their orbital position. All the 8 planets revolve around.

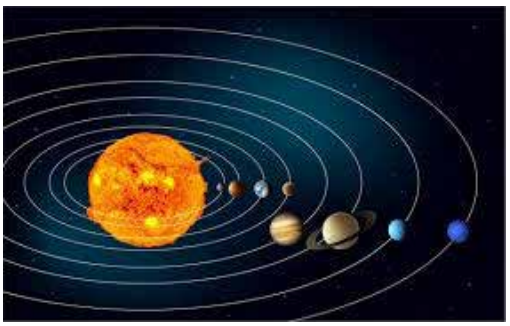


Figure 4.85. The sun in the solar system

1. Characteristics of the Sun

The sun as any other heavenly body, has characteristics that distinguish it from the rest of other components of the solar system. These are explained hereunder:

- It makes or emits its own light/heat.
- It has the diameter of 139,200 km.
- Its temperature ranges from 4000-9000 degrees Celsius.
- Its mass stands at 1.98892 x 1030 kilograms.
- It has a density of 1.4 grams per cubic centimeters.
- The sun is made up of hydrogen and helium.
- Its radius is estimated to be at 695,500 kilometers.
- It takes 25 days to turn once on its axis.

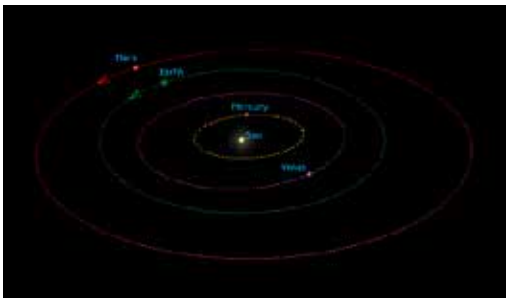
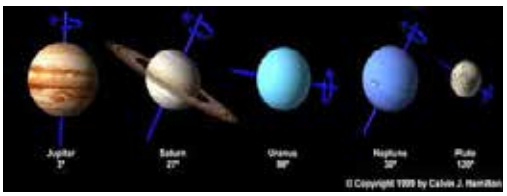
2) The influence of the sun on the Earth

- It holds the earth in its orbital position.
- It contributes greatly in the balancing of the tidal bulge caused by the moon's gravitational pull and the inertia.
- The sun is the source of the energy that is used by the earth and all that is therein.
- It engines the hydrological cycle.
- Supports life on earth through many ways such as creation of suitable and favourable temperatures.
- The sun influences the general climate at the hand of the solar radiation received.
- Contributes to the formation of tides that support in one way or the other support ecosystem and man's activities.

4.2.2. Characteristics of different planets and their positions

The term planet means the rock solids that are in oval or spherical shape floating in space and rotating on its axis and revolving round the sun. Planets are grouped into categories as shown below:

Table 4. 32. Planets of the solar system

Groups	Planets
Inner planets / Terrestrial planets 	Mercury Venus Earth Mars
Outer planets / Jovian planets) 	Jupiter Saturn Uranus Neptune

Pluto is known as a dwarf planet. It never developed fully. It is very important to know that Pluto was removed from the list of planets in 2006, because of the following reasons:

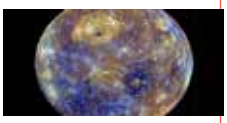
c. Its size is too small to be classified as a planet.

a. It has no uniform revolution round the sun.

b. Its revolution is not circular but spherical in nature.

c. Its movement is too slow when compared with the rest of the planets of our solar system.

Table 4. 33. List of planets and their major characteristics

No	Planets	Position in relation to the sun	Characteristics of planets
1	Mercury 	58 million km	– It is the smallest and nearest planet from the sun. – Completes its revolution in only 88 days. – Its diameter is 4,880km. – Its total mass is estimated to be 3.30e23kg (3.3 x 1026grams. – It is characterized by great escarpments. – Its surface has craters. – Its magnetic field is small of about 1% in comparison to that of our earth. – Has no natural satellites.
2	Venus 	Between 107 - 108 million km	– It is the second planet from the earth. – It shares some characteristics with the earth especially in terms of chemical composition and gravity. This explains why it is referred to as the twin planet of our planet. – It experiences hot temperatures. It reaches 4620c – It orbits an average distance of 108 million km around the sun. – To complete its revolution around the sun it takes 225 days. – Its atmosphere is poisonous. – Rotates backwards from other planets. – It has the radius of 6,052 km. – Its gravity is 90 % of the earth's. – Its mass is 4.87 x 1024kg.

3	Earth 	150 million km	– It orbits an average distance of 108,208,000 km. – It is the third planet from the sun. – The only planet known to support life (flora and fauna). – It is 93 million miles from the sun. – It has one natural satellite called moon. – It has the diameter of 7,926 miles. – It is the fifth largest planet in the solar system. – Its greatest part is covered by water, 71% of its surface is covered by water. – It completes its revolution within 365 days. – It completes its rotation on its axis within 24 hours.
4	Mars 	228 million km	– Is slightly cooler. – It is the 7th largest planet in the solar system. – It has the diameter of 4,222 miles. – It takes 686.98 earth days to complete its revolution around the sun. – Its rotation on its axis takes 24.6 earth hours. – It has hard, rock and completely dry surface. – It has two satellites.

5	Jupiter 	778 million km	– It is the largest planet in the solar system. – It has 63 satellites. – It is composed of hydrogen and helium. – It has the diameter of 88,729 miles. – It takes 9.84 earth hours to complete its rotation on its axis. – Its revolution around the sun takes 11.862 earth years.
6	Saturn 	1,427 million km	– It is composed of liquid and gas – It has rings composed of billions of ice particles. – It is 550.9 million miles from planet earth. – It takes 10.2 earth hours to complete its rotation. – It is the second largest planet in our solar system. – Its diameter is 74,600 miles. – It takes 29.456 earth years to complete its revolution around the sun.
7	Uranus 	2,870 million km	– It is the 3rd largest planet in our solar system. – Its surface is not solid. – It has a diameter of 36,600 miles. – It is composed of hydrogen, helium and methane. – To complete its revolution around the sun it takes 84.02 earth years. – Its rotational period on its axis is 17.9 earth hours.

8	Neptune 	4,497 million km	– It is 1.14 times the surface of the earth. – It completes its revolution within 164.8 earth years. – It is the farthest planet in our solar system. – It takes the eighth position – It has a mass 1.023 x 1026kg

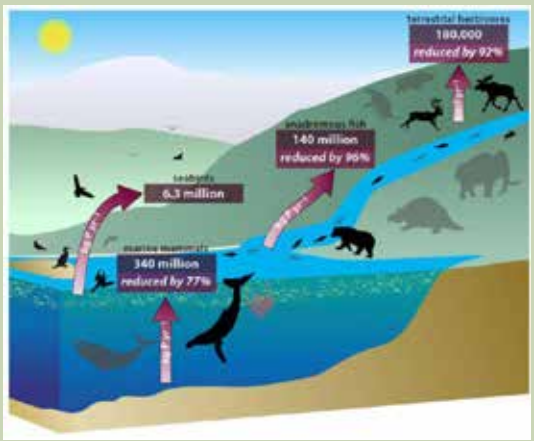
Application Activity 4.2

1. You are asked to address the senior fives from other schools, explain what you would tell them about the positioning and characteristics of the planets found in our solar system.
2. "The earth is the only planet that supports life" Explain why it is so and show how you would ensure that it continues supporting flora and fauna.

4.3. Earth: Peculiar elements of the earth

Learning activity 4.3

Examine the illustration below and use it to answer the questions that follow:



a. Using the illustration shown above, explain to your friend the meaning of Peculiar elements of the earth.

b. Identify the componets of the earth that form its exterior part shown in the illustration.

c. Using the skills and knowledge acquired in Unit 1 of senior 5, draw a pie chart that shows how the external structure of the earth has been affected in the illustration.

d. Discuss ways through which man can protect and conserve the peculiar elements of our planet earth.

The peculiar elements of the earth are outer parts of the eath. They include the following:

1. Hydrosphere or water bodies
2. Lithosphere or Land and rocks
3. Atmosphere or Gasses
4. Biosphere or flora and fauna

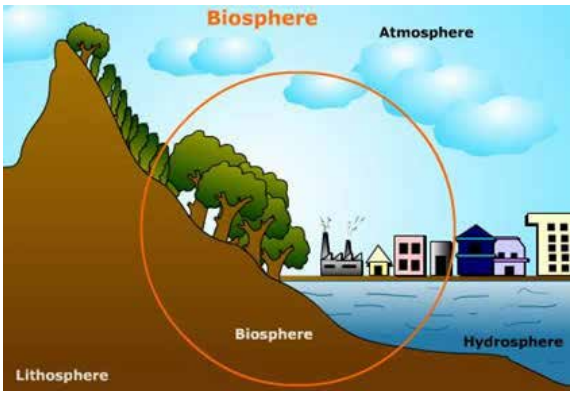


Figure 4.86. Peculiar elements of the earth

- **Hydrosphere:** This stands for all the waters found on the earth surface.It covers 71% of the earth's surface.It includes: Lakes, Seas,Oceans,Wetlands , Rivers,Wells,Streams,Clouds.
- **Biosphere:** This is known as ecosphere. It is a part of the earth that includes the totality of life on the earth (Animals,Plants and Man).
- **Lithosphere:** This is the solid part of the exterior area of the earth.It is made up of the crust and a small percentage of the upper mantle (Land ,Rocks, Soils and Minerals).
- **Atmosphere:** It describes the zone occupied by air or gasses that surround the earth.This zone is composed of gasses such as: Nitrogen,Oxygen, Argon ,Water vapour, Carbon dioxide, Helium and Methane.

Application Activity 4.3

Study the table below and match the statements with the appropriate peculiar elements of the earth

Peculiar elements of the earth	Description
Biosphere	Stands for water bodies
Lithosphere	Gasses or air that surrounds our earth
Atmosphere	Deals with flora and fauna
Hydrosphere	Rocks and land

a. Explain why it is very important to conserve the peculiar elements of planet earth.

b. Suppose you are appointed the minister of environment and natural resources, list and describe the programs or ways you would emphasize to ensure that the planet Earth remains habitable.

4.4. Earth's movements

Learning activity 4.4

Read the following passage and answer the questions provided.

Every day the sun rises in the east and sets in the west. This process led many people in the past to think that the sun is moving, and the earth is fixed. The sun moves around the earth. But with the advancement of science, this has been proved that the sun itself is moving and the earth has also motion. Later it has been revealed that the sun does not move around the earth, rather the earth moves around the sun.

With the help of your knowledge and skills acquired in previous studies answer the following questions?

a. How many movements does the earth make?
b. Identify proof for the earth rotation and revolution
c. Describe effects caused by the above movements

4.4.1. Rotation of the Earth

Rotation of the Earth is defined as the movement of the Earth spinning on its own axis. This movement of the Earth on its own axis is in an anticlockwise direction. The earth takes 24 hours to complete 360˚. At the equator the earth rotates at a speed of 1676 km and zero km at the poles per hour.

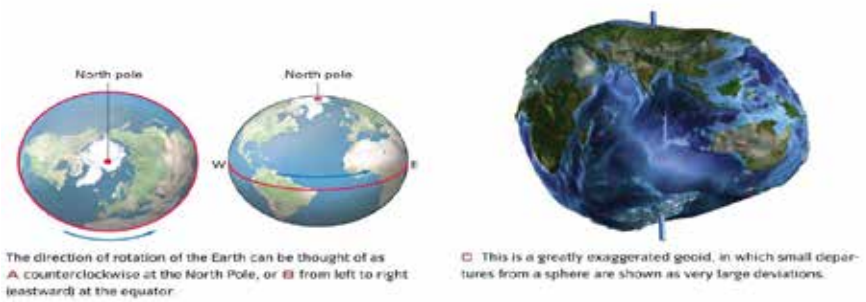


Figure 4.87. Rotation of the earth in anti-clockwise

The effects of rotation of the earth

As the Earth turns around its axis, it affects some processes on the earth's surface and other associated celestial phenomenon. Some effects of the earth rotation are:

i. Rotation causes day and night

Earth's rotation on its axis creates day and night. The one half of the Earth that faces the sun has day time, while the opposite half facing away from the Sun has night time.

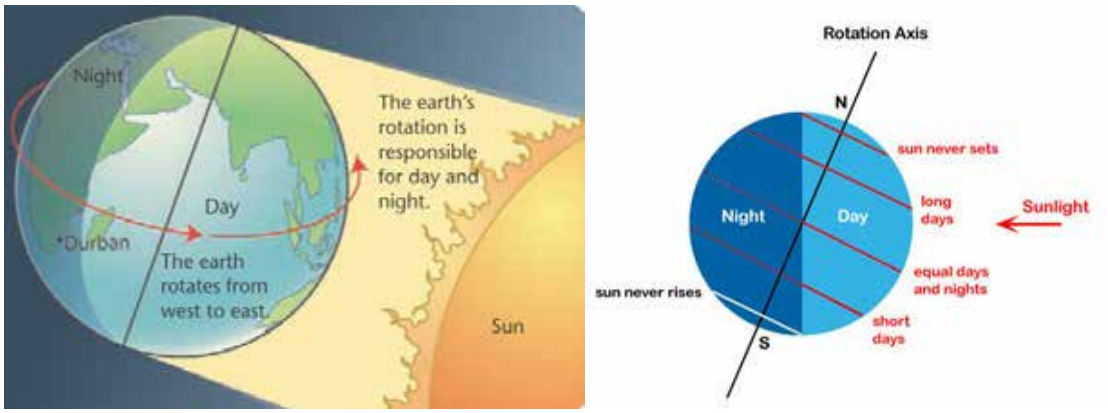


Figure 3.88. Day and Night

ii. Rising and falling of ocean water (tides)

During the rotation of the earth, gravitation force pull of the sun and the moon acts on the ocean water to produce tides which may be high or low.

iii. Deflection of wind and ocean current (Coriolis Effect)

Rotation causes winds to be deflected to the right in the Northern or to the left in southern whenever they cross the Equator. This deflection is called the Coriolis Effect.

iv. Time difference between longitudes

One round of the Earth is completed after turning 360^{oo}.

This implies that the earth takes 24 hours to complete rotation. Therefore, for the earth to cover 15o it is calculated as follows:

$$\frac{360\ degrees}{24\ hours} = 15\ degrees$$

If it takes the earth to covers 15 degrees in 60 minutes, then 1o degree is completed within 4 minutes. This is obtained:

$$\frac{60\ Min}{15\ degrees} = \frac{60\ Min}{15\ degrees} = 4\ \text{Minutes}$$

For example, supposing the local time at Greenwich Meridian is 12:00. What is the local time at Kigali which is on longitude 30^{oo} East?

Solution

- Find the difference in degrees between two longitudes: (30o-0o)=30o
- Determine the time that is equivalent to 30 degrees. This is obtained by: 30^{oo} X 4 minutes = 120 minutes.
- Change the 120 minutes into hours. This obtained by: $\frac{120\,\text{min}}{\theta\ \text{min}/hour} = 2hours$
- Finally add 2 hours to the original time experienced at the Prime meridian / Greenwich.

12:00+2hours=1400hrs. The time at Kigali is: 14:00 PM

v. Temperature difference

Due to the spherical shape, the parts of the Earth located in the tropical areas between 23.5˚ North and South of Equator, get direct sunlight all the year round. Regions located in higher latitude get less rays during the year.

4.4.2. Revolution of the Earth

The revolution of the earth is the movement of the earth around the sun. Earth revolves around the Sun along an oval-shaped path called an orbit. The area of the oval-shaped path is called Plane of the ecliptic, in which the axis of the Earth is tilted at an angle of 23^{oo} 27′. Earth takes 365 days and 6 hours or one year to complete one revolution, at a speed of 106,260 km/h around the Sun (30 kilometres per second).

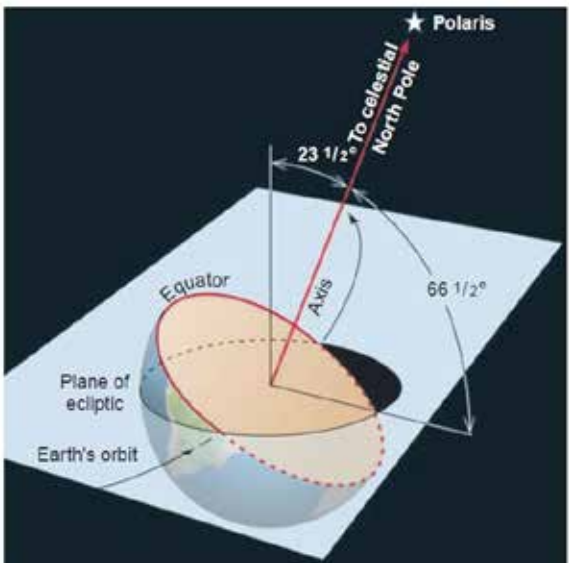


Figure 4.89. Earth's ecliptic plane

The Leap year is the year with 366 days which come after four years where February has 29 days instead 28 days. This results from adding 6 hours of rotation of each year to make one year after 4 ordinary years.

The consequences of the revolution

i. Determination of seasonal variation

The whole year has been divided into four divisions. Each of such division is known as a season. There are four seasons namely summer, autumn, winter, and spring.

The earth's revolution leads to change in the sun's overhead positioning. This comes along with the occurrence of solstices (winter solstice, summer solstice) and equinox.

- **Solstice** is either of two times of the year at which the sun reaches its highest or lowest point in the sky at midday, marked by the longest and shortest days over the tropics. Solstice occurs on 21st June and 22nd December when the sun's overhead position is either at the tropical of Cancer or Capricorn.
- **Equinox** occurs two times in the year (around 21st March and 23rd September) when the sun is above the Equator, day and night have equal length.

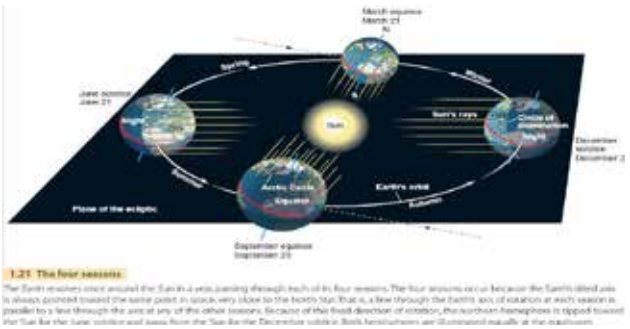


Figure 4.90. The four seasons

The four seasons:

Summer is the hottest of the four temperate seasons. This occurs immediately after the spring season and before autumn. When it is the summer solstice, the days are the longest and the nights are the shortest. The day length begins to decrease as the season progresses towards autumn. When it is summer in the Northern Hemisphere, it is winter in the Southern Hemisphere, and vice-versa.

Winter is the coldest season of the year in the polar and temperate zones. It occurs after autumn and before spring in each year. Winter is caused by the axis of the Earth in that hemisphere being oriented away from the Sun. when it is winter in the Northern Hemisphere, it is summer in the Southern Hemisphere, and vice versa. During winter the days are short and nights have longer hours. However, this changes as the season progresses towards spring.

Spring is one of the four conventional temperate seasons, following winter and preceding summer. Days become longer, and weather gets warmer in the temperate zone because the Earth tilts towards the Sun. In many parts of the World plants grow and flowers bloom.

Autumn, this is a season of the year between summer and winter during which temperatures gradually decrease. The fall in temperatures brings direct impact on the growth of vegetation. Therefore, the vegetation begins to decrease. It's the season when the days get shorter and colder, and everything turns brown and the plants begin to shed leaves.

ii. Varying length of day and night at different times of the year

The revolution causes variations in the length of the day and night over different latitudes. When the sun is in the Southern hemisphere i.e. overhead the tropic of Capricorn, the latitudes in the northern hemisphere receive less hours of the sunlight (daytime) but more hours of night time; while the Southern hemisphere receives more hours of heating hence more hours of daytime.

During the summer solstice, day time is longer than night time in areas found in higher latitudes. This implies that, latitudes beyond equator will experience increase in hours of day time towards the poles (from 12hrs to 24hrs at the arctic circle and beyond). During the winter solstice, night time is longer than day time at latitude beyond equator.

Norway is known as the land of the midnight sun because the sun does not go below the horizon or comes above it on 21st June

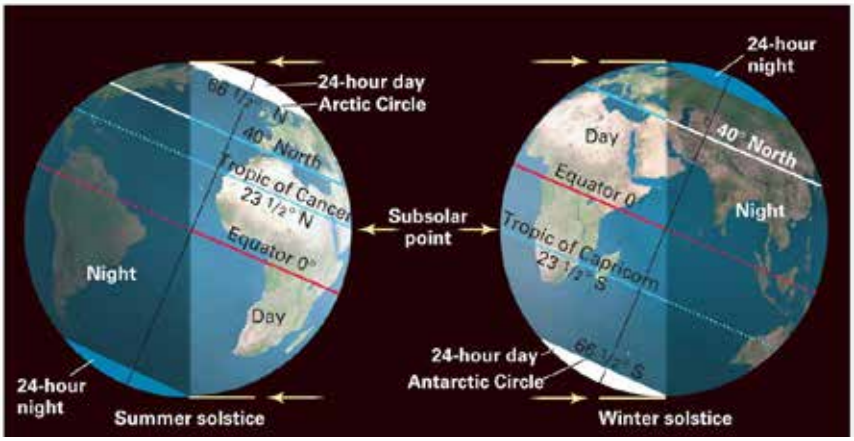


Figure 4.91. Variation of lengths of hours in different time based on hemisphere and seasons.

iii. Climatic zone.

These are divisions of the Earth's climate into general climate zones according to average temperatures and rainfall. The three major climate zones on the Earth are: the Polar, Temperate, and Tropical climatic zones. Temperatures in these three

climate zones are determined mainly by the location, or latitude. The reason why the equatorial zone is hotter than the poles is that sun's rays fall vertically at the equator and obliquely at the poles.

Example, the stations around the equator such as Kisangani, Masaka, Libreville, and Manaus experience hot temperatures while areas such as Alaska, Greenland and Siberia near the poles experience cold temperature.

iv. A light year

A light year is a unit of distance. It is the distance that light can travel in one year. Light moves at a velocity of about 300,000 kilometers (km) each second. More precisely, one light-year is equal to 9,500,000,000,000 km.

Why such a big unit of distance?

Well, on Earth, a kilometer may be just fine. It is few hundred kilometers from Kigali city to Rwamagana; it is a few hundred kilometers from Rusizi to Ngoma. In the Universe, the kilometer is just too small to be useful.

For example, the distance to the next nearest big galaxy, the Andromeda Galaxy, is 21quintillion km. That's 21,000,000,000,000,000,000 km.

Astronomers use other units of distances in terms of the Astronomical Unit (UA). The AU is defined as the average distance between the Earth and the Sun. It is approximately 150 million km.

Application activity 4.4

1. Rusizi is 28^{oo} E and the time is 6:00 am. What is the time in a place which is located at 60˚W?
2. What is the longitude of a place X whose local time is 11:00 a.m. if the local time at longitude 30^{oo} E is 2:00 pm?
3. Explain why some parts of the earth's surface are getting hotter while others are becoming cool and cold.

4.5. The Moon

Activity 4.5.1

With the help of geographical documents and other relevant sources of information, search for the following information:

a. The natural satellite of the earth.
b. The characteristics of the moon.
c. How moon influence the earth.
d. Types of eclipses.
e. Identify the effects tides may cause.

The moon is a natural satellite that moves around the planet (larger natural body) in space. It is the only satellite of the earth which is about 4.5 billion years old. The moon is the natural satellite that goes around the earth and that people can see shinning in the sky at night.

4.5.1. Characteristics of the moon

The moon has several characteristics. These include the following:

- It has a cold surface
- It is a dry orb (globe)
- Its surface is dominated with craters
- Its landscape is made up of rocks and dust
- It has no or low gravitational force
- The atmosphere is very limited
- The Moon, like Earth, has a layered structure, which consists of crust, the upper mantle, and the core.
- Its composition is made up of minerals like those of the Earth, mostly silicates.
- The highlands are predominantly lunar breccia, which are rocks formed by fusing together of smaller pieces of rocks during impacts.
- The albedo of the amount of sunlight that its surface reflects is only about 7 % contrasted with Earth's average of 31%.
- Surface temperatures can range from 127 $^{\circ}C^{\circ}C$ in sunlight, - 173 $^{\circ}C^{\circ}C$ when it is dark.
- The diameter of the Moon is about 3,480 km, or about one-fourth that of Earth.
- Its distance to the earth is about 384, 401 km.
- The same side of the moon always faces the Earth.
- Moon completes one revolution in an elliptical orbit around the Earth in 27 days, 7 hours and 43 minutes, according to Sideral time.
- For the Moon to go from one phase to the next similar phase, a period known as one lunar month requires 29 days, 12 hours, 44 minutes. This period is called "synodic month" or "lunation".

4.5.2. Phases of the moon

As the Moon orbits Earth, it reflects light from different angles, which change shape of the moon. These change shapes of the moon are called the phases of the Moon.

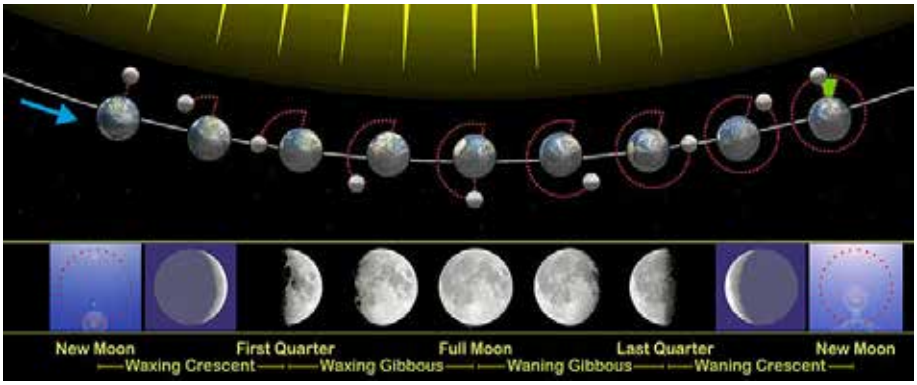


Figure 4.92. Phases of the moon

The phases of the Moon are divided into Primary phases and Intermediate phases.

Primary phase includes the following:

- **The New moon phase:** This is a period when the moon is between the Sun and the Earth. Its sunlight side is turned away from Earth (it is not visible).
- **The first quarter phase:** Is a phase that occurs 7 days after new moon phase when half shape of the Moon appears to be receiving sunlight.
- **The full moon phase:** The whole side of the Moon receiving sunlight faces the Earth, 14 days after new moon. This implies that the Earth, Sun, and Moon are almost aligned in a straight line, with the moon in the middle.
- **Last quarter phase:** A half of the moon appears to be lit by sunlight. The left part of the moon is facing the direction of the rising sun. This is because the moon is in front of the sun but between the Earth and the sun.

Intermediate phases

- **Waxing crescent** is a small part of the moon that receiving sunlight seen from the Earth just as a bright crescent in the direction of the setting sun.
- **Waxing Gibbous:** This is when the moon appears to be having a small part that receives sunlight as seen from the Earth. It is just as a bright crescent in the direction of the rising sun.
- **Waning Crescent:** The Moon appears to be partly but less than one-half illuminated by direct sunlight. The fraction of the Moon's disk that is illuminated is decreasing.

– **Waning Gibbous:** This occurs when more than a half of the lit portion of the moon can be seen and the shape decreases in size from one day to the next. It occurs between the full moon and the third quarter phases.

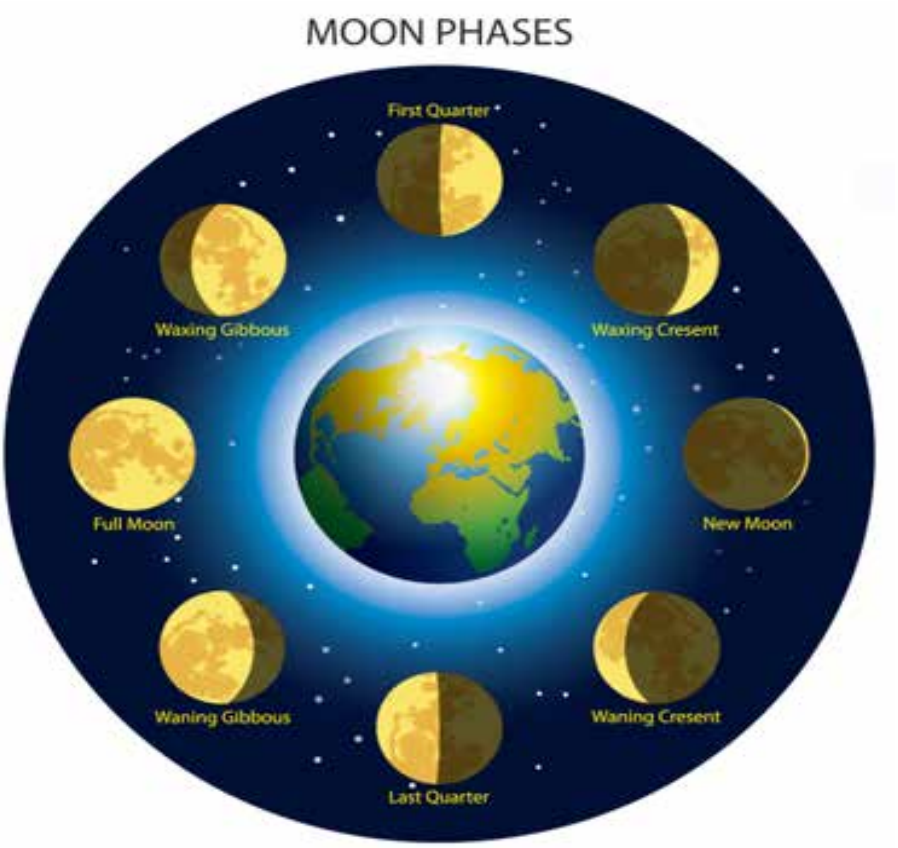


Figure 4.93. Phases of the moon

4.5.3. Influence of the moon on the earth

1) Eclipses of the moon

Eclipse is the obscuring of one celestial body by another, particularly that of the sun or a planetary satellite.

Types of eclipses

– **A lunar eclipse:** A lunar eclipse occurs when the moon passes directly behind the earth into its umbra (shadow). This can occur when the sun, earth and the moon are aligned exactly or very closed with the earth in the middle. A lunar eclipse occurs only during night. A lunar eclipse may be total lunar eclipse: that happens only when the sun, earth and moon are perfectly aligned. When its alignment is less than perfection, therefore a partial lunar eclipse occurs.

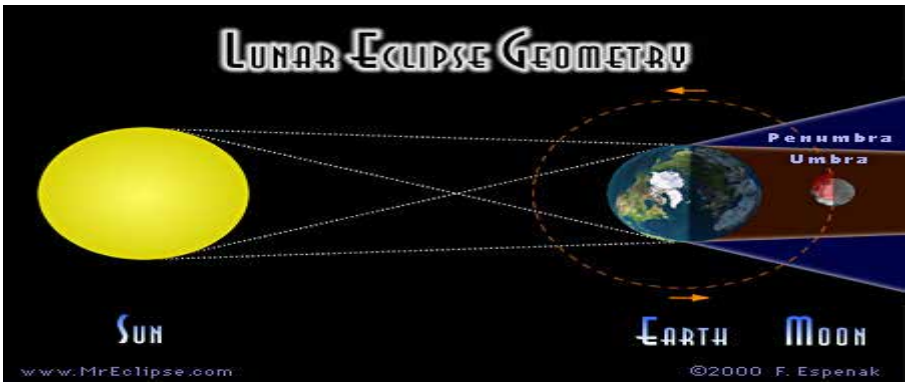


Figure 4. 94. Lunar eclipse

– **Solar eclipse:** This is a type of eclipse that occurs when the moon passes between the sun and earth, and the moon fully or partially blocks rays of the sun from reaching the earth. This occurs during daytime.

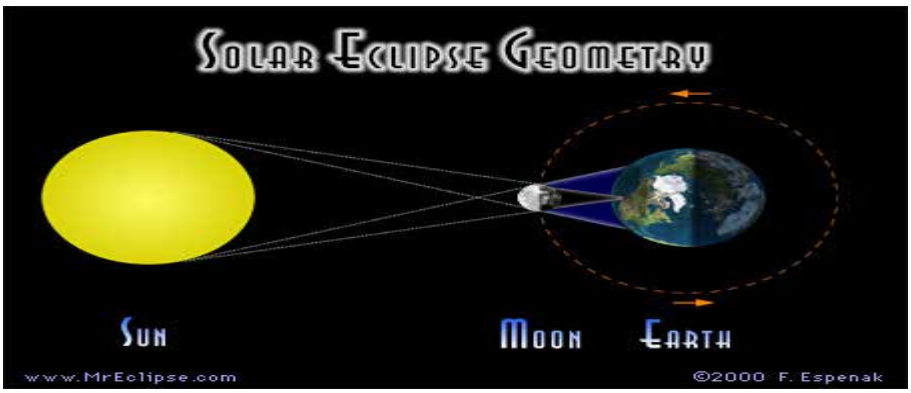


Figure 4.95. Solar eclipse

2) Tides

The word "tide" is a term used to define the alternating rise and fall in sea level, produced by gravitational attraction of the moon and the sun. The moon tries to pull anything on the earth to bring it closer, but the earth is able to hold onto everything except water. Since the water is always moving, the earth cannot hold onto it, and the moon is able to pull it. Each day, there are two high tides and two low tides. The ocean is constantly moving from high tide to low and then back to high tide. The high tide is called spring and the low tide is named neap.

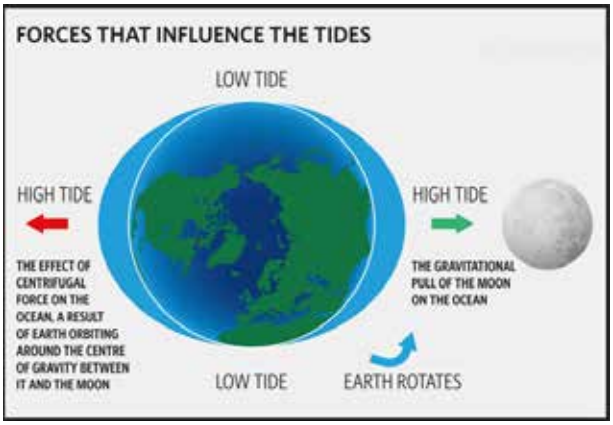


Figure 4.96. The earth's tides

Application activity.

Using specific examples answer the following questions.

1. Explain why the moon shows one side from the earth.
2. Explain what happens when the moon is placed between Earth and the sun.

4.6. Other heavenly bodies

Activity 4.6.1

Study the photograph below and use your analysis to answer the following questions and present the findings in classroom.

1. What does the photograph show?
2. Describe other heavenly bodies that exist apart from earth, sun and stars.
3. Find out if there is another planet in the Universe that is capable of supporting life like the earth.

It is important to note that there are other heavenly bodies. These include the ones shown below:

-Asteroids - Meteoroids - Meteorite - Meteors

-Comet - Constellations - Galaxies

Table 4. 34. Other heavenly bodies

 **Asteroids**	Asteroids are minor planets especially those of the inner Solar system. The larger ones have also been called planetoids

Meteoroids 	These are small bodies often remnants of comets, travelling through space. When such body enters the Earth's atmosphere it is heated to luminosity and becomes a meteor.
Meteorite 	It is a solid piece of debris from an object, such as Comet, Asteroid, or Meteoroid, that originates in outer space and survives its passage through the atmosphere to reach the surface of a planet or Moon.
Meteors 	Meteors are pieces of rock or other matter from space that produce a bright light as it travels through the atmosphere. It is visible at night when the sky is having many stars. Meteors are also known as a shooting star. These are classified as minor components of the solar system.
A comet 	It is a heavenly body or lump of rocks made up of dust and frozen gasses which orbit the sun. These often surround the sun.

Constellations 	A constellation is a shape displayed by a group of celestial bodies, usually stars, which appear to form a pattern or a picture in the sky. There are 88 constellations. The constellation with the most stars is the Water Snake or Hydra. The brightest constellation is the Southern Cross or Crux
Galaxies – Elliptical galaxy – Spiral galaxy – Irregular galaxy	A galaxy refers to the group of billions of stars held together by the same gravitational force. There are several galaxies both known and unknown. The known ones are in 3 groups as described in the table below:
Type of galaxy	**Description**
Elliptical galaxy 	– This is a group of billions of stars which form a spherical shape characterized by no arms, little gas or dust clouds. – This galaxy has no distinctive features, only that it displays great brightness.
Spiral galaxy 	– This is a group of billions of stars, composed of the old stars with a central bulge. – This galaxy has arms made of the younger stars that display spiral layout. – This galaxy is flattened disc that keeps on rotating. The arms that are displayed contain huge clouds of gas and dust radiating outwardly.

Irregular galaxy 	– This is a galaxy that has no definite shape. – Billions of stars are unevenly distributed. – It is a very rare galaxy. – It is very hard to describe its shape as it has no fixed shape.

Application activity

Search on internet and use other geographical documents and answer the following questions:

1. Discuss conditions that make our planet habitable.
2. What are the benefits people gain from some heavenly bodies that land on the earth's surface?

End unit assessment

1. Study the two photographs shown below.

Source: Mcpactions.com shawacademy.com

   a. Identify the heavenly bodies shown in the two photographs.

   b. Mention and describe the heavenly bodies found in the universe that are not shown in the two photographs.

   c. Explain why the areas shown in the two photographs are all found on planet earth yet having different habitable conditions.

   d. Draw a program that can enable man to live in harmony with the universe and the earth.

2. Read the story below and use it to answer the questions that follow:

Recently John and Mary went to visit their uncle in Rubavu. In the afternoon of their second day, they were taken by their cousins to visit the lake shores. Evening came, and the moonlight was so intense that one could pick the smallest thing at that time. Suddenly, they saw water extending in a rhythmic manner to the place they had made a camp fire."

   a. How could you use your knowledge to convince John and her sister Mary that what happened was connected to the moon, sun and earth's rotation.

   b. Suppose you want to build near the coastline, explain how the knowledge and the skills acquired from the lesson on tides can guide you.

   c. The Indian Ocean experiences many tides, design a project that you would sell to the Kenyan government to address the effects of tides on the coastal biodiversity.

UNIT 5

THE ORIGIN OF THE EARTH

UNIT 5: THE ORIGIN OF THE EARTH

Key unit competence:

By the end of this unit, I should be able to discuss the theories of the origin of the Earth.

Introductory activity

Using previous knowledge gained in Geography and other disciplines:

a. Explain how the Earth came into existence.
b. Identify the major characteristics of the earth.
c. Describe the internal structure of the Earth.
d. Find out and describe the various geological eras and periods recorded in history.

5.1. Theories of the origin of the earth

Learning activity 5.1

Carry out any experiment below to prove the formation of the universe:

a. Collect the balloons provided and blow air into each of them.
b. Make sure the balloons are inflated to their maximum sizes.
c. Tie the ends of the balloons containing air to prevent it from escaping.
d. Press hard on the balloons to make sure that they burst.
e. Discuss most generally accepted hypothesis for the formation of the universe related to the practical exercise performed in a, b, c and d.

Source: https://www.nature.com/news/cosmologist-claims-universe-may-not-be-expanding-1.13379

The formation of the Earth is imbedded in the whole process of the universe formation. The study of the universe is called cosmology. Cosmologists study the structure and the changes that take place in the universe. The universe contains all the star systems, galaxies, gas and dust, and all the matter and energy that exist.

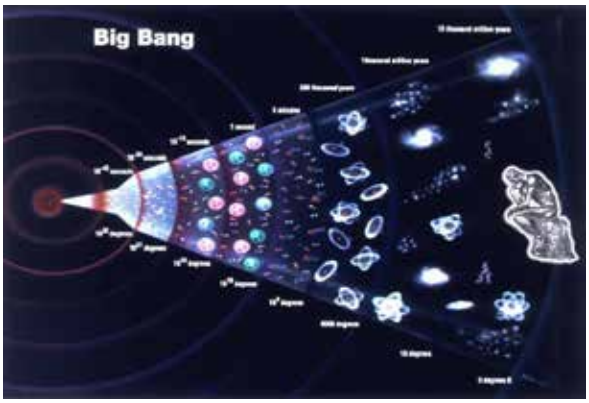
The universe also includes all of space and time. The part of the entire universe that we can see is called the observable universe. It can be seen because light from celestial bodies is able to reach the earth. The earth is part of it. Now the big question is to know: what is the origin of the earth? In other words, how the earth came into existence?

The origin of the earth has resulted into many theories that were put forward to explain its possible origin. Eleven theories about the origin of the earth are highlighted below. However, the two first ones - Big Bang theory and Creation theory – seem to be the most accepted.

1. The Big Bang theory
2. The creation or biblical theory
3. The dust cloud theory
4. The Kant-Laplace nebular hypothesis
5. The Chamberlin-Moulton planetesimal hypothesis
6. The Cometary collision hypothesis
7. The Encounter hypothesis
8. The Tidal theory
9. The Fission theory
10. The Accretion theory
11. The Stellar collision theory

5.1.1. The Big Bang Theory

This theory was first suggested by a Belgian priest named Georges Lemaitre in 1920. He hypothesized that the Universe began from a single primordial atom. This theory further states that in the beginning, there was totally nothing. In about 15 billion years ago a sudden explosion happened (big Bang) which produced a speck of matter that was smaller than an atom. From the time of its formation, this small matter has continued expanding and resulting into the formation of the Earth and all that forms it: the atmosphere, hydrosphere, lithosphere, and biosphere. This theory is criticised on one ground; how can nothing lead to the occurrence of something.



Source: https://www.universetoday.com/54756/what-is-the-big-bang-theory/

Figure 5.97. A simplified diagram of the expansion of the universe by George Le maître

5.1.2. The Biblical or creation theory

The biblical or creation theory is based on the liturgical narrative as expressed in Genesis chapter one of the Holy Bible. It talks about specific acts of divine creation. The theory is believed in by Christians. According to the creation theory, at the beginning there was nothing. The divine power (God) created heaven and earth and all that are in them. The theory holds that God is the master creator of planet Earth and the universe in general. The theory further shows that God created two great lights that is; the greater light which He called Sun and the lesser light which was named the moon. The sun was to provide light during the day and the moon to provide light at night. The whole creation process took place in six days.

- On the first day, God created the day and the night.
- On the second day, He created the sky.
- On the third day, He created the land which is the earth, the sea and the plants.
- On the fourth day, He created the sun, moon and stars.
- On the fifth day, He created the sea creatures and the birds.
- On the sixth day, He created land animals of all kinds and human beings.

Therefore, according to this theory, the Earth and universe were all together created by God.

Source: https://biblescienceforum.com/2014/01/03/6-day-creation-of-the-universe/

Figure 5.98. A summary of the six days' creation

Application activity 5.1

From the theories that you have learnt above;

a. Explain the difference between the Big bang theory and the Biblical theory about the origin of the earth.

b. Make a research on other theories of the origin of the earth.

5.2. Characteristics of the Earth

Activity 5.2

Read the passage below and answer the questions asked

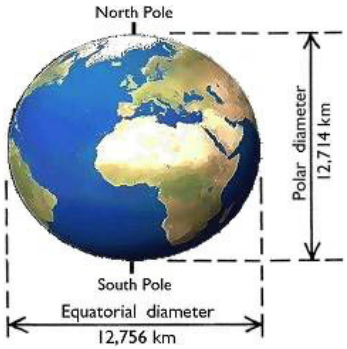
Far back in ancient times, everybody thought the earth was flat. This is because it looks flat. If you are in a boat way out in the middle of the ocean, the top of the water looks flat in every direction and the sky seems to fit over it like an upside-down bowl. The line where the sky and water meet is called the "horizon." The horizon looks like a circle with you yourself at the center. If you are on land, the land stretches out to a horizon also. The horizon on land, however, is not even. It goes up and down because of houses, trees, hills, and other things. Some ancient people suspected that the earth went on forever. They thought it might be a huge flat piece of land and sea with no end at all.

a. What does the story above talk about?
b. How do you find the shape of the earth?
c. Find out the evidences advanced to support the most agreed shape of our planet.
d. How big is the planet Earth?

5.2.1. The shape of the earth is spherical

1. The shape of the earth

Determining the shape of the earth was a point of concern for many centuries. It was first believed that the earth was flat. This is because the planet appears to be generally flat (not considering mountains and valleys); but the surface of the earth has a slight curve. Further studies based on modern technology proved that the shape of the earth is not a perfect sphere, but an oblate spheroid also known as a geoid. This is because observing the polar areas reveals that they have a flat landscape. At the same time, the equatorial areas have a bulging appearance as shown below:



Source: https://www.quora.com/If-the-Earth-is-an-oblate-spheroid-then-why-isnt-this-evident-in-NASA-images-from-space

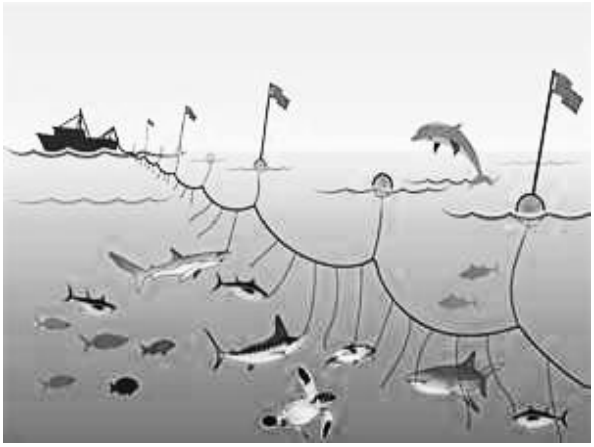
Figure 5.99: An oblate spheroid form of the earth

2. Evidences showing that the earth is spherical

There are several evidences to prove the spherical form of the earth:

- The circumnavigation: If one travelled across the world along the straight path without stopping would come back to the point of origin where the journey started from.
- Images from the space: photographs taken from space by satellites show that the earth's surface is curved (spherical shape).
- Ride of plane: If on takes a trip, especially for a long destination, 2 interesting facts are noticed about the planes and the earth:
  - Plane can travel in a relatively straight line a very long time and not fall off any edges;
  - If one looks through the window on the trans- Atlantic flight, in most of the time sees the curvature of the Earth in the horizon.
- The view of other planets: All observations from telescopes reveal that the planetary bodies are spherical from whichever angle. Therefore, since the earth is one of them, its shape is also spherical in nature.
- The shadow of the earth during eclipses: The shadow resulting from the eclipse of the moon (Lunar eclipse) shows that the earth is round.
- Day-night and seasonal change: The earth's tilted axis produces seasonal climatic conditions and gives days and night of varying length. If the earth was at right angles to the sun, the day and the night would always be of equal length, and there would only be one season throughout the whole year.
- The size and diameter of the earth: The earth has an equatorial diameter of 12, 751 km and its circumference is 40,080 km. These however, are much bigger than those of the polar areas.
- The International Date Line: if two people started off from the prime meridian and one went east while another went west, both would meet at the International Date Line which separates east from west and if they continue moving, each would end up where they started at the prime meridian.
- The sun rise and sun set: if the earth was flat, the sun would rise and set at the same time in all countries. But, the sun rises and sets at different times in different places.
- The polar star: As one moves towards the poles, the size of the polar star increases and when one moves away from the Polar Regions it decreases. This means that, the Earth is round. In case it was flat, the size of the polar star would remain the same or constant.
- The changing altitude of the sun at different times of day: When the sun rises and sets, it displays a lower sun's altitude than when it is overhead at mid-day.

– The ship sailing away from or towards the coast: The lower parts of a ship that is moving away from the coast disappear before the upper parts. On the other hand, on an in-coming ship, the upper parts appear first before other parts of the ship. The figure below helps to understand this evidence:



The line of sight

***Figure 5. 100**. View of an approaching ship*

– The view of circular horizon: the distant horizon viewed from the top of a hill or deck of a ship at a sea is always circular in shape.

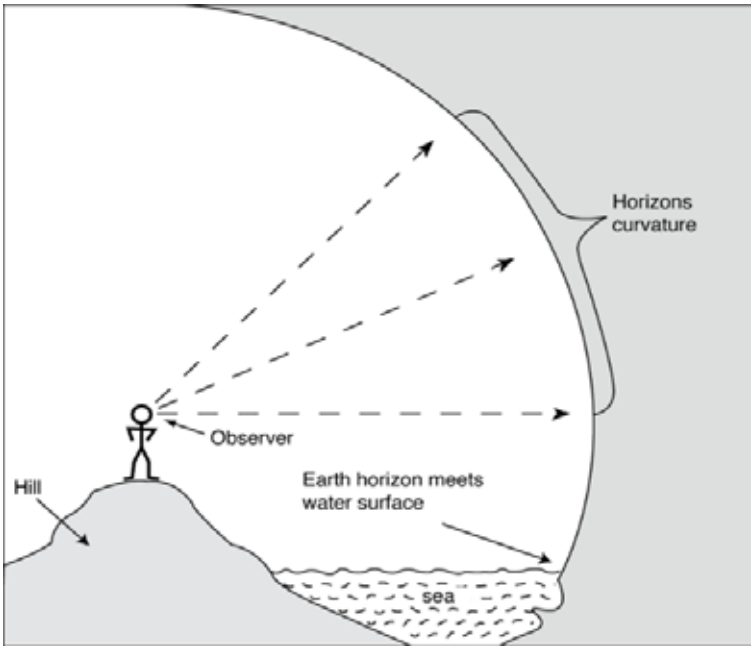


Figure 5.101. The curved horizon of the earth

5.2.2. The shape of the earth is oblate

The earth is slightly flattened at the poles and bulging at the equator. From the outer space, the earth looks perfectly round and smooth. The oblateness of the earth's shape is more pronounced at the equator due to the earth's rotation.

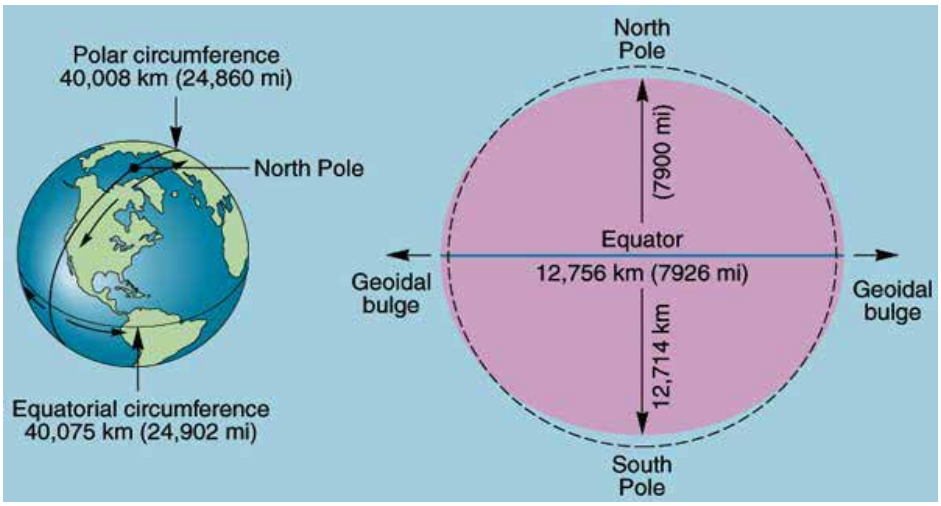
The bulging at the equator is because of strong centrifugal force at the equator is enough to over-ride the earth's gravity. Therefore, being able to pull matter away from the centre. The main cause of the flat appearance at the Polar Regions is because of the great gravity existing at the poles due to limited rotational speed. This result into the pulling of matter at the polar regions towards the centre of the earth, hence flattening them.

The following are more details proving that the shape of the earth is not a perfect sphere:

1. The equatorial diameter is larger than the polar diameter. The diameter of the Earth at the polar region is 12,713 km, while at the equator it is 12,756 km.
2. The polar circumference is less than that of the equatorial circumference. The polar circumference is 40,008 km while the equatorial circumference is 40,075 km.
3. Latitudes near the equator are longer than those near the polar areas. For example, 10 latitude near the equator is 111,926 km, while near the north pole it is 109,051 km.
4. Areas at the equator are far away from the centre of the earth hence they have a lower gravity than the areas at the poles. At the poles, the areas are near the centre of the central part of the earth. This is the reason for the intense gravitational pull at the poles.
5. Basing on the images taken by the satellites, it has been found out that the Northern Hemisphere is smaller than the southern hemisphere.

5.2.3. The Earth's size: radius, diameter, circumference, volume and mass

- The average radius of the earth is 6,371 km.
- The Earth's equatorial diameter is 12,756 km while the polar diameter is 12,714 km.
- The Earth's circumference at the equator is 40,075 km. From pole to pole, its circumference is 40,008 km.



Source: https://laulima.hawaii.edu/access/content/group/2c084cc1-8f08-442b-80e8-ed89faa22c33/book/chapter_1/size_eg1.jpg

Figure 5.102. The size of the Earth

- The Earth's volume is 1.08321×1012 cubic kilometres.
- The Earth is the largest of the four inner planets, although it is nothing compared to the gas giants.
- The Earth's mass is 5.9736 x 1024 kg.
- The Earth's density is 5.52 g/cm3. It is the densest planet in the solar system because of its metallic core and the nature of the content of mantle.

5.2.4 The earth's gravity

Planets are held in their orbits by the force of gravity. The force pulling the planet is the pull of gravity between the planet and the Sun. when you throw an object into the air, it come back and fall to the ground. This is due to the force of gravity.

Normally, the gravity of the earth is approximately 9.8 m/s2. The Earth's gravity is so intense at the poles because, as mentioned above, such areas are near the centre of the earth than at the equatorial areas. The earth's gravity at the equator is 9.78m/s2 while at the poles it is 9.832m/s2. In other words, you weigh more at the poles than you do at the equator because of this centripetal force.

The influence of the gravity

The earth's gravity plays a great role as shown below:

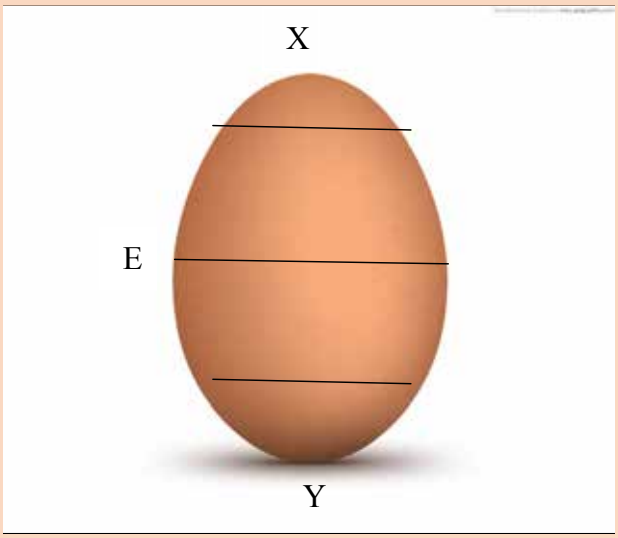
- The density and weight of the materials that compose the interior of the earth are influenced by gravitational force. Without this force, the interior of

the earth would be unconsolidated and easily pulled by the forces of other heavenly bodies.

- The earth's gravity glues all materials that form the earth together, hence forming a single mass called planet earth.
- The gravitational force leads to the occurrence of disturbances in the asthenosphere which lead to the mobility of the lithosphere. Hence, facilitating the formation of new features of great importance. This means that the earth's surface is always renewed.
- It plays a great role in holding up the organization structure of the solar system. The constituents of the solar system are held together by the gravitational pull. O such was not in existence, external gravitational forces could literally pull components of the solar system including apart, thus destroying them.

Application activity 5.2

- Use an egg, a piece of thread, a ruler and markers.
- Mark that egg following the marks in the illustration below.



a. With reference to the divisional lines drawn on the illustration above, use the egg provided to measure its diameter and circumference.

b. From your findings above, describe the shape of the earth.

c. Assume the above illustration stands for our planet earth, name X, E and Y, and indicate the size of E:

   i. X: ……

   ii. E: ……...

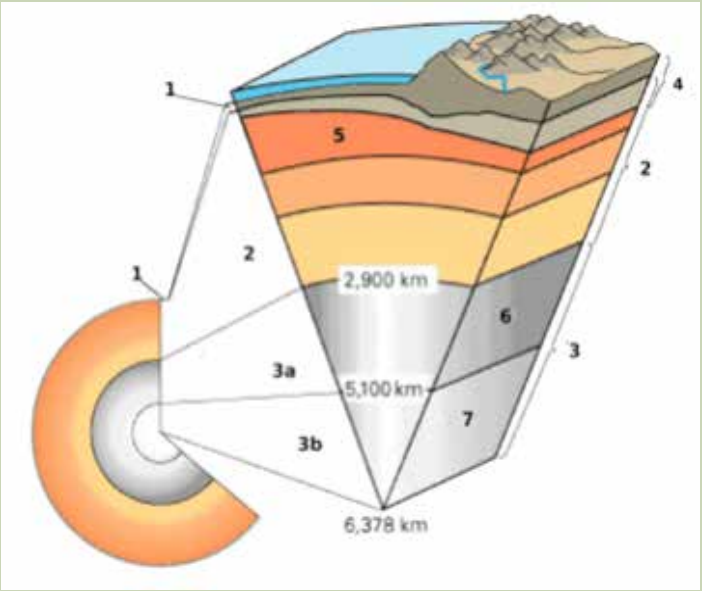
   iii. Y: ……..

d. Describe the role of gravity in the operations and mechanics of the solar system.

5.3: The internal structure of the earth and mineral composition

Learning activity 5. 3.

1. The study of the earth's environment cannot be complete without understanding the nature of the earth's interior structure. What do you know about the interior of the earth?
2. Using the knowledge acquired so far, study the illustration given below and give names of layers represented by the figures.



Source: https://es.m.wikipedia.org/wiki/Archivo:Earth_cross_section-i18.png

   a. Name the parts of the earth corresponding to numbers, 1,2, 3a, 3b,4,5,6 and 7.
   b. Describe the characteristics of the parts you have named.
3. Carry out a research to find the main mineralogical composition of the earth.

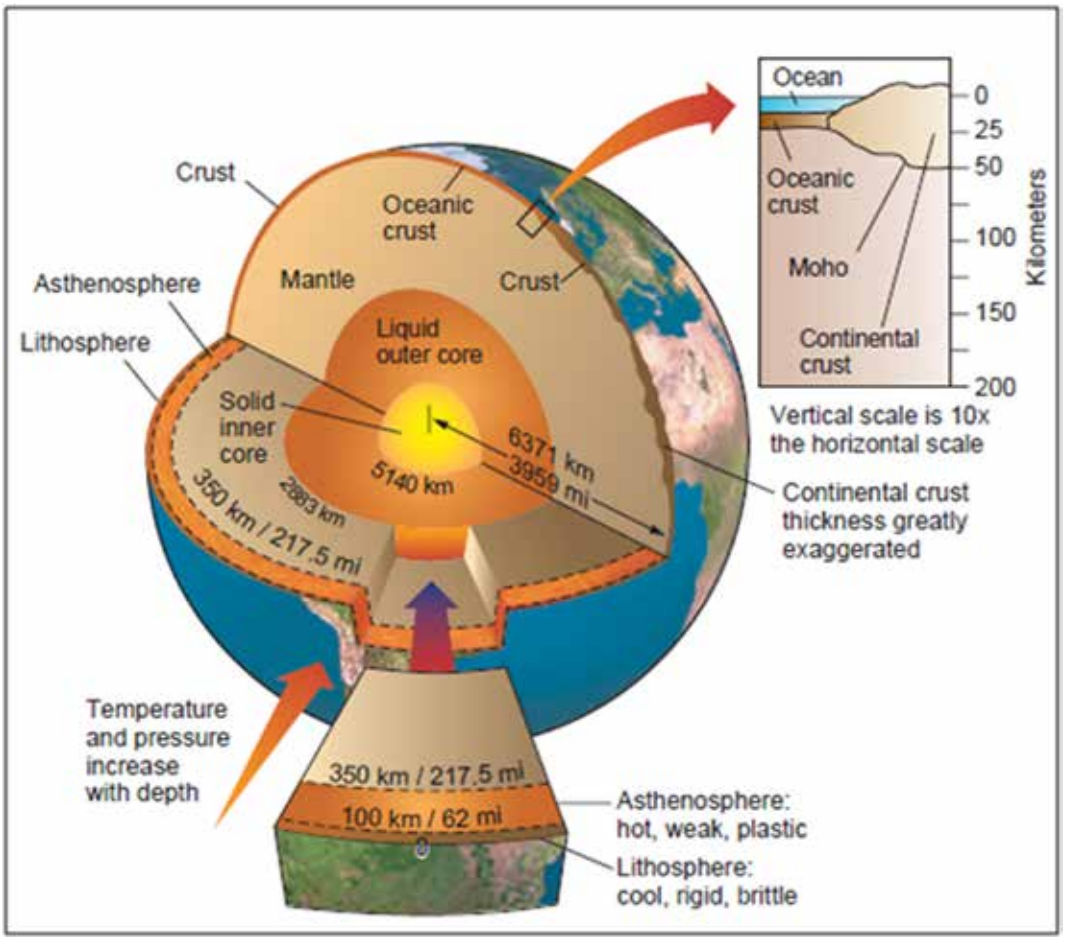
5.3.1. The internal structure of the earth

The layers of the Earth's interior include the crust, mantle, liquid outer core, and solid inner core. Continental crust has both felsic and mafic rock zones, while oceanic crust has only mafic rock. The interior structure of the earth is layered in concentric shells:

- An outer silicate solid crust.
- A highly viscous mantle.
- A liquid outer core that is much less viscous than the mantle.

– A solid inner core.

The figure below depicts the main layers of the earth's interior part and their respective properties.



Source: https://socratic.org/questions/what-does-earth-consist-of

Figure 5.103. The interior parts of the Earth

1) The crust

The crust is the outermost layer of the Earth. Various landforms feature like mountains, plateaus and plains, rivers, lakes, sea, oceans and human settlements are found on the crust. It is also referred to as the lithosphere. The crust is divided into two types, the oceanic crust and the continental crust:

– Oceanic crust (SIMA) is a layer consisting mainly of basalt, averaging 6-10 km. in thickness. At its deepest it has a temperature of 1200° C.

– Continental crust (SIAL) can be up to 70 km thick. The crust separated from the mantle by the Moho discontinuity. The crust and the rigid lower layer bordering the mantle are collectively known as the Lithosphere.

2) The Mantle

The mantle is composed mainly of silicate rocks, rich in iron and magnesium. The mantle is under the crust. It is composed of rocks that are in a semi-molten state. These have relatively higher density compared to the rocks that constitute the crust. The mantle has a mean density of 4.6g/cm3. They are mainly composed of Ferro magnesium silicate (iron, magnesium) minerals.

The mantle is divided into three main parts, namely the asthenosphere, the upper mantle and the lower mantle:

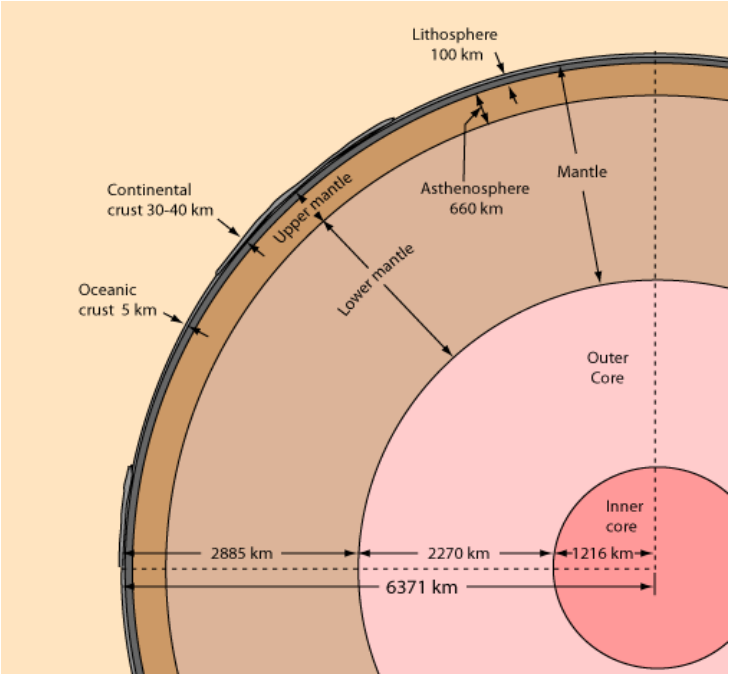
- The asthenosphere: It is a soft layer of the upper mantle, beneath the rigid lithosphere. It is separated from the crust by the transitional line of discontinuity called Mohorovicic discontinuity that is shortened the Moho discontinuity.
- The upper mantle: It is a layer of less rigid and more plastic rocks. It extends from Mohorovicic discontinuity to the depth of 1,000 km.
- The lower mantle: It goes from 1,000 km to 2,900 km in depth. At this depth the lower mantle is separated from the outer core by a discontinuity surface called Gutenberg.

3) The core

The core is composed of outer core and inner core. They are mostly constituted by:

- The outer core: Is liquid and kept in a semi-molten state.
- The inner core: Is solid and made mostly of iron and with some nickel (NIFE). The temperature at the centre of the Earth (6 371 km below the surface) is about 6200° C (hotter than the surface of the Sun).

The figure below shows the relative depth of different internal layers of the earth.



Source: http://hyperphysics.phy-astr.gsu.edu/hbase/Geophys/earthstruct.html

Figure 5.104*.Relative depth of internal structure of the earth*

5.3.2. The mineral composition of the Earth

The mineral composition refers to both the types of minerals within a rock and the overall chemical makeup of the rock. Earth's rocks are produced by a variety of different arrangements of chemical elements. A list of the eight most common elements making up the minerals found in the Earth's rocks is described in the table below.

Table 5. 1: Common chemical elements found in the Earth's crust

Element	Chemical Symbol	Weight in Earths Crust (%)
Oxygen	O	46.6
Silicon	Si	27.7
Aluminium	Al	8.1
Iron	Fe	5.0
Calcium	Ca	3.6
Sodium	Na	2.8
Potassium	K	2.6
Magnesium	Mg	2.1
All others	-	1.5
Total	-	100

Rocks are classified into three categories: Sedimentary rocks, Metamorphic rocks and Igneous (magmatic) rocks. Each category has its particular mineralogical composition as summarized in the table below.

Table 5. 2: Types of rocks and their forming minerals

Types of rocks rock	forming processes	Forming minerals
Sedimentary rocks	Erosion, lithification, cementation, compaction	Silicate, Clay, Dolomite, Gypsum, Anhydrite, Hematite, Limonite,
Metamorphic rocks	Increase in pressure and temperature, metamorphism	Quartz, Muscovite, Sillimanite, Andalusite, Kynite, Garnet, Sericite, Staurolite
Igneous (magmatic) rocks	Melting (magma), crystallization (intrusive), consolidation (extrusive)	Quartz, Feldspars, Plagioclase, Micas (Muscovite, Biotite), Pyroxene, Amphibolite, Olivine,

Application activity 5.3

Apply the knowledge you have acquired in this lesson to answer the following questions:

1. Suppose you are asked to describe how Mount Muhabura is related to the internal structure of the earth, what would be your response?
2. The earth's crust is composed of many minerals. Indicate its most common chemical elements.

5.4. Superficial configuration of the earth: Continents and Oceans

Activity 5.4

1. Conduct a research on the superficial configuration of the earth.
2. Use a manila paper to draw the world map with colours to separate continents from oceans.
3. Looking at the photograph of the earth below, we can see the green and the blue colours standing for landmass and waters respectively.
   a. What is the name given to the part covered by the green colour?
   b. How many parts / subdivisions of those areascovered by green colour?

   c. What does the blue colour represent?

Superficial configuration refers to the distribution of continents and water bodies especially oceans and seas. Oceans and seas occupy the larger part of the earth's surface. Therefore, the superficial configuration of the earth means the way parts or elements of the planet earth are arranged on its surface. Superficial configuration deals with the distribution of continents and oceans.

The size of the land surface of planet earth is 148 million km^2, while the water surface is estimated to be at 363 million km^2. This shows that the land surface occupies 29 % of the total area of the globe; while the remaining 71 % is composed of water surface coverage.

The greatest part of the land surface is found in the Northern Hemisphere. For that reason, it is also named the land hemisphere. The greatest parts of the oceans occupy the Southern Hemisphere hence referred to as the water hemisphere.

5.4.1. Continents

A continent refers to the world's continuous masses of land. The earth is constituted of the following 7 continents: Europe (10,532,000 km2), Asia (44,383,000 km2), Africa (30,330,000 km2), America: North America (24,256,000 km2) and South America (17,819,000 km2), Australia (7,687,000 km2) and Antarctica (14,000,000 km2).

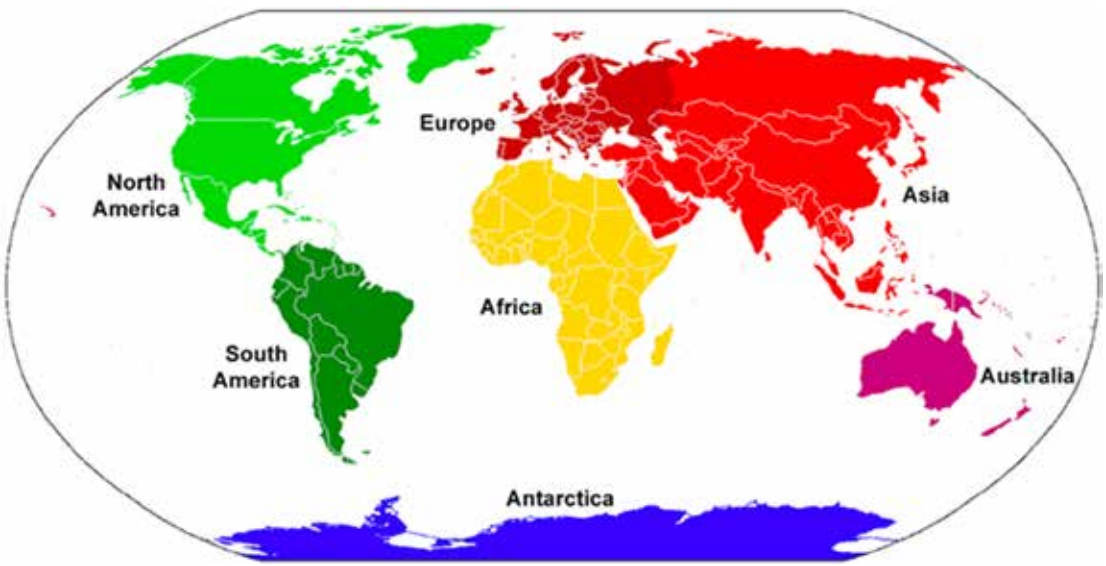


Figure 5.105: The 7 continents of the world

Some Geographers, like Peter George, defined continents as the big land areas surrounded by oceans. Hence, apart from that common assertion of 7 continents, there can be several ways of distinguishing the continents according to the countries:

- Four continents: Afro-Eurasia, America, Antarctica, Australia;
- Five continents: Africa, Eurasia, America, Antarctica, Australia;

- Six continents: Africa, Asia, Europe, America, Antarctica, Australia;
- Six continents: Africa, Eurasia, North America, South America, Antarctica, Australia/Oceania
- Seven continents: Africa, Asia, Europe, North America, South America, Antarctica, Australia/Oceania.

5.4.2. Oceans

An ocean is a large mass of saline water. It occupies a basin between continents. An ocean is different from a sea. A sea refers to a relatively large body of the salty water that is completely or partially landlocked. Examples of seas include the Mediterranean Sea, the Black Sea, the Red Sea, the Dead Sea, the Caspian Sea and the North Sea. There are five oceans in the world and they include the following:

- Pacific Ocean: 155 million km2
- Atlantic Ocean: 76 million km2
- Indian Ocean: 68.5 million km2
- Antarctica Ocean: 20 million km2
- Arctic Ocean: 14 million km2

Figure 5.106: Oceans of the world

Application activity 5.4

Suppose that the Government of Rwanda has granted the scholarships in the following countries North Korea, Germany, Japan, Brazil, Senegal and New Zealand. As you get home your parents ask you:

1. Where the above countries are located? What will be your answer?
2. Describe the world large mass of saline water.
3. With specific examples, explain how water is an important resource. Describe how it can be conserve.

5.5. Geological time scale

Learning activity 5.5

Read the passage below and answer the questions that follow:

A study of fossils (palaeontology), together with other geological and biological evidence, provides information on the history of Earth and the evolution of life. Fossils provide evidence about the relative ages of rock strata, paleo-environments and evolution of life. The fossil record has been used to develop the worldwide geological time-scale. Organisms may leave traces of their existence in the sediments formed during, or shortly after their lifetimes. As you have learnt early in this unit, the earth is old enough. If you take a journey back through the history of the earth you will get much understanding about this. Every discipline tells you its own story. Then:

1. What does the passage above tell us?
2. Search on internet or other geographical documents on the meaning of fossils mean.
3. Find out and describe the various geological eras and periods recorded in history.

The geological time scale refers to a scheme or chart that indicates age classification of rocks and associated geomorphological and biological events.

The earth's history is divided into smaller units based on the types of life-forms living during certain periods. The division of earth into smaller units makes up Geological time scale. Some of the division in the geologic time scale are also based on geologic changes occurring at that time.

The geological time scale is a record of Earth's history, starting with Earth's formation about 4.6 billion years ago. The geological time scale is used by geologists, palaeontologists and other earth scientists to describe the timing and the relationship between events that have occurred throughout Earth's history.

Subdivision of geological time

There are three types of subdivisions of geological time. These are: Eras, Periods, and Epochs.

Eras are major units (subdivisions) of geologic time scale based on differences in life-forms. There are 3 major eras indicated on the geological time scale. They include the following:

I. Cenozoic (recent life).

ii. Mesozoic (middle life).

iii. Palaeozoic (ancient life).

In table 5.37 The Precambrian time is shown. However, this is not included in eras because it lacks reliable geological evidences.

Table 5. 3: Transitions between eras

Name of era	Transition events	Millions of years Ago (Ma)
Cenozoic (recent life)	Extinction of dinosaurs and many other organisms	66
Mesozoic (middle life)	Extinction of over 90% of living organisms, including trilobites	250
Palaeozoic(ancient life)	First appearance of organisms with hard parts i.e. the Cambrian explosion	540
Precambrian time	Geologic time older than the beginning of the Cambrian or Palaeozoic period. There was bacteria-like forms and several episodes of mountain buildings.	600

- Eras are subdivided into Periods (refer to the figure below). Periods are based on the types of life existing at the time and on geologic events, such as mountain building and plate movements.
- Periods may be divided into smaller units of time called Epochs. The figure

below shows that only the Cenozoic era is subdivided further into epochs. Why is this so? The fossil and geological events records are more complete in these recent rock layers.

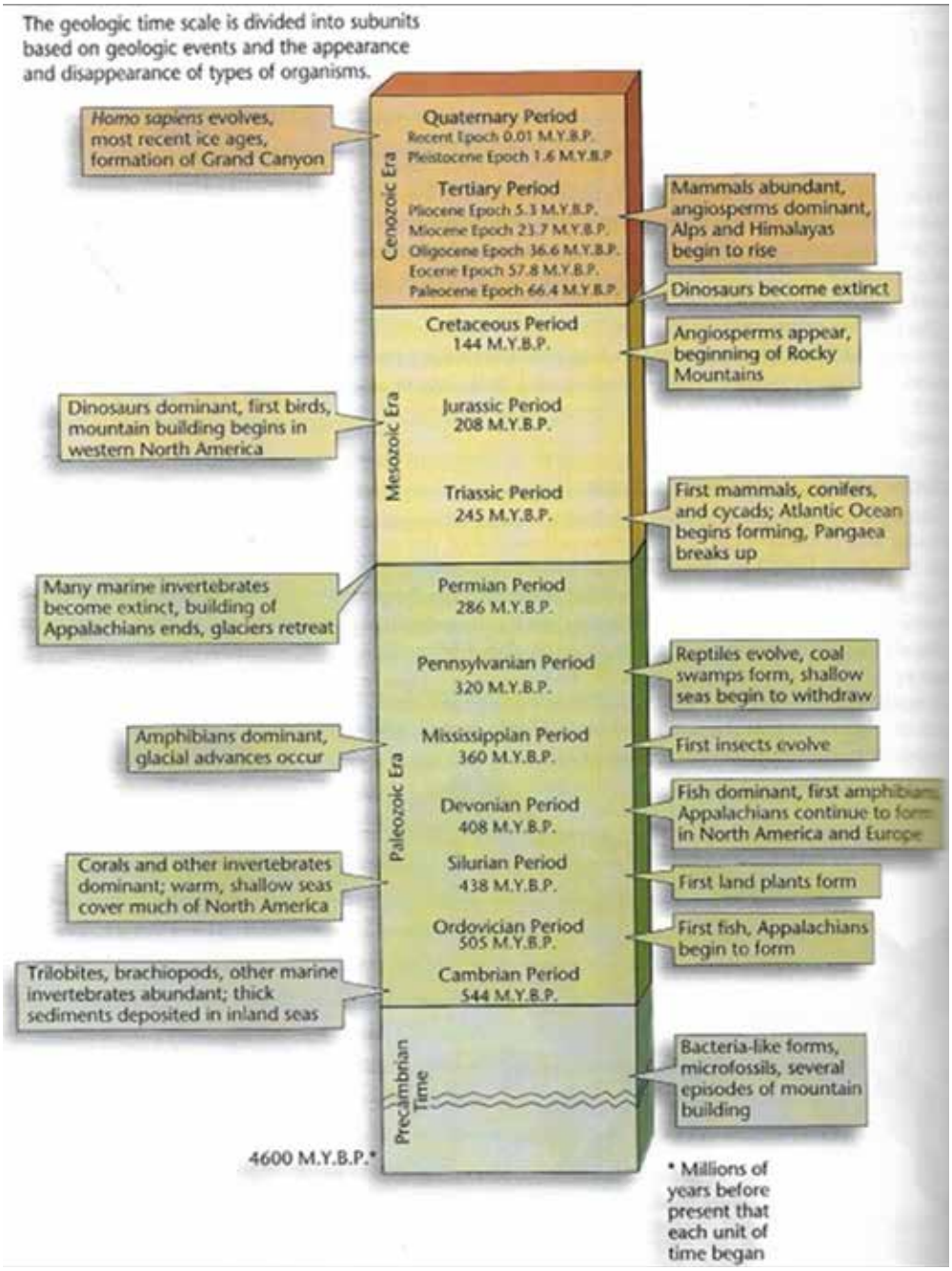


Figure 5.107. subdivision of the geological time scale

Application activity 5.5

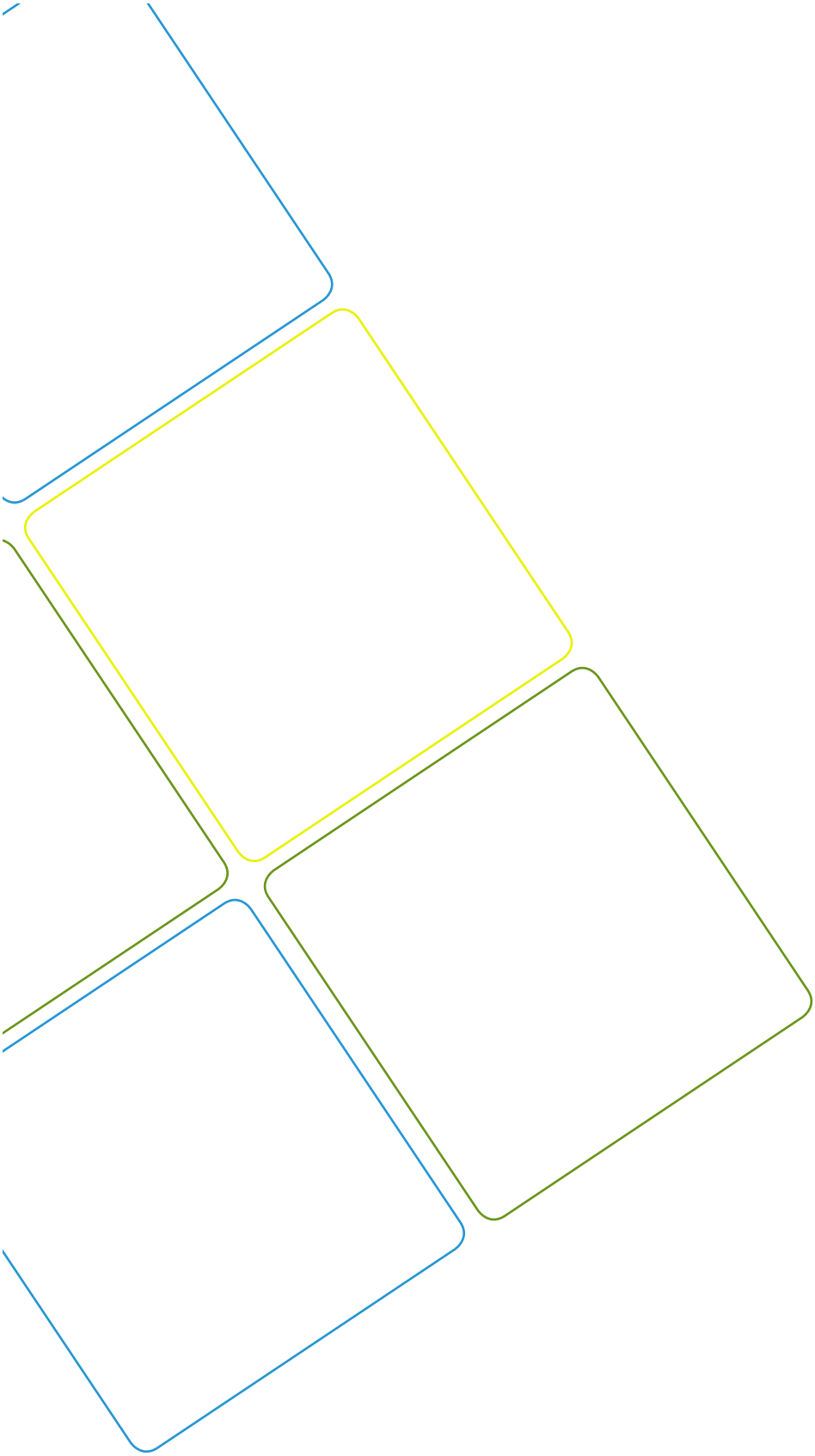
Using knowledge and skills acquired from this unit 5, make debate and discussion to find answers for the following questions:

1. How can archaeological research and environmental protection be promoted?
2. Explain the importance of Geological time scale.

End unit assessment

Read the following discussion between two students and answer the questions asked:

1. Two students Mugisha and Uwamahoro were discussing about the origin of the earth. Mugisha said that the earth and other celestial bodies came into existence in different ways: some were formed due to the collision of stars, others by explosion. With confidence, Uwamahoro said that everything in the universe was created by God.
    a. Who is right, who is wrong?
    b. Describe four theories of the origin of the Earth
2. The physical features of the earth are changing day by day due to natural reasons and human activities. Suggest ways people can use to conserve the nature for its sustainability.



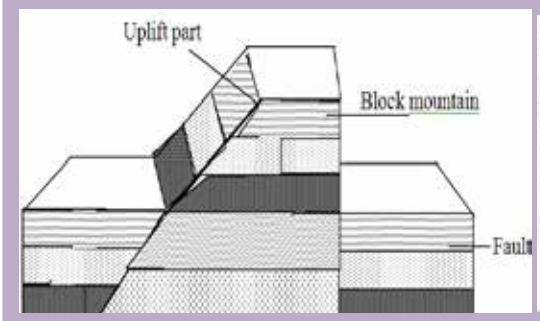
UNIT 6: INTERNAL LANDFORM PROCESSES

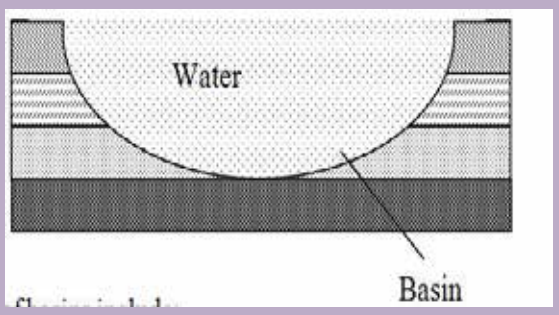
Key unit competence:

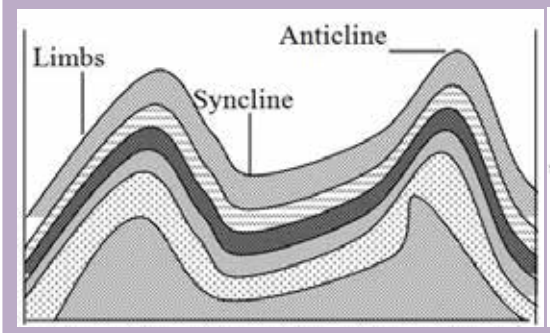
By the end of this unit, I should be able to examine the internal processes responsible for the evolution of different relief landforms.

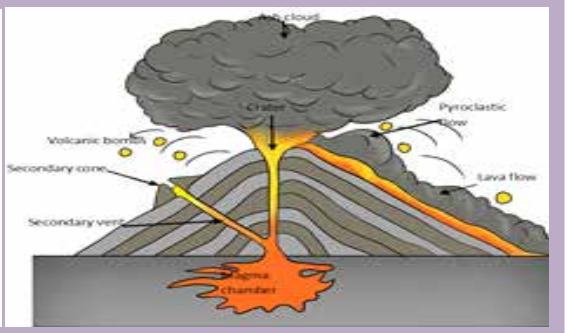
Introductory activity

Observe critically the diagrams below and answer the questions that follow:









Refering to the diagrams above showing the internal landforms 'processes; answer the following questions:

a. Identify the internal processes associated with each diagram illustrated above

b. Describe how the internal processes lead to the formation of various relief features.

c. Identify the effects of the features resulting from internal processes on human activities.

6.1. Faulting and processes leading to the formation of different faulted features

Learning activity 6.1

Using textbooks, internet, and other sources of geographical information research on:

1. The meaning of the faulting and fault
2. The processes responsible for the formation of different faulted landforms

Forces causing faulting

Faulting is the fracturing of the crustal rocks due to the influence of endogenic forces or processes. Endogenic forces are responsible for various types of vertical irregularities that give birth to numerous relief features including mountains, plateaus, plains, lakes, faults and folds. The endogenic forces include faulting, folding, warping, vulcanicity and earthquake.

The endogenic forces and related horizontal movements are caused by the existence of convectional currents within the mantle. These lead to lateral earth movements, that are either tensional or compressional in nature. Sometimes there are up and downward movements that cause the crustal rocks to fracture, fold, down warp or up warp.

The endogenic forces result in the formation of features or landforms such as plateaus, block mountains, basins and rift valleys.

Meaning of faulting and fault

Faulting is the process through which the rocks of the earth's crust crack or fracture due to tectonic forces as accompanied by the displacement of blocks. The direct effects of faulting include the formation of rift valley, block mountains, fault scarps, tilt block landscape, etc.

A fault is a fracture in the crustal rocks where the rocks are displaced along a plane called a fault plane. A fault is also considered as a rupture or fracture of rock strata due to strain, in which displacement is observable.

Main parts of a fault

Processes of faulting: the process of faulting is caused by tensional and compressional forces. When these forces act on crustal rocks of the earth's crust, they develop stress in them and break along the zone of maximum tension. The rocks are then removed from their original position either upwards, downwards or horizontally.

When a rock is displaced upward it is called up throw, and the downward displacement is called down throw.

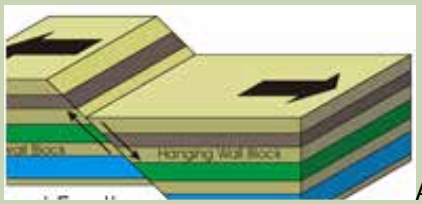
Application activity 6.1

Rwanda is made up of six physiographic regions which resulted from different internal processes including faulting. With convincing examples/evidences support this statement.

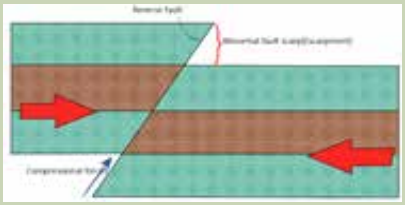
6.2. Types of faults

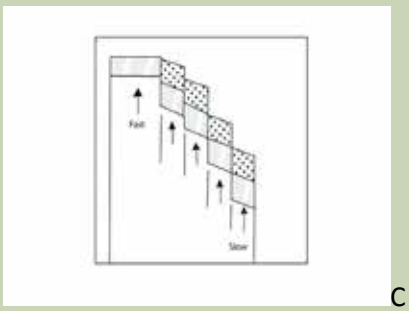
Learning activity 6.2

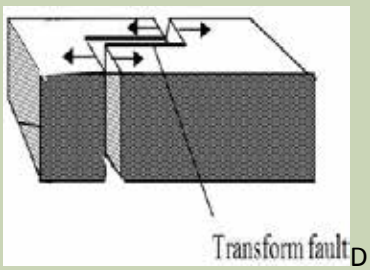
Observe the diagrams below and use other geographical resources to answer the questions that follow:



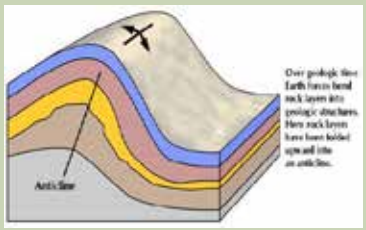
A


B


C



D


E

1. Identify the types of faults labelled by letters A, B, C,D, and E .
2. Compare and contrast the illustrated faults.

Faulting leads to numerous types of faults that include the following:

i. **Normal faults/consequent fault lines** are formed due to the tensional forces that lead to opposite displacement of the rock blocks. The steep scarp resulting from normal faults is called fault-scarp or fault-line scarp.

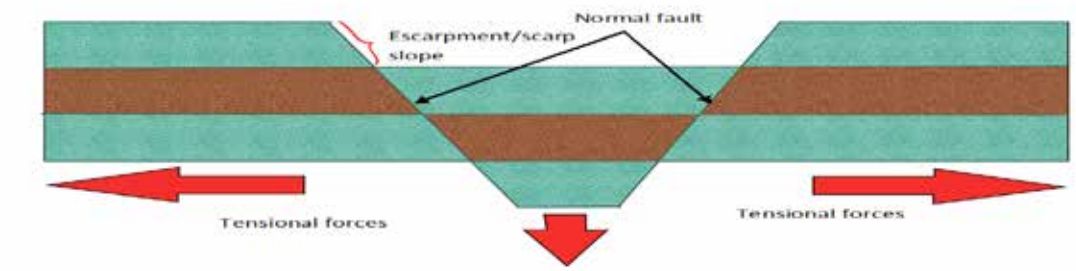


Figure 6.108: Normal faults

ii. **Reverse faults/ obsequent fault lines** are formed due to compression forces that lead to the movement of the fracture rock blocks towards each other. The fault plane in a reverse fault is usually inclined.

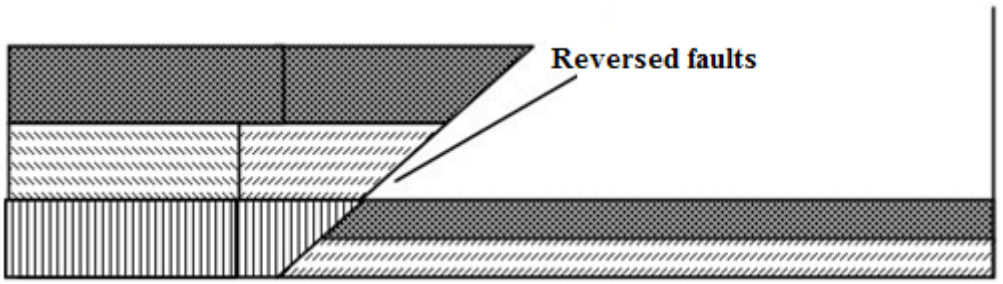


Figure 6.109: Reverse faults

iii. **Lateral or strike-slip faults** are formed when the rock blocks are displaced horizontally along the fault plane. They are called left-lateral or sinistral faults when the displacement of the rock blocks occurs to the left; on the other side of the fault, they are called right-lateral or dextral faults.

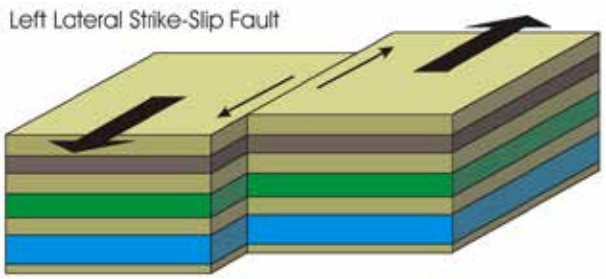


Figure 6.110: Lateral faults

iv. Step faults are formed when many parallel faults occur within the crustal layers of the rocks in a way that the slope of the entire planes of the faults are in the same direction. The series of blocks are thereafter up lifted at different rate, therefore forming step faults.

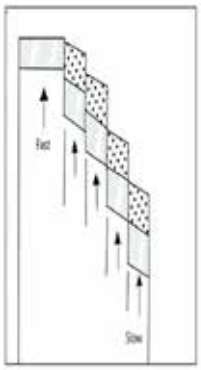


Figure 6.111: Step faults

v. A thrust fault refers to a reverse fault in which the dip of the fault plane is at a small angle to the horizontal and it is caused by strong crustal compressional forces.

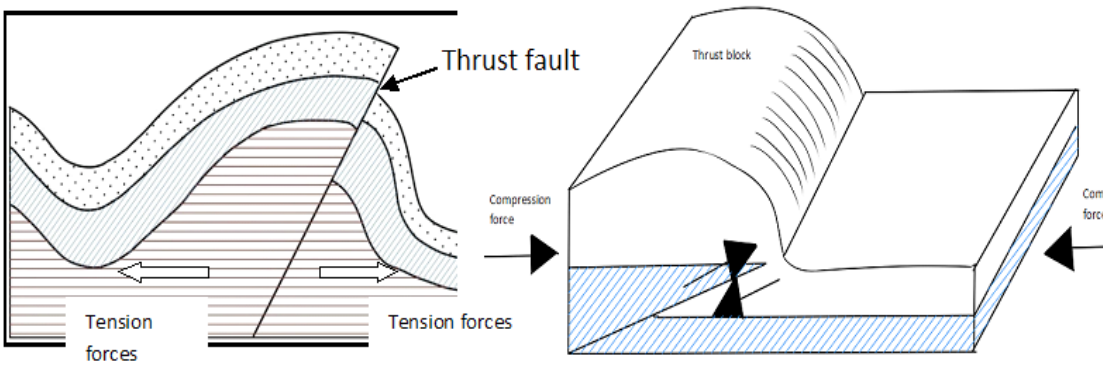


Figure 6.112: Trust fault

vi. Anticlinal faults are formed as a result of great compressional forces acting on layers of rocks. Compressional forces further cause stress leading to the development of cracks (faults) on the crest of the anticline.

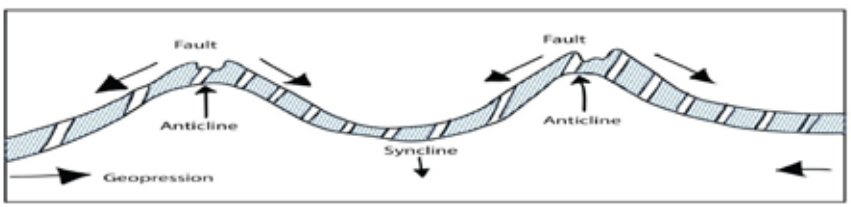


Figure 6.113: Anticlinal faults

vii. Shear or tear faults/strike or wrench faults

These are formed as a result of horizontal movements caused by the intense stress coming from opposite directions but acting obliquely to one another. In case there is displacement of blocks during the formation of tear faults, that is, when there is both horizontal movement and vertical displacement, the fault formed will be called Oblique slip fault.

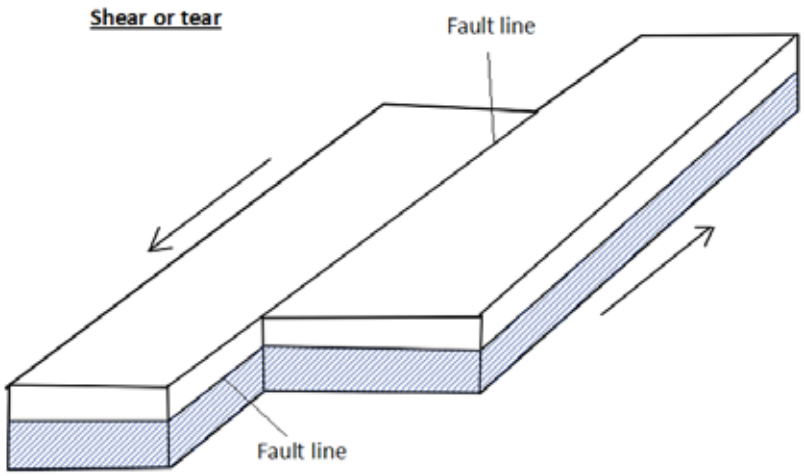
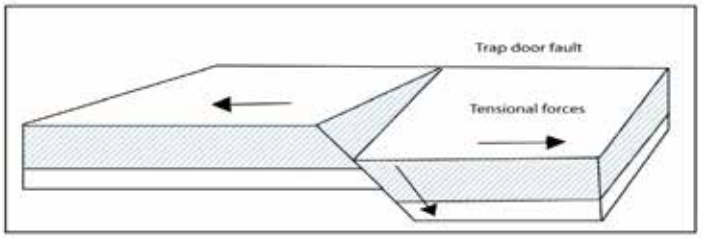


Figure 6.114: Tear faults

viii. Trap door fault is a type of fault produced by tension forces when fracturing does not cut through the whole crustal rocks (i.e: semi-diplacement takes place).



Application activity 6.2

Basing on the knowledge and skills acquired from the above lesson, describe the area where the faulting process occurred.

6.3. Influence of faulting on landscape and drainage

Learning activities 6.3

Kwigira and Mahoro are students from GS Terambere. They visited Lake Kivu and its surrounding area in the western part of Rwanda. Back to school, they were told to give the description of the area they had visited. In the description they included: Lake Kivu and other different relief features around. They said that their teacher called Bumwe who accompanied them explained how Lake Kivu was formed. He said that Lake Kivu was formed in the same way as Lake Tanganyika, Eduard, George, Manyara and Turkana in East Africa. Furthermore, teacher told them that there are other landforms which resulted from faulting in Africa and in the World. Basing on this story answer the following questions:

1. Describe the impact of faulting on the landscape of the area visited by Kwigira and Mahoro.
2. Examine other landforms produced as a result of faulting not mentioned in the passage above.
3. Assess the impact of faulting on the drainage system.

6.3.1. Influence of faulting on landscape

There are several landforms produced by faulting including: rift valleys, fault scarp, escarpments, block or Horst Mountains, fault guided valleys, titled block/landscape, Rift valley lakes and grabens.

Rift Valley

Rift valley is a trough or hollow/depression (graben) which may result from both tensional and compressional forces. It is formed when two faults are developed parallel to each other. The middle part sinks to form the floor of the rift valley. The outer blocks remain standing to form escarpments.

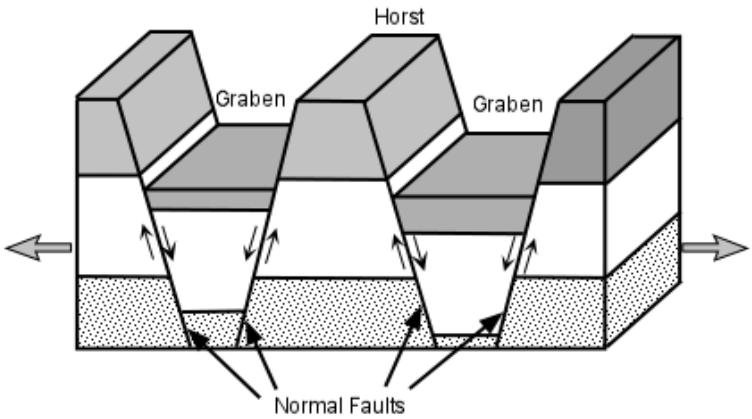


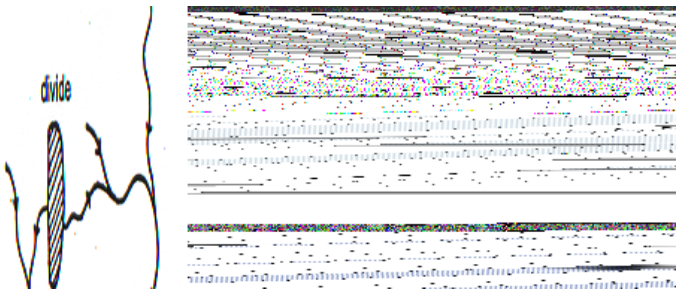
Figure 6. 116: A Graben

There are various theories put forward to explain the formation of the rift valley and they include: Tensional theory, compressional theory, differential up-lift theory, crustal separation theory and relative sinking theory.

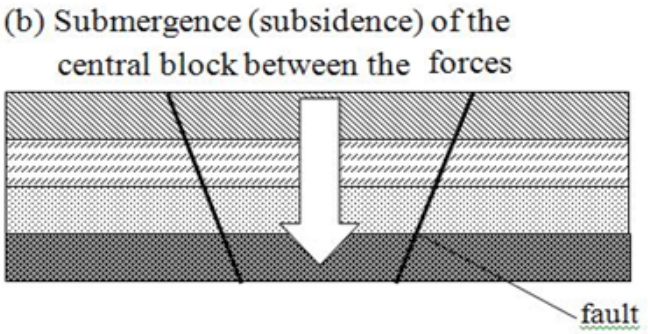
a. Formation of the rift valley by tensional forces (Tensional theory by J.W.Gregory)

A rift valley is formed when tensional forces move away from each other. These tensional forces produce faults and the block (part of the crustal block in the middle) of between two parallel faults subsides to form a rift valley. The outer blocks remain standing to form escarpments.

Phase 1: Before faulting



Phase 2: During faulting /creation of normal faults



Phase 3: Rift valley formed

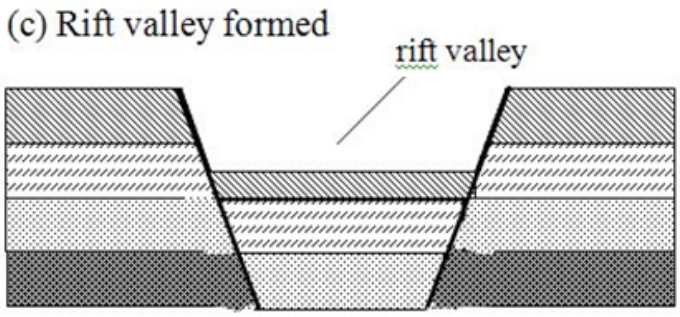


Figure 6.117: Rift valley formation by tensional forces

b. Formation of the rift valley by compressional forces (Compressional theory by E.J. Wayland)

Rift valley is formed when horizontal forces act towards each other. These forces push the crustal rocks or layers towards the centre from all sides. These forces of compression produce two parallel faults and the pieces of land on either side are lifted above the general level of the ground to form a rift valley.

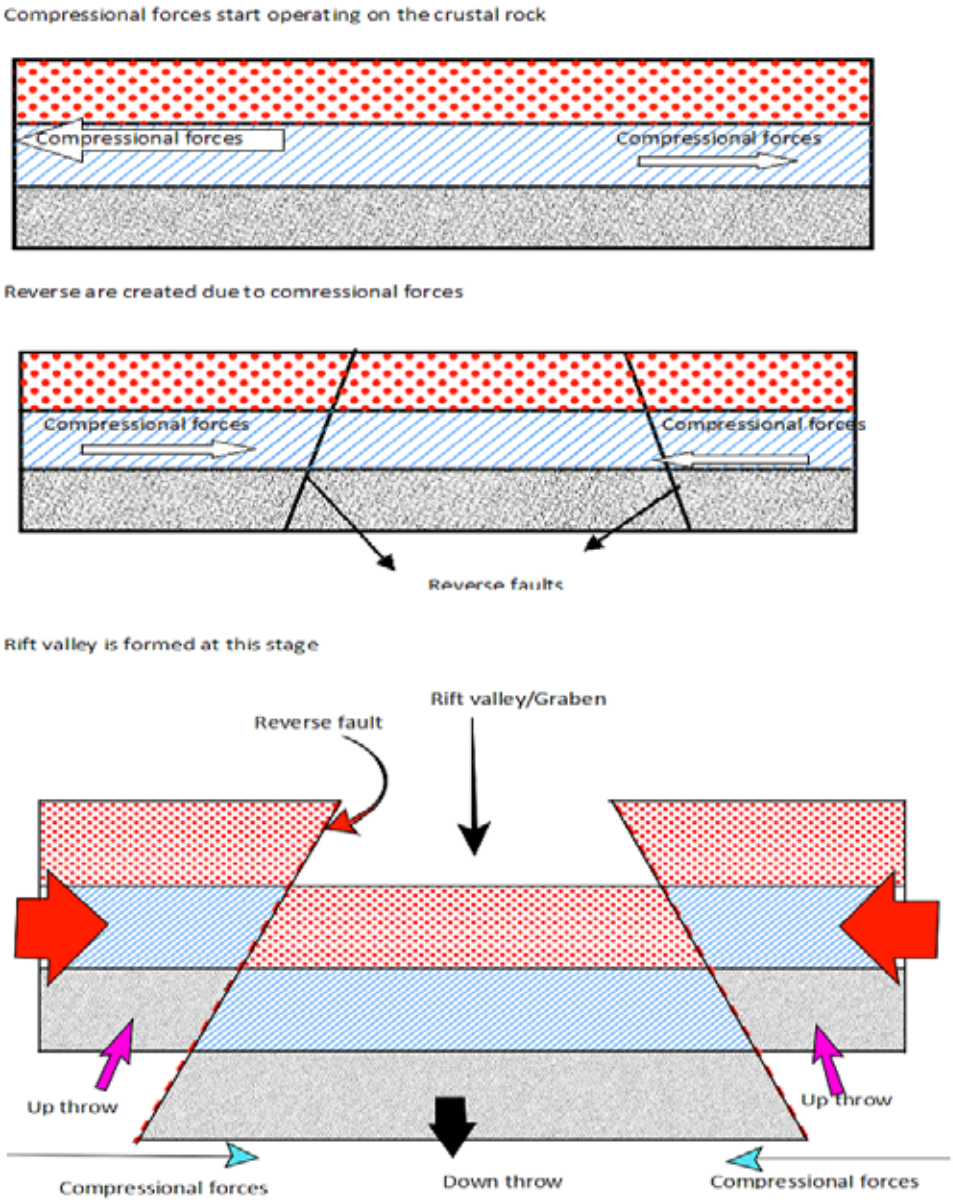


Figure 6.118: Formation of the rift valley by compressional forces

c. Theory of differential uplift (by Dixey and Troup)

Rift valley is formed when normal faulting produces several normal fault lines followed by gradual up lift of the faulted area with several step faults. Typical example is Kedong in the part of Nairobi.

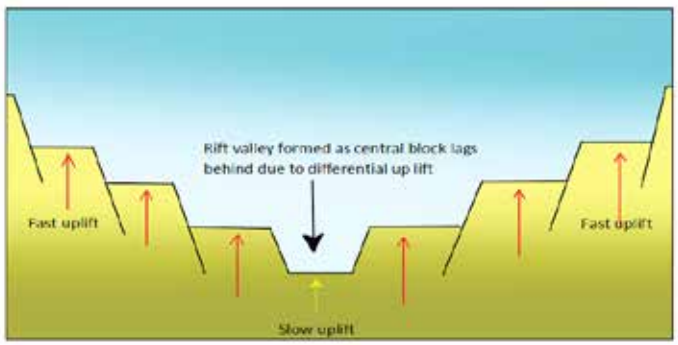


Figure 6.119: Rift valley formed as central block lags behind

d. Theory of crustal separation/Plate tectonics theory

The theory suggests that the rift valley was formed as a result of sea-floor spreading or tectonic movement, where convectional currents within the mantle rise vertically and then divert from each other horizontally. This results in the dragging of oceanic or continental plates. Such results in the breaking of crustal layers that are dragged apart together with continental rafts. As the movement continued, the central block was forced to subside. Example: along the Atlantic oceanic trench, where the plates continue moving apart.

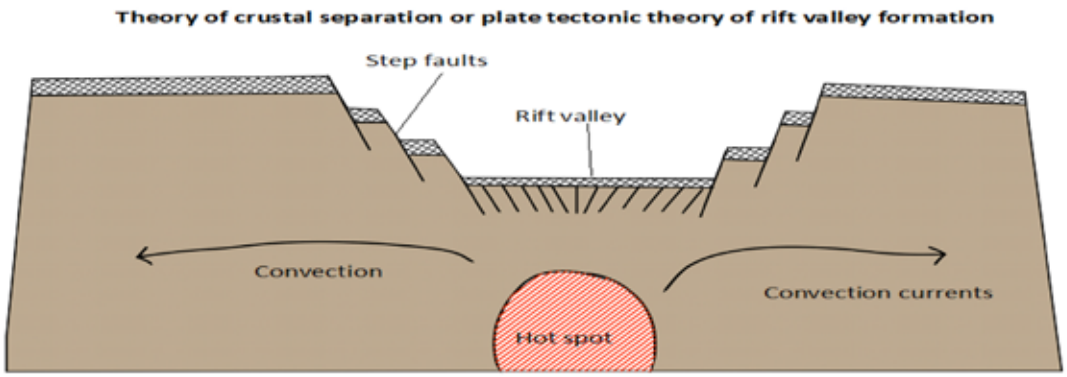


Figure 6.120: Rift valley formed in the manner of sea-floor spreading or tectonic movement

e. Theory of relative sinking (by Suess)

This happens when there is contracting of the earth followed by the fault blocks that are slowly settled. It makes some blocks remaining in the original position (standing up) to form horsts. Others,which are settled faster, form graben or rift valleys. A typical example is the Kamasia ridge in Kenya.

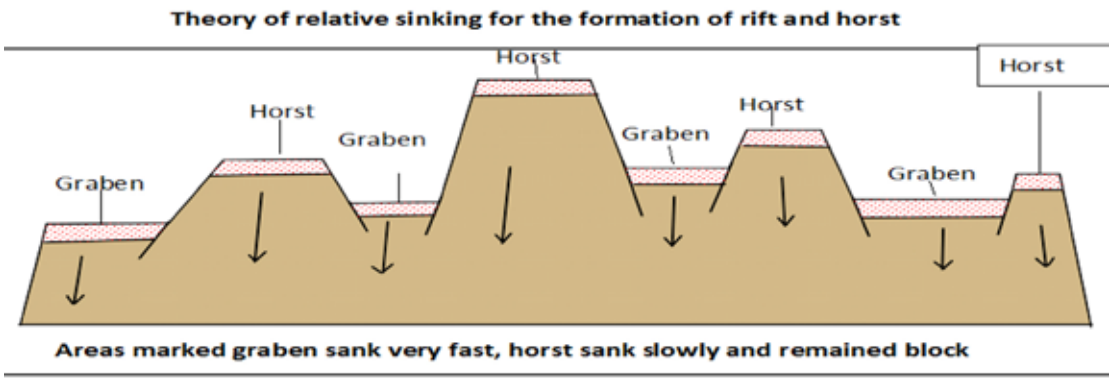


Figure 6.121: Rift valley formed when there is contracting of the earth

The following are some examples of rift valleys: East African rift valley in Africa; Jordan rift valley in Asia and Rhineland rift valley in Europe.

Block mountain (horst)

A block mountain is an upland bordered by fault scarps on both sides (the block of land between two faults being uplifted because of compressional forces.

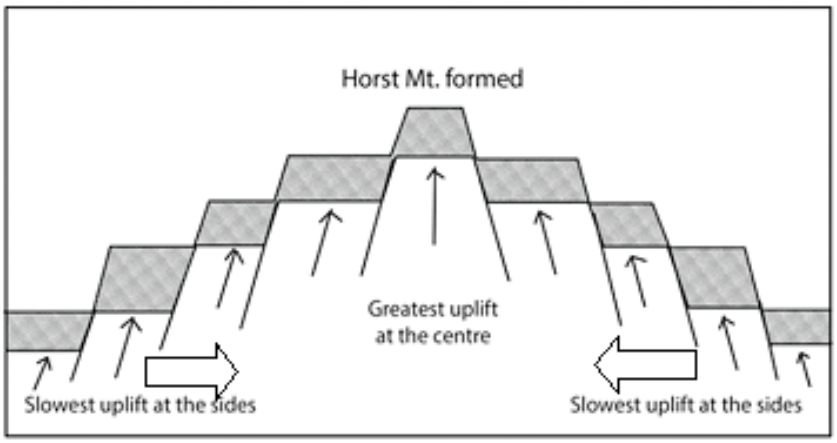


Figure 6. 122: Block Mountain

The following are some examples of Block Mountains: Cyamudongo, Mishahi, Muzimu, Cyendajuru in the western part of Rwanda; Usambara and Uluguru in Tanzania; Rwenzori in Uganda; Vosges and Black Forest in Europe and Mount Sinai in Asia.

Fault step landscape/tilt block landscape is when vertical tectonic forces push a block of crustal rocks or layers upwards and it happens that some middle parts are pushed higher than others. This is usually because of uneven forces that cause the formation of horst titled landscape characterized by several fault carps (step faults). These can also be formed as a result of differential up-lift.

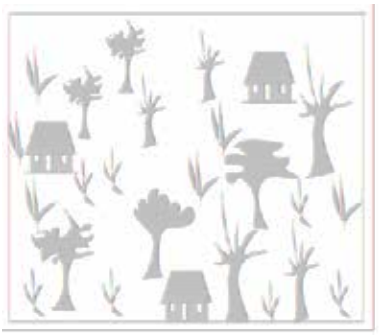


Figure 6.123: Fault step landscape/tilt block landscape

Fault scarp: An escarpment or cliff/steep slope (a wall of lift valley) formed by a fault that reaches the Earth's surface. Most fault scarps have been modified by erosion and mass wasting that may reduce the vivid evidences of faulting.

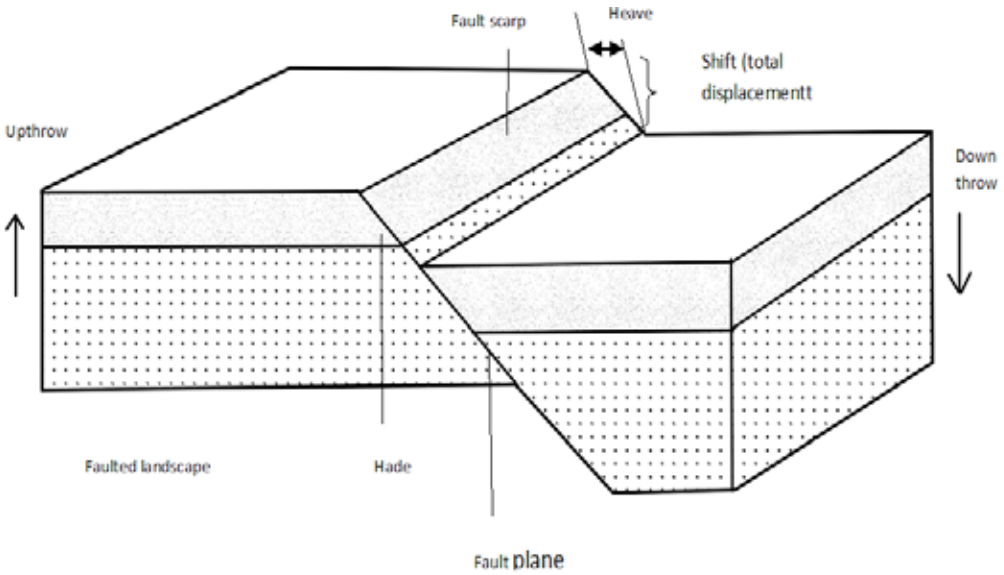


Figure 6.124: Fault scarp

6.3.2. Influence of faulting on drainage

- Faulting influences the drainage pattern in a given area. The different drainage patterns influenced by faulting include rectangular, parallel and trellised drainage patterns.
- Most of the time, water passes through the valleys, depressions and fractured areas hence forming fault guided valleys. A good example is River Rusizi in western Rwanda.

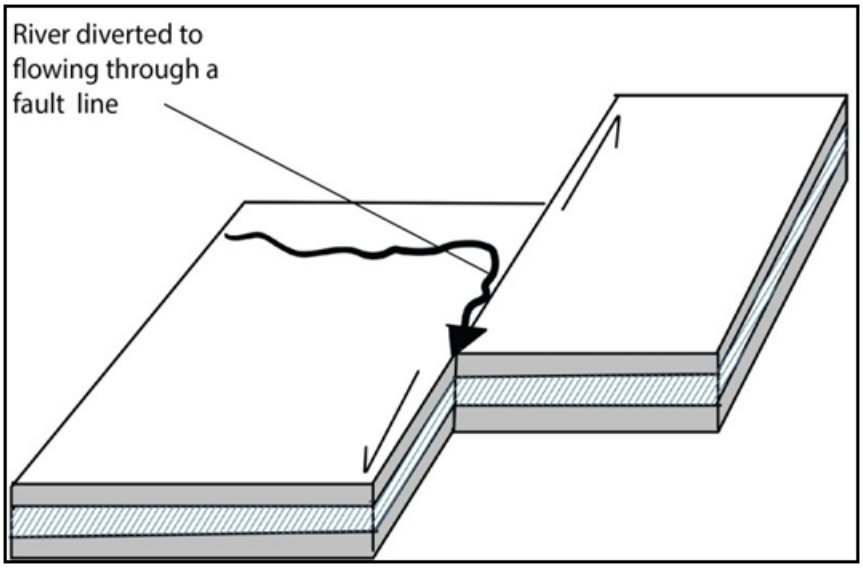


Figure 6.125: A river in faulted area

- Faulting leads to river reversal (change of direction). Example of river reversal due to faulting include River Katonga and Kafu in Western Uganda that were joining the Congo river basin and reversed towards Victoria basin. The figure below shows how River Katonga and Kafu changed their flow of direction to Lake Victoria basin as a result of faulting in Western part of Uganda.

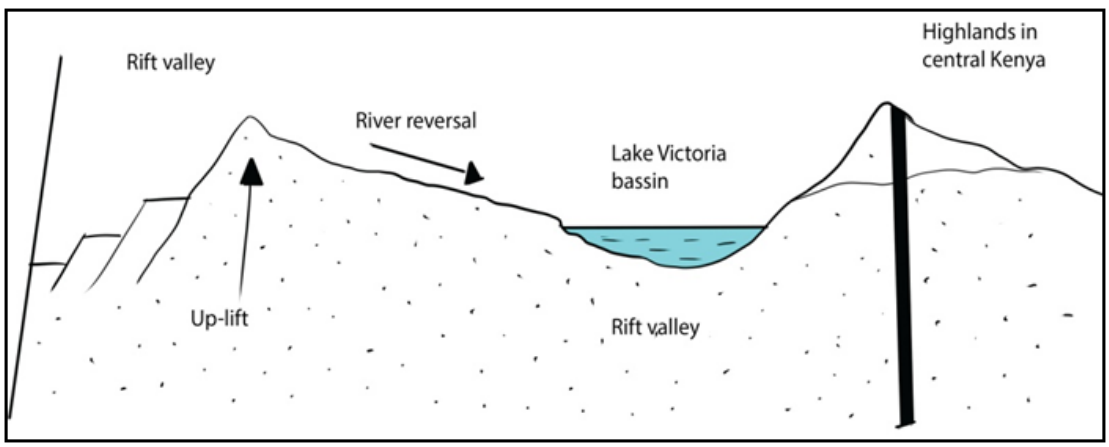


Figure 6. 126: River reversal from faulting

– Rift valley lakes are formed when graben or rift valleys are filled by water. Typical examples include: Lake Kivu, Eduard, Albert, George, Tanganyika in the western arm/branch of East African rift valley, Turkana, Manyara, Nyasa, Magadi in the Eastern arm/branch of East African rift valley.

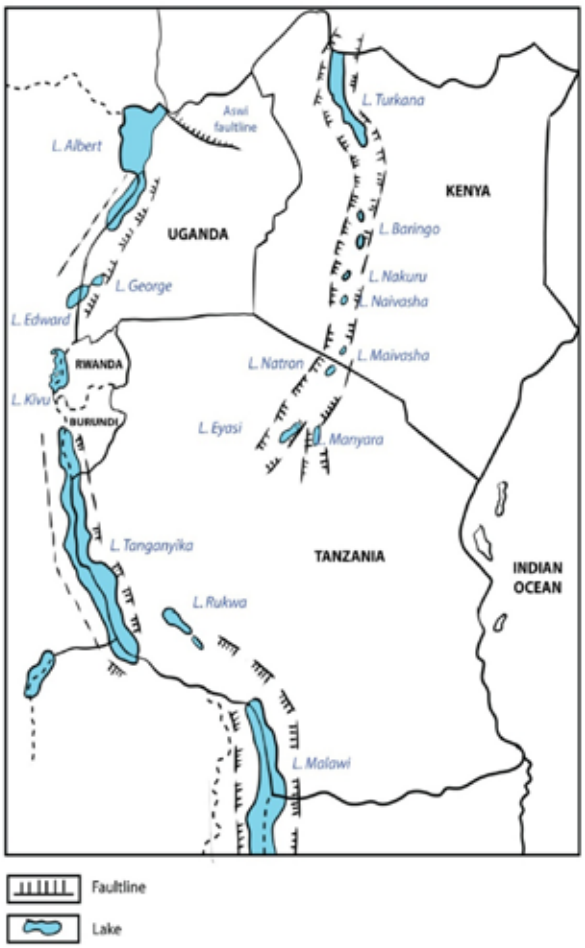


Figure 6.127: East African rift valley

– Some of the waterfalls are in faulted areas e.g. Rusizi, Mururu, water falls in Rwanda and Mubuku water falls in South Western part of Uganda.
– Faults give rise to the underground water table along fault planes. Typical examples are Mwiyanike and Nyamyumba in Rwanda.

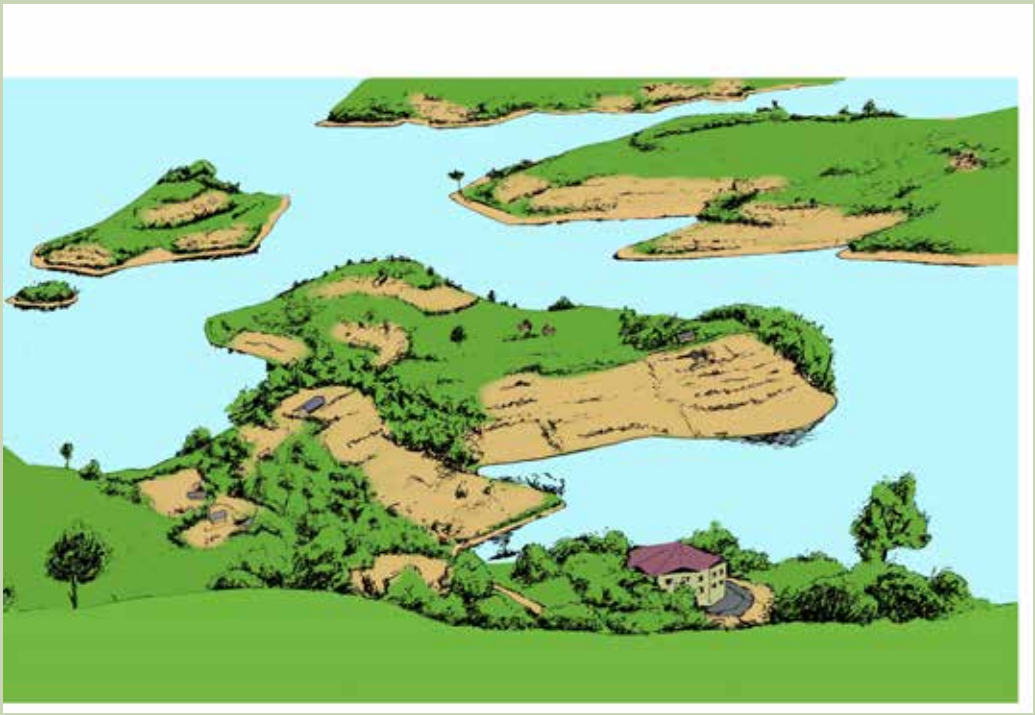
Application activity 6.3

Explain the influence of faulting on landscape and the drainage system in the context of Rwanda.

6.4. Impact of faulting on human activities

Learning activities 6.4

Study the photo below that has been taken from a faulted area and answer the questions that follow:



a. Describe the relief features represented on the illustration above.

b. Explain the relationship between physical features and man's activities taking place in the illustration.

6.4.1. Positive impacts

The positive impacts/effects of faulting to man include:

- Faulted sedimentary strata are good for oil exploration. A good example is oil deposit from Lake Albert in Uganda.
- Faults give rise to the underground water table along fault planes. This water is important for agriculture and it is used in industries and domestic activities.
- Faulting leads to the formation of depression which, when filled with water , form lakes like Kivu, Edward, etc. These lakes are used for fishing, irrigation, transportation and mining.

- Faulting creates lines of weaknesses in the earth's crust through which the underground hot water reaches the surface as hot springs and geysers. These are sites for geothermal power production. A good example is Nyamyumba hot spring.
- Faults may also give rise to waterfalls which are used for hydroelectric power generation.
- Features produced through faulting, for example, fault scarps, rift valleys and horsts are major tourist attractions.
- Faults play a leading role in the weathering of rocks. The courses of small streams often follow rock joint systems. This, therefore, facilitates soil formation.
- Some faulted features like rift valley lakes are good sources of minerals like methane gas from Lake Kivu.
- Faulting exposes mineral bearing layers of rocks, hence facilitating mining. E.g. copper mining around Mt. Rwenzori in Uganda.

6.4.2. Negative impacts

Below are some of the negative effects/impacts which include:

- Faulting processes result in destructive earthquakes
- Faulting processes change the existing landforms to create the new landforms; hence deforming the already existing beautiful scenery.
- Faulting processes may result in volcanic eruption which comes along with ill-effects.
- Fault scarps form topographic barriers that make the development of infrastructure such as roads and railways difficult.
- Faulted areas are barriers to the development of transport and communication lines.
- Faulted areas discourage the settlement, agriculture and livestock, industrial development, etc.

Application activity 6.4

Conduct your own research to assess both the negative and positive impacts of faulting on human beings.

6.5. Distribution of landforms associated with faulting

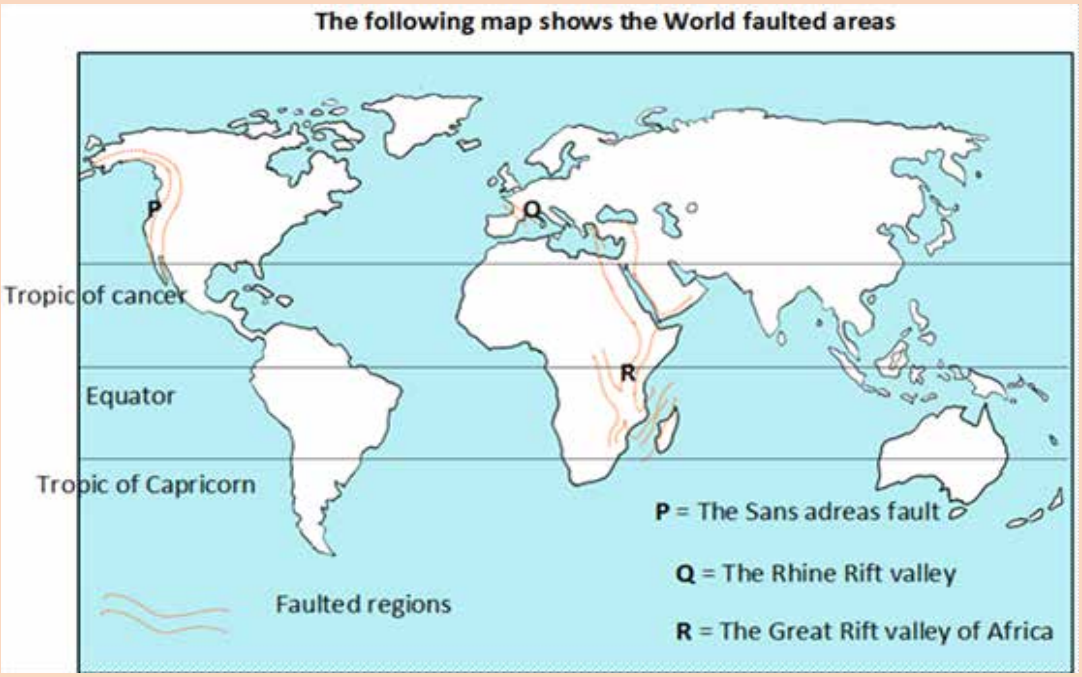
Learning activity 6.5

1. Draw a sketch map of East Africa, name and locate faulted areas.
2. Identify the world areas that are most affected by faulting outside East Africa.

Fault areas are mainly located in the following areas:

- East Africa: Faulted areas in East Africa extend from Mozambique in the South to the Red Sea in the North and from Malawi through Tanzania and Burundi, then Rwanda to Uganda and Kenya.
- Western Europe: Many faulted areas are in deep oceanic parts of the Atlantic Ocean in Western Europe.
- The Rhine Rift Valley extends along the border of North East France and South West Germany.
- The Western Coast of North America, which includes the San Andreas Fault of California.
- The Alpine fault region in New Zealand in the Far East.
- The North Western highlands of Scotland and the Guadalquir valley of Spain.

Application activity 6.5



Study the world map above, indicate and name the main areas affected by faulting.

6.6. Definition of folding and its process

Learning activity 6.6

Read the passage below and provide answers to the question that follow:

The relief of Rwanda is characterized by six topograhic units that include Bugarama plain and Lake Kivu Banks, Congo-Nile crest, Central plateaus, Eastern low lands, Buberuka region and the Volcanic region. Some of these topographic units were formed through faulting process as it was explained in the previous lesson. Those topographic units formed as a result of faulting include Bugarama plain and Kivu banks. On the other hand, volcanicity has been responsible for the formation of volcanic relief in the North, while the Eastern lowlands resulted from warping. Some landforms of Rwanda were formed through folding processes. Refer to the above presented passage to answer the following questions:

a. Explain the folding processes

b. Differentiate the folding processes from other internal processes in the passage.

Meaning of folding and folds

Folding is a process by which crustal rocks bend due to compressional forces. This results from horizontal movements caused by the endogenic forces originating deep within the earth.

Folds are the wave-like bends resulting from folding processes. The up-folded rock strata in arch-like forms are called anticlines, while the down folded structure forming trough-like feature is called syncline. The sides of a fold are called limbs of the fold.

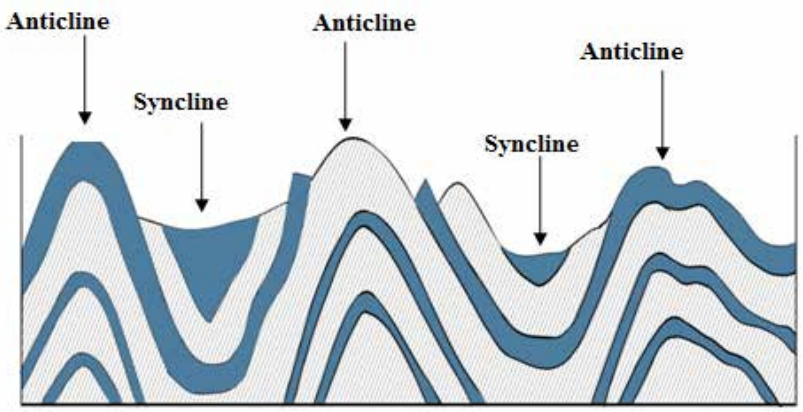


Figure 6.128: Anticline and syncline

Processes of folding

The processes of folding are mainly engineered by the presence of compressional forces that push intensely the crustal layers/rocks towards a common centre. When crustal parts move towards each other under the influence of horizontal or convergent forces (compressional forces), the crustal rocks undergo the process of 'crustal bending.

The process of folding occurs in areas with soft and young rocks and instead of fracturing due to the internal forces or convectional currents that lead to the formation of compressional forces, the crustal layers start to bend.

Application activity 6.6

Compare the process of faulting and folding in the context of Rwanda.

6.7. Types of folds

Learning activity 6.7:

Referring to the knowledge and skills about folding, describe the characteristics and categories of the limbs, synclines and anticlines formed as result of folding process.

Based on the inclination of the limbs, folds are divided into the following categories:

Symmetrical folds are simple folds whose limbs incline uniformly. These folds are examples of open folds. Symmetrical folds are formed when compressional forces work regularly but with moderate equal intensity. Symmetrical folds are very rare indeed.

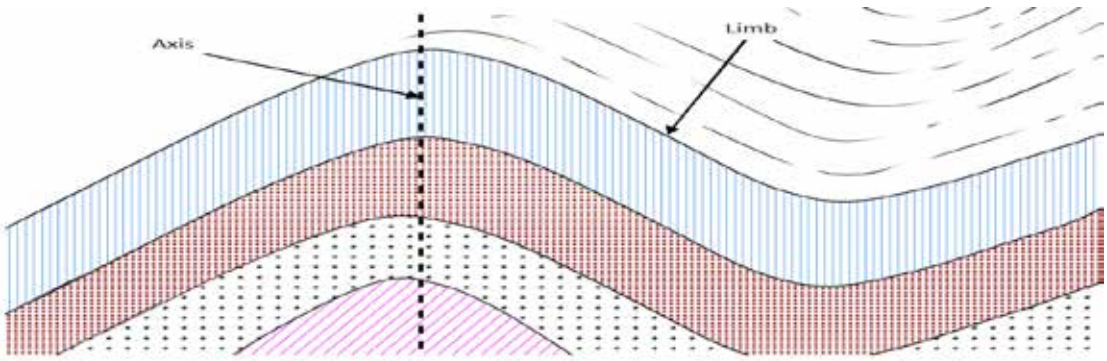


Figure 6. 129: Symmetrical folds

Anticlinal fold: This is a fold that has the convex appearance with the oldest beds at its core.

A syncline fold: This is a fold with younger layers closer to the folded structure. Synclines are typically a downward fold, termed as syncline (i.e. a trough) but synclines that point upwards or perched can be found when strata have been overturned and folded.

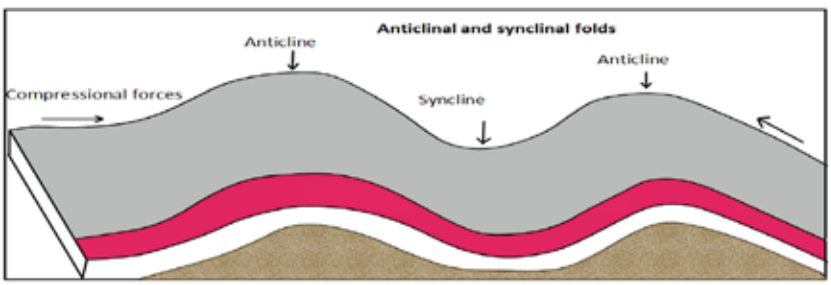


Figure 6.130: Anticlinal and syncline fold

Asymmetrical folds: These are characterized by unequal and irregular limbs. Both limbs incline at different angles. One limb is relatively larger,with moderate and regular inclination, while the other is relatively shorter with steep inclination. Thus, both limbs are asymmetrical in terms of inclination and length. They are formed when compressional forces acting upon the crustal young layers are unequal. One side is intensely pushed while the other is moderately compressed.

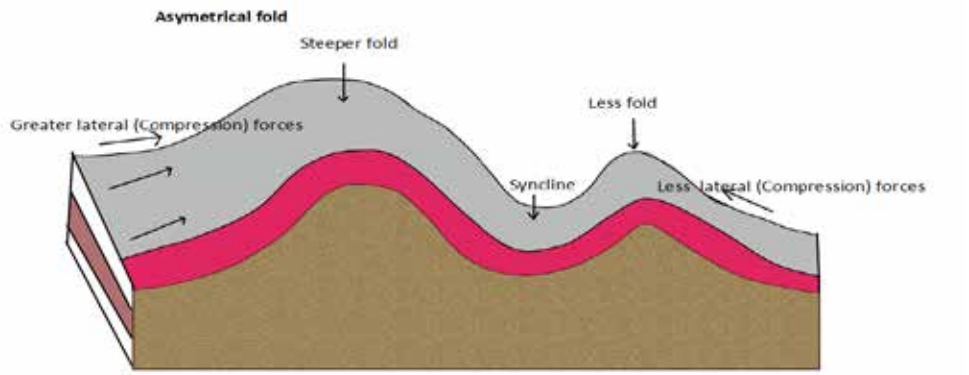


Figure 6.131: Asymmetrical folds

Over fold: This is a type of fold formed where the compressional forces push one limb in asymmetrical fold over the other limb at a short distance.

Figure 6.132: Overfold

Monoclinal folds: These are folds in which one limb inclines moderately with regular slope while the other limb inclines steeply at the right angle at the slope is almost vertical. Splitting of limbs gives birth to the formation of faults. Also monoclinal folds are formed as a result of unequal horizontal compressional forces coming from both sides.

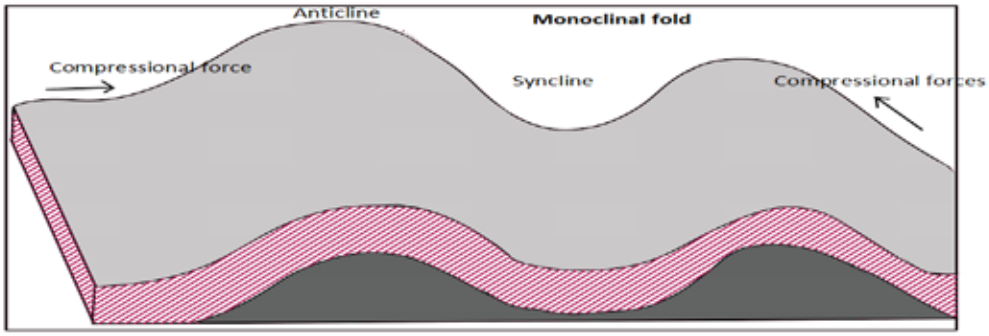


Figure 6.133: Monoclinal folds

Over thrust / Nappes: These are the results of complex folding mechanism caused by an intense horizontal movement and resultant compressional forces. Both limbs of the recumbent fold are parallel and horizontal. The great intensity of the compressional forces on one limb causes the crest to fracture (Faulting). Therefore, one part of the block jumps over the other.

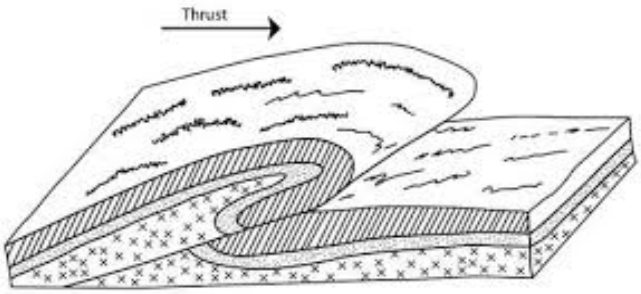


Figure 6.134: Overthrust fold

Isoclinal folds are formed when the compressive forces are so strong that both the limbs of the fold become parallel to each other and not horizontal.

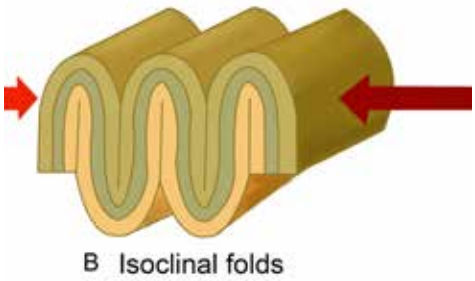


Figure 6.135: Isoclinal folds

Recumbent folds: These are formed when the compressional forces are so strong that both the limbs of the fold become parallel as well as horizontal.

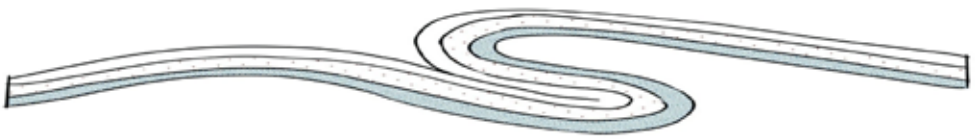


Figure 6.136: Recumbent folds

Overturned folds: They are folds in which one limb of fold is thrust up on another fold due to intense compressive forces. Limbs are seldom horizontal.

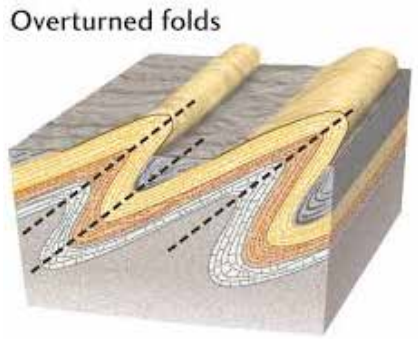


Figure 6.137: Overturned folds

Fan folds represent an extensive and broad fold consisting of several minor anticlines and synclines. Such folds resemble a fan and the resultant feature is called an anticlinorium or synclinorium.

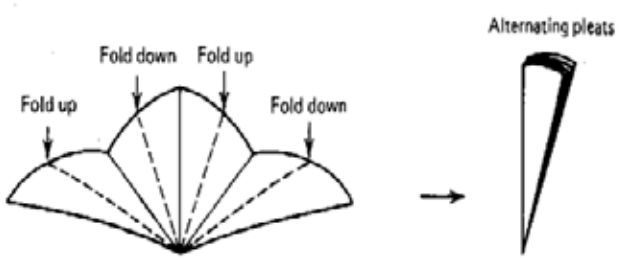


Figure 6.138: Fan folds

Open folds are those in which the angle between the two limbs of the fold is more than 90° but less than 180°. Such open folds are formed due to wave like folding because of the moderate nature of compressional forces.

Closed folds are the folds in which the angle between two limbs of a fold is acute. Such folds are formed because of intense compressional forces.

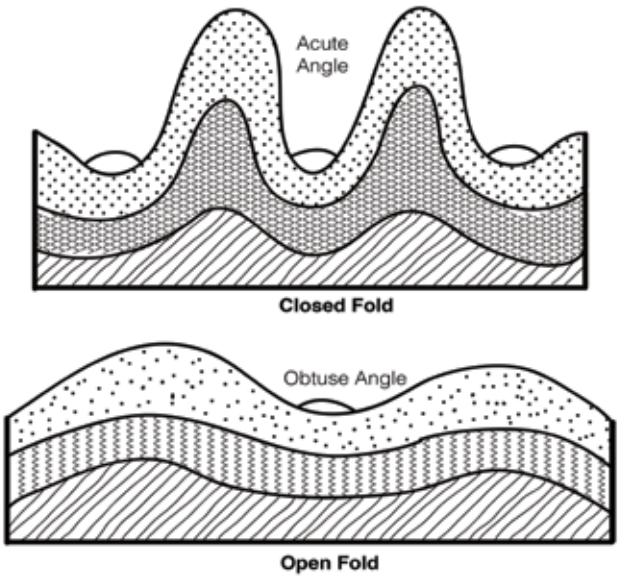


Figure 6.139: Closed and open folds

Chevron folds are structural features characterized by repeated well behaved folded beds with straight limbs and sharp hinges. These display a set of repeated set of v-shaped beds.

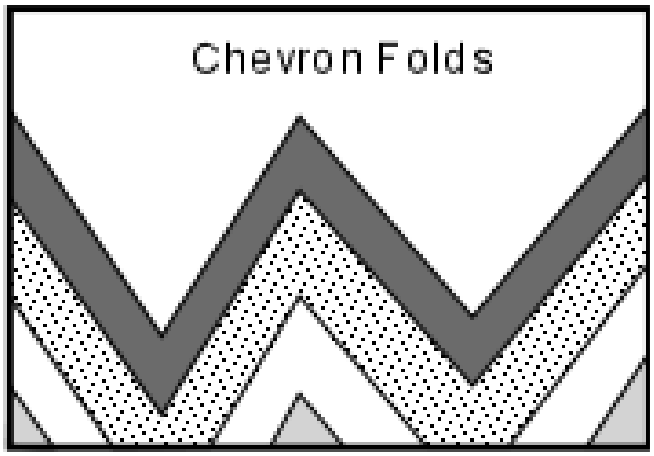


Figure 6.140: Chevron folds

Dome and basin fold:

These are types of folds that display dome-like anticlines instead of arching. Therefore, the fold assumes a dome shape that looks like an inverted bowl. The would-be syncline forms basin like appearance instead of having a sinking arch. A typical example is the Mauritania desert.

Figure 6.141: Dome and basin folds

Application activity 6.7

With help of digram, differentiate symetrical fold from other type of folds referring to knowledge and skills you gained about folding.

6.8. Influence of folding on the drainage and landscape

Learning activity 6.8

1. Suggest the impact of folding processes on any landscape you have observed.
2. Assess the impact of folding on the drainage system.

6.8. 1. Influence of folding on drainage

The following are examples of the influence of folding on drainage:

- Folding led to the formation of many waterfalls in Rwanda and elsewhere in the World. Some of the waterfalls are located on the upward folded areas. A good example is Rusumo waterfall.
- Fold Mountains are good catchment areas. A typical example in Rwanda is in Gicumbi District.

6.8.2. Impact of folding on landscape

There are various landforms resulting from folding. They include:

Rolling plains: These types of landforms result from down warping movement caused by the folding processes. They have gently sloping anticlines with very wide synclines.

Ridge and valley landscape: The strong compressional forces create a series of asymmetrical folds. The anticlines form the uplands (ridges) while the synclines form the valleys.

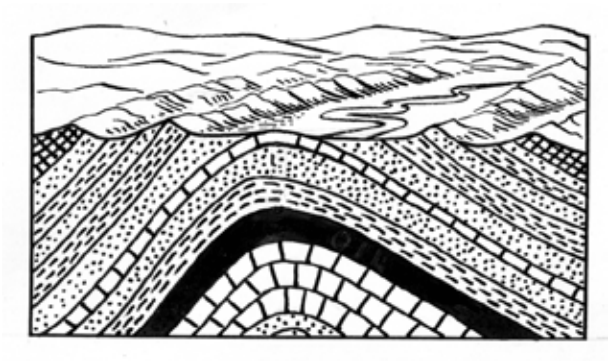


Figure 6.142: Ridge and valley landscape

Fold Mountains: The most common features resulting from the process of folding are the mountains. The mountains rise to different heights depending on the velocity and intensity of compressional forces.

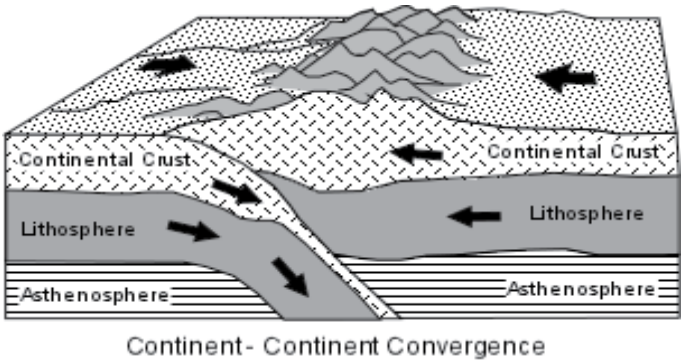


Figure 6.143: Fold Mountains

The following are examples of folded mountains:

- Highlands located in the Northern region of Rwanda (various mountains located for instance in Gakenke, Musanze, Burera);
- Kigezi highlands in South Western Uganda;
- Caledonian folds: The folds of Caledonia are found in Scotland, and they affected the Caledonia and Scandinavian countries during the primary era

(Paleozoic);

- Hercynian folds, they include: Mountains in Scotland and the Appalachians in America
- Rockies and Andes in America;
- Insular arcs of the Pacific Ocean;
- Parts of Asia: Japan, Philippines, Kouriles Islands;
- Near the Equator: Marianna, New Zealand, Kermadea;
- Parts of Europe: Alps;
- Parts of South Asia (Saudi Arabia and India);
- North Africa: around the Mediterranean Sea.

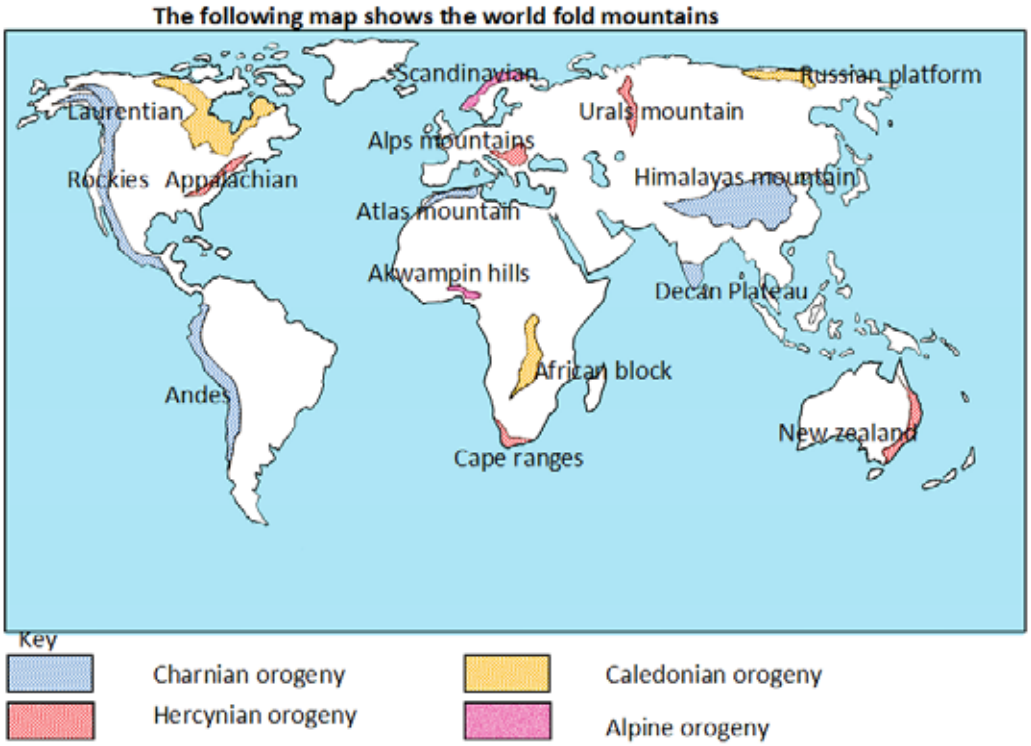


Figure 6.144: The world main fold mountains

6.8.3. Impacts of folding on the physical environment

The above features formed through folding process influence the human activities positively and negatively as follow:

Positive effects

- Fold Mountains receive heavy rainfall on the windward side hence favouring crop growing while the leeward side receives little or no rainfall. Thus, there is

agriculture and livestock keeping on the windward side;

- Fold mountains are a source of clean water, which is used by human beings;
- The fold mountainous areas can be used for lumbering activities;
- During folding, some valuable minerals are brought closer to the earth's surface. This promotes mining activities.
- Some features resulting from folding attract tourists who bring foreign exchange.

Negative effects

- The Foëhn winds associated with leeward sides in fold mountain areas discourage the growing of crops, hence hindering agriculture.
- Fold Mountains are barriers to the development of transport and communication lines. They hinder air transport due to poor visibility;
- The steep and rugged slopes of Fold Mountains discourage settlements, agriculture and livestock keeping.
- Fold moutains discourages the development of mining sector since some minerals can be taken deeper into the ground and become hard to exploit especially in synclinal parts.

Application activity 6.8

1. Conduct your own research to identify both negative and positive impacts of folding on environment.
2. Assess the significance of fold mountains to the economic development of Rwanda.

6.9. Meaning, causes and types of warping

Learning activity 6.9

Read the passage below and provide answers to the questions that follow:

The relief of Eastern Rwanda is characterized by low plateaus formed through an internal process that operate by gentle compressional forces caused by internal convection currents. That process led to formation of various physical features namely undulating gentle hills, basin and basin lakes.

a. Identify the process that has been responsible for the formation of features mentioned in the above passage.

b. Describe how the process of warping occurs.

c. With specific examples; explain the influence of warping on the drainage system.

6.9.1. Meaning of warping

Warping is the downward movement of crustal rocks caused by the sinking of convectional currents within the interior part of the earth. This results in a saucer-shaped basin. It is produced where only a gentle deformation of crust has taken place over a considerable area and time. It results from the sinking of convectional currents which pull the earth's crust towards the core. A typical example where warping took place in East Africa is Lake Victoria basin.

6.9.2. Types of warping

There are two types of warping:

Down warping: This is formed when the sinking of convectional currents drag downwards the lower part of the crust. Therefore, the crustal layers bend inwardly to form basins. This created East African major basins i.e. the depressions occupied by Lake Victoria, lake Kyoga in Uganda and Lake Muhazi in Rwanda are good examples.

Up warping: During the down warping, the outer parts of the crustal layers tend to move upwards. This is commonly caused by isostatic movement associated with upward movement. It produced up land regions like East African plateaus and other uplands elsewhere in the world.

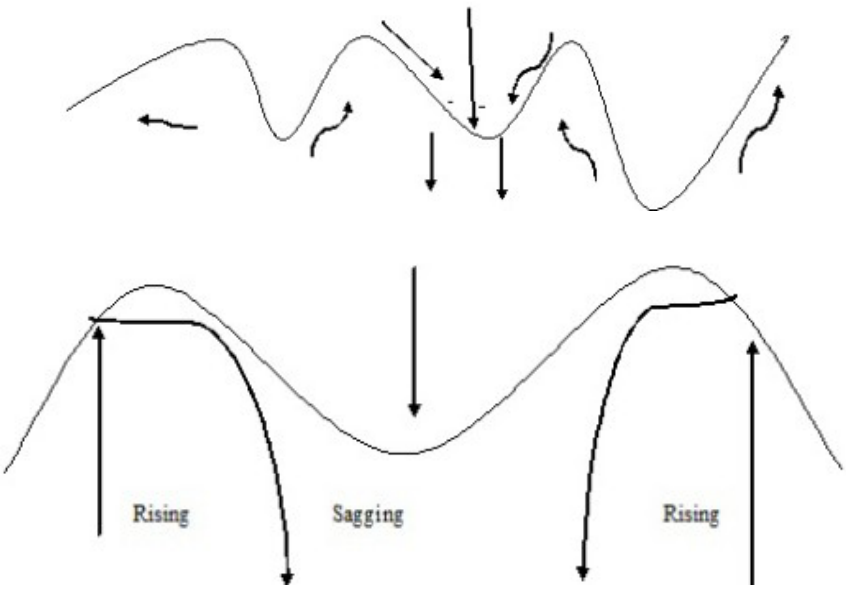


Figure 1.145: Up and down warping

Broad warping

When the process of up warping and down warping affects larger areas, the resultant mechanism is called broad warping.

6.9.3. Causes of warping

Warping is mainly caused by convection currents that result in lateral compression forces of low intensity or gentle compressional forces. Typical examples are in East Africa where few areas escaped the down warping and up warping processes. The process led to the formation of Great East

African Basin, crustal warped lakes, extensive swamps around the lakes, extensive plateaus, reversal of some rivers, etc.

6.9.4. Landforms associated with warping

The process of warping led to formation of numerous landforms which include:

Plateau: it is a large and extensive uplifted part of the earth's crust which is almost flat at the top. The top of the plateau is mostly flat (i.e. a plateau is a flat toped hill. Example: Eastern plateaus of Rwanda, the Rwandan part affected by Warping). Other plateaus resulted from warping include: Guinea highlands, Jos plateau, Ahaggar, etc.

Basin: It is a large and extensive depression on the earth's surface. Most basins are formed due to vertical downward movement of the earth's crust.

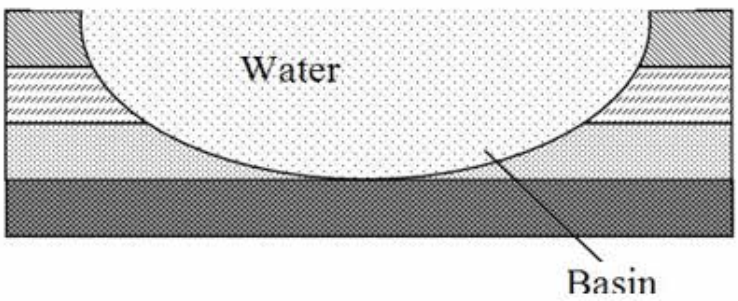


Figure 6.146: Basin

Examples of basins include: An inland drainage e.g. Congo; Chad; and Amazon basins. When a basin is filled by water; it forms basin lakes like Lake Muhazi and Mugesera in Rwanda, Lake Victoria, etc.

Plains: These refer to flat areas that are located in lowland areas. Typical examples are generally in coastal regions that were greatly affected by warping process.

6.9.5. Influence of warping on drainage

Warping plays a major role in the drainage system

- Some rivers change their courses due to warping in a given area. A good example is the case of hydrography of East Africa where some rivers changed direction and other filled the depressions to form lakes.
- Warping led to the formation of many lakes in East Africa. Good examples include: Lake Victoria and Lake Kyoga in Uganda, Lake Muhazi and Mugesera in Rwanda.
- Some of the waterfalls are located on the upward warped areas.
- The drainage of Rwanda flows from West to East from the up warped features of Rwanda.

Positive effects

- Upward warping areas receive heavy rainfall on the windward side favouring crop cultivation.
- The water of river flowing from the warped areas is clean and may be used by human beings in various activities;
- The upward areas may be used for lumbering activities;
- During warping, some valuable minerals are brought closer to the earth's surface. This promotes mining activities;
- Some features resulting from warping attract tourists which bring foreign exchange.
- Basin lakes stimulate various activities like fishing, water transport and provision of water for irrigation;
- Hills formed under warping stimulate the development of communication by favouring the construction of communication masts.

Negative effects

- The destructive Foehn winds are common in warped mountain areas.
- Warped areas are barriers to the development of transport and communication, where they lead to high cost of the construction of roads.
- The steep and rugged slopes of warped mountains discourage the settlement, agriculture and livestock keeping.
- During warping, some valuable minerals can be taken deeper into the ground and become hard to exploit.

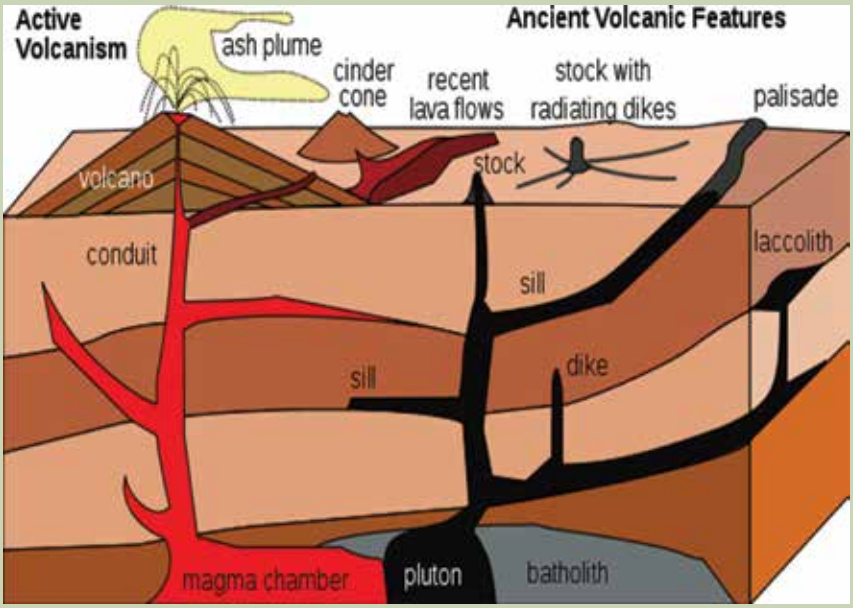
Application activity 6.9

1. "Some parts of East Africa have been affected by up warping and down warping". With relevant examples support this statement.
2. Draw a sketch map of Rwanda on it label and name the major landforms which resulted from wraping.
3. Assess the significance of warping on drainage system of East Africa.

6.10. Processes of vulcanicity and volcanic materials

Learning activity 6.10

Study the figure below and answer the questions that follow:



1. Identify and explain the process illustrated in the above figure.
2. Suggest the materials which are ejected out associated with the process identified in (1) above.

The following are the key terms used in vulcanicity studies:

- **Vulcanicity** refers to the processes from which the molten materials are either ejected on the surface of the earth or remain in the earth's crust.
- **Volcanicity** refers to the process by which lava through volcanic eruption is ejected to the earth's crust.

– **A volcano** is a mountain that opens downward to a reservoir of molten rock below the surface of the earth.

Materials of vulcanicity:

Volcanic materials of various types are ejected through the volcanic pipe known as a vent. This is situated in the part of fault line that assisted the escape of magma. Volcanic materials include the following:

– **Vapour and gases:** Stream and vapour include phreatic vapour and magmatic vapour. Volcanic gases include carbon dioxide, nitrogen oxides, sulphur dioxide, hydrogen and carbon monoxide.

– **Magma and lava:** Generally, molten rock materials are called magma when they are still below the earth's surface. When they reach the earth's surface, they are known as lava. However, when it is still in the mantle it is refer to as molten material. Lava and magma are grouped into two classes. These include the following:

  a. Based on silica percentage; lava and magma are divided into two groups: acidic magma (high percentage of silica) and basic lava (low percentage of silica).

  b. Based on light and dark coloured minerals; lava and magma are also classified into Felsic and Mafic lava.

– **Fragmental or pyroclastic materials.** These are thrown out during the explosive type of eruption. They are grouped into three categories:

  – Essential materials - consolidated forms of live lava
  – Accessory materials - dead lava
  – Accidental materials - fragmental materials of crustal rocks.

Based on the size of pyroclastic materials: They are grouped into four kinds:

  – Volcanic dust (finest particles)
  – Volcanic ash (2 mm in size)
  – Lapilli (of the size of peas), and
  – Volcanic bombs (6 cm or more in size).

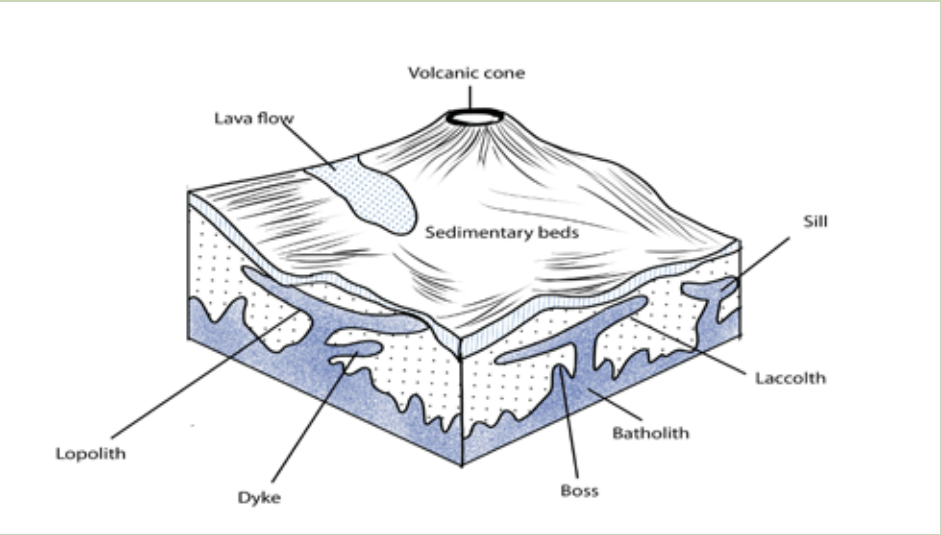
Application activity 6.10

1. Describe the main materials derived from vulcanicity.
2. Name and locate the volcanoes available in Rwanda.

6.11. Intrusive and extrusive features

Learning activity 6.11

Critically observe the illustration shown below and use it to answer the questions that follow:



Basing on your observation of the above illustration and the previous lessons on relief features of Rwanda studied in Senior Four, describe the landforms of volcanic region of Rwanda.

Magma found inside the crust may sometimes reach the surface of the crust through fracture, fissures and consolidate from there. In this case, the features formed are extrusive features.

But when the magma fails to reach the earth's surface and consolidate inside the crust before reaching the surface, the features formed are called intrusive features.

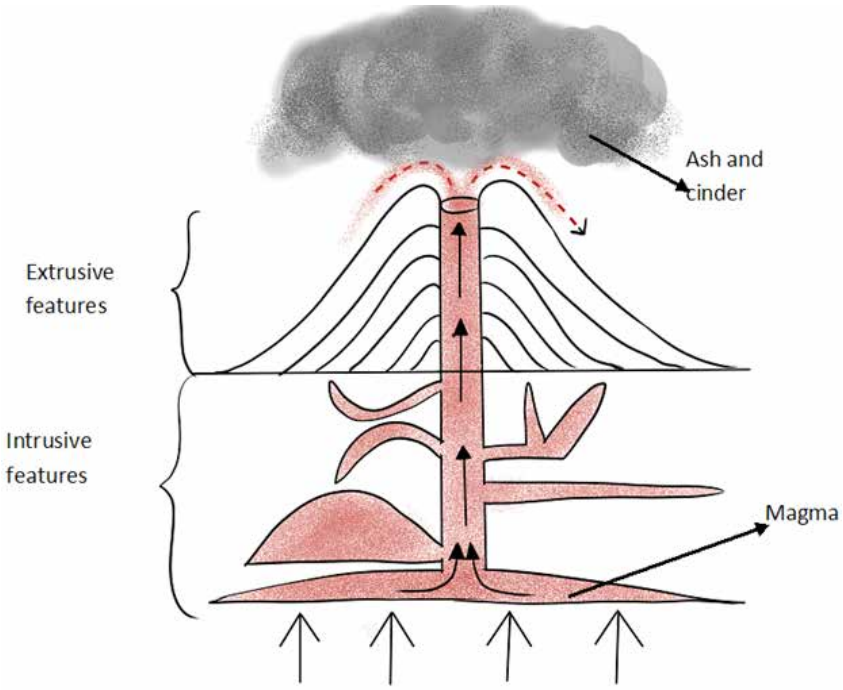


Figure 6.147: intrusive features

6.11.1. Extrusive volcanic features

These features include the following:

Volcano: This is formed when molten materials escape from the mantle and solidify on the earth's surface to form a highland known as volcano.

Acidic lava cone: This refers to a cone made of viscous lava normally that is ejected out of the earth's crust and solidifying faster as soon as it reaches the Earth's surface. It always cools faster than basic lava because it is viscous in nature.

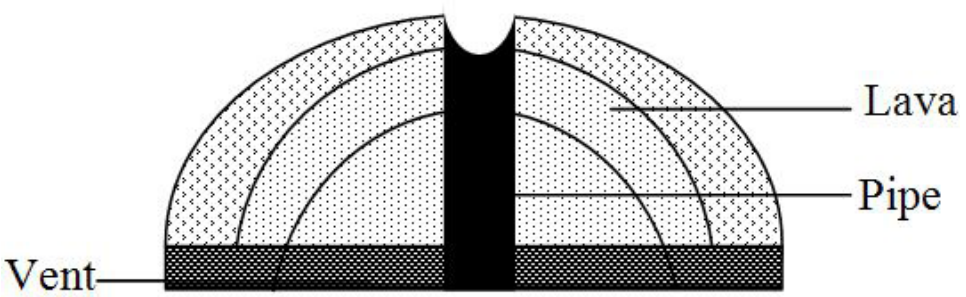


Figure 6.148: Vent, pipe and lava

Basic lava cone which is a cone of basic fluid/lava spread over a long distance. Basic lava cone is characterized by gentle slope. Basic lava cone is also known as shield or basalt volcanoes. Typical examples include Nyamuragira in DRC and Muhabura in Rwanda.

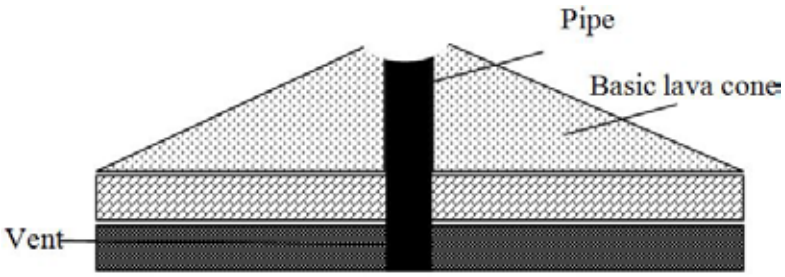


Figure 6.149: Basic lava cone

Crater: This is a volcanic depression on top of the volcano. There can be a ring crater or explosive crater in circular shape when a crater is filled by water, it forms a Crater Lake. Examples of crater lakes in Rwanda are found on Kalisimbi, Muhabura and Bisoke volcanoes.

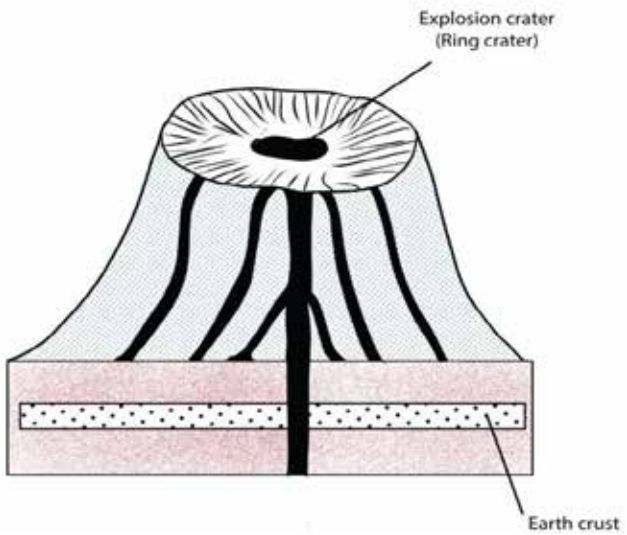


Figure 6.150: A crater lake on the top of volcano

A caldera: This is a wide depression that usually forms on top of a volcanic mountain due to explosive secondary eruption. When a caldera is filled with water, a Caldera Lake is formed. A typical example of dry caldera is Ngorongoro Caldera in Tanzania.

The stages in the formation of a caldera

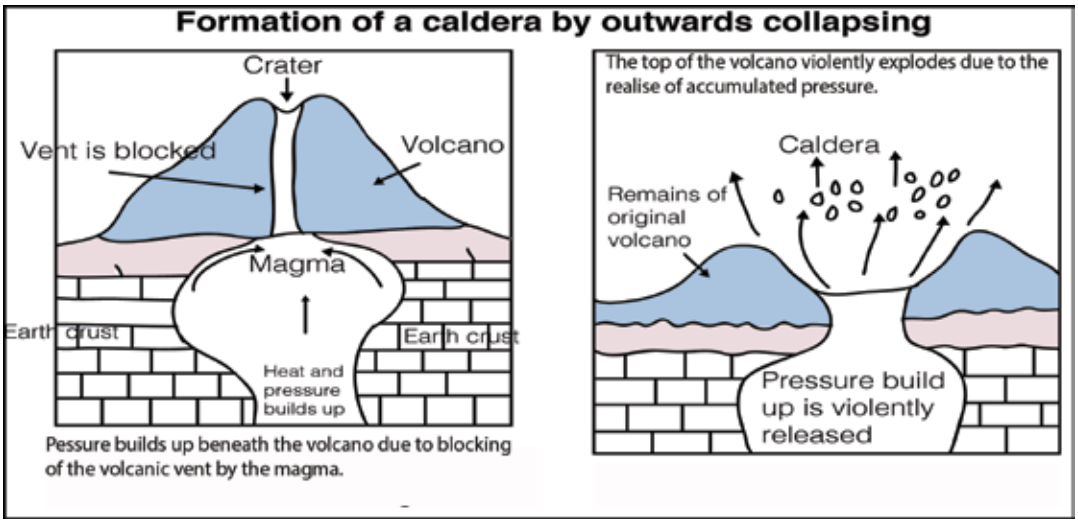


Figure 6.151: Stages in the formation of caldera

Ash and cinder cone: These are formed when lava is ejected into the air violently and breaks into small particles known as Ash and cinder. These fall back and pile up to form alternating layers of ash and cinder. These have slopes that are importantly concave and asymmetrical in nature.

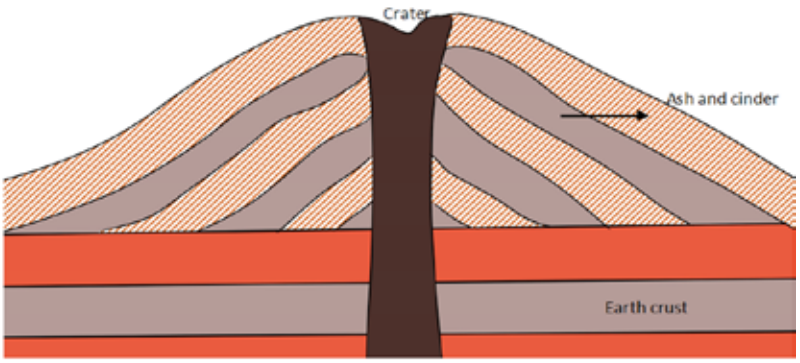


Figure 6.152: Ash and cinder cone

Volcanic plateaus: These are formed when there are various fissures or vents and basic lava flowing out and spreading to a wide area. This results into the formation of a flat-topped highland known as volcanic plateau.

There are two types of volcanic plateaus which include: Lava plateaus which are formed by highly basaltic lava during numerous successive eruptions through several vents without violent explosions (quiet eruptions). They form an extensive and flat landform. Typical examples of lava plateaus are found in Musanze, Nyabihu, Rubavu, Burera (North West of Rwanda), Ethiopian highlands, Deccan plateau in India and Bui plateau in Nigeria.

The second type of lava plateau is known as pyroclastic plateau which is produced by massive pyroclastic flows and is underlain by pyroclastic rocks. Examples include Shirasu-Daichi in Japan and the North Island Volcanic plateau in New Zealand.

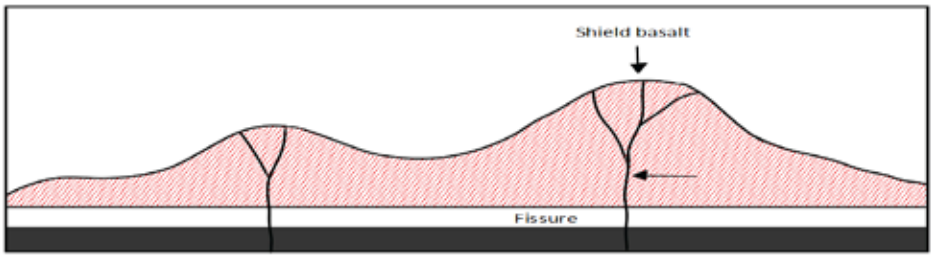


Figure 6.153: Lava plateau

Volcanic plug: This is also called a volcanic neck or lava neck; it is a volcanic feature created when the magma solidifies within a vent and later the soft layers of rocks surrounding it are eroded away. Then, a hard rock in form of a pillar is left standing as a volcanic plug.

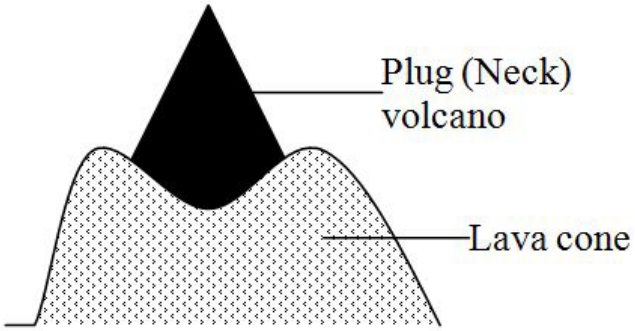


Figure 6.154: Volcanic plateau

Composite cone: This is a volcano associated with various cones. This is formed when after the formation of the main cone, the magma solidifies in the vent, therefore, blocking it. This forces the active magma for subsequent eruption to find its way out through subsidiary vents along the sides of the cone. This results in the formation of other cones on the sides of the main cone. Examples include, Mt. Kilimanjaro, Mt. Muhabura, etc.

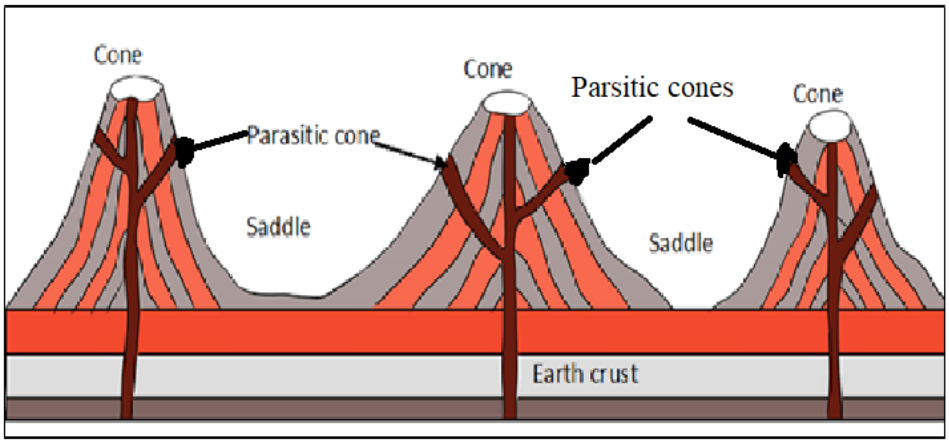


Figure 6.155: Composite cone

Lava and ash cone or strato volcanoes: They are formed when the lava is violently blown to high heights, breaking into small particles. These fall in the form of Ash. When the pressure reduces, magma comes out gently to form a layer of lava on top of the ash layer. The typical examples include: Muhabura, Elgon, Longonot, etc.

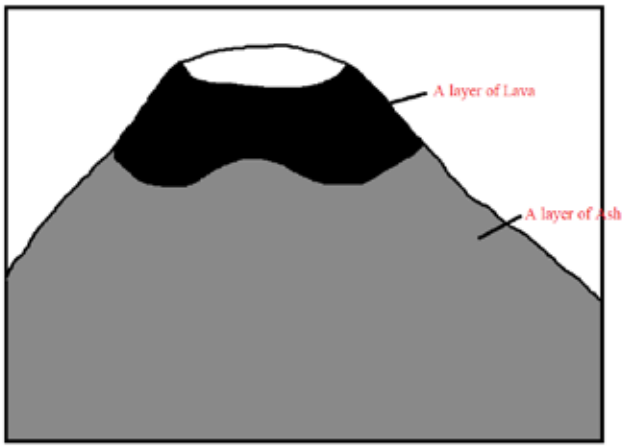


Figure 156 : Lava and ash cone

Dissected volcanoes: This is a volcanic mountain that is greatly and deeply affected by serious erosion. A typical example is Mt. Sabyinyo between Rwanda, Uganda and DRC.

Cumulo dome/Volcanic dome/Lava Dome: This is formed when lava is so viscous that it cannot flow away readily. It therefore accumulates around the vent. Hence, a steep sided volcanic dome with no visible crater is formed. Cumulo dome has convex sides.

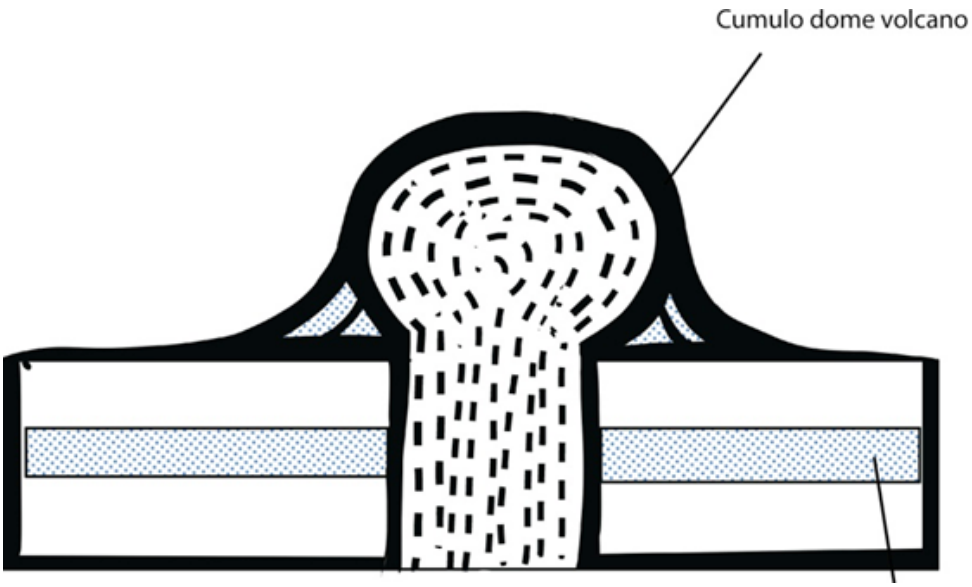


Figure 6.157: Cumulo dome/Volcanic dome

Explosive crater: This is a depression formed when the pressure reduces and the magma is now subsiding. This means that the crater is occupied by relatively active magma that is under low pressure. It has a circular shape.

Hot spring: This refers to natural outflow of superheated water from the ground. This is formed when the underground water is in contact with superheated rocks associated with the magma. The water heats up, and when it finds its way out, it flows out in the form of Hot spring. It contains mineral substances in solution. Hot springs are found in Iceland, (in Europe), Kenya and Ethiopia (in Africa).

Geysers: These refer to the forceful emission of hot water and steam from the ground to a high level in the air. This is formed in the same way as hot springs, the only difference is that, the super-heated water and steam are realised and ejected out at irregular interval. Geysers are found in Iceland, North Island and New Zealand.

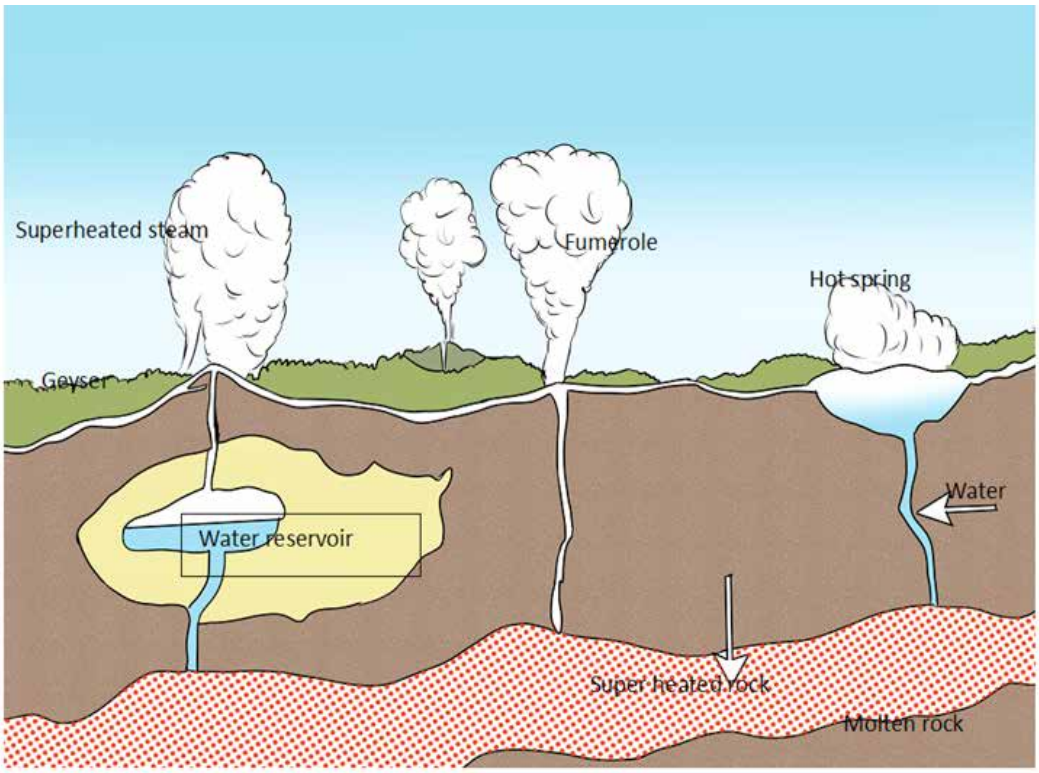


Figure 6.158: Geysers and hot spring

Fumaroles: This is a volcanic feature associated with the emissions of gases from the vents. These gases are composed of steam that continuously comes out from the Earth's crust in volcanic region. They are formed when the underground water meets the hot magma and creates steam.

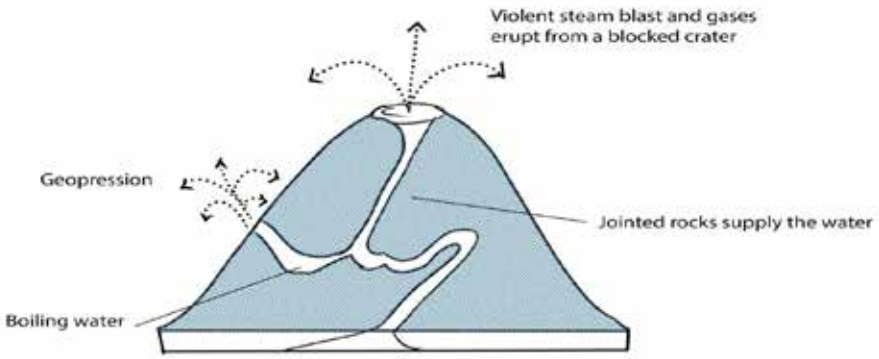


Figure 6.159: Fumaroles

6.11.2. Intrusive Vulcanic features

This is a type of vulcanicity where the magma does not reach the earth's surface but cools and solidifies within the crustal rocks. Intrusive vulcanicity leads to the formation of intrusive features. These features occur beneath the crust and may be exposed to the surface after the overlying rock is removed by erosion. They include: Lava flow, laccolith, Volcano, Dyke, Lapolith, sill, etc.

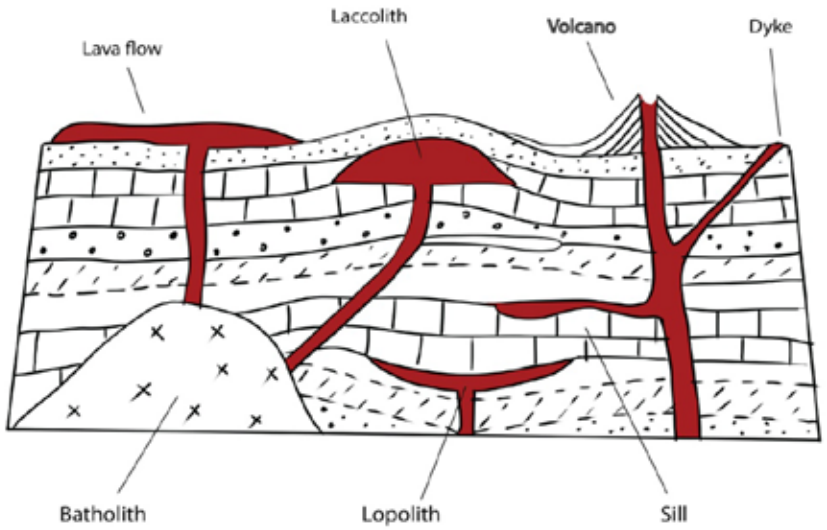


Figure 6.160: Intrusive vulcanic features

Batholith: This refers to large dome-shaped intrusion of the magma extending to great depth within the earth's crust. Batholiths are formed deep below the surface when large masses of magma cools and solidifies. These may later be exposed because of erosion to form inselbergs.

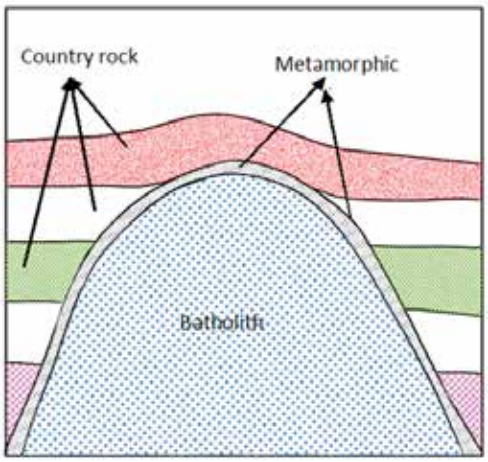


Figure 6.161: Batholith

Laccolith: It is a dome-shaped intrusion of the magma formed when the magma cools and solidifies in anticline bedding plane

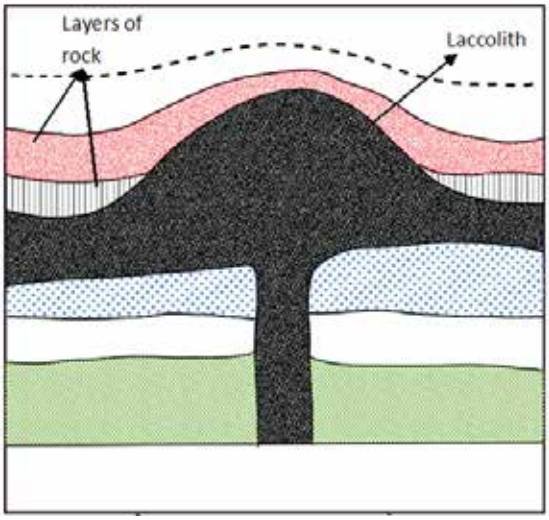


Figure 6.162: Laccolith

Phacolith: This is lens-shaped mass of igneous rock formed when the magma cools and solidifies at anticline and syncline in folded rocks. Phacolith is much shallower.

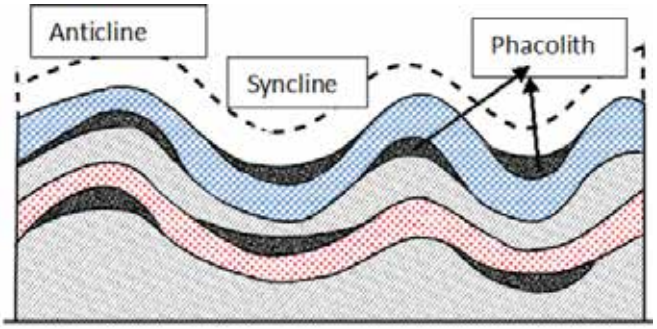


Figure 6.163: Phacolith

Lapolith: It is a large saucer-shaped intrusion formed when the magma (molten rocks) cools and solidifies in a syncline bedding plane. Lopoliths form shallow basins along the rock bedding plane.

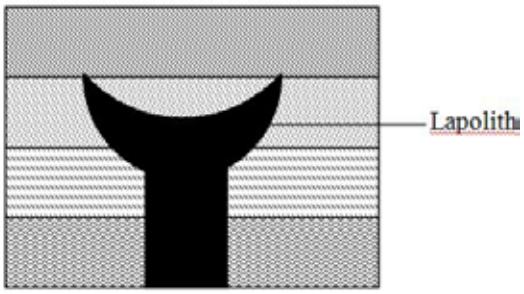


Figure 6.164: Lapolith

Sills are horizontal intrusions of magma which have solidified along the lines of bedding planes.

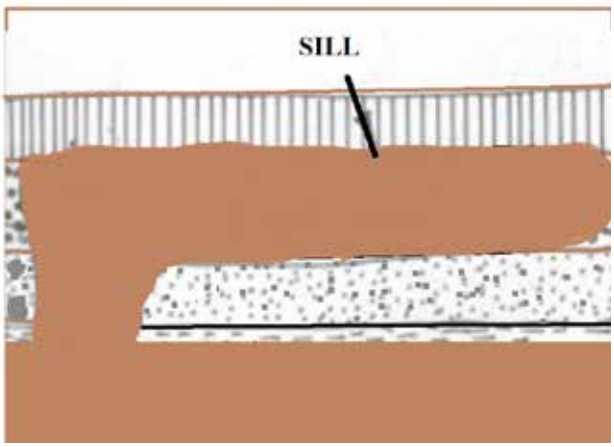


Figure 6.165: Sills

Dykes: These are vertical intrusions formed when magma solidifies in a vertical manner or within the vent and subsidiary vents. They cut across the bedding planes of the crustal rocks into which they have been intruded. Dykes often occur in groups where they are known as dyke swarms.

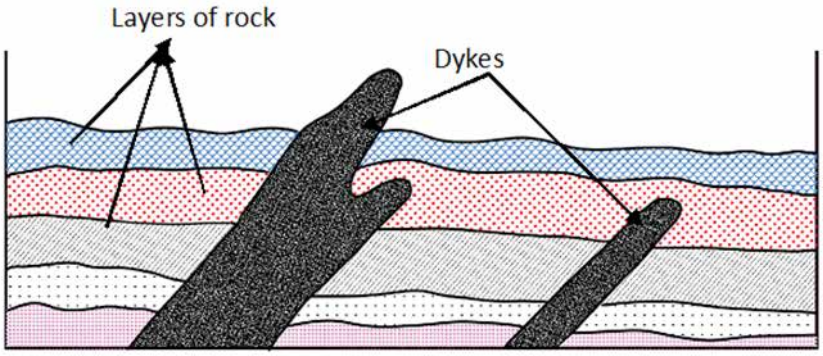


Figure 6.166: Dykes

Application activity 6.11

With the help of diagrams, differentiate intrusive and extrusive volcanic landforms.

6.12. Types of volcanoes and their characteristics

Learning activity 6.12:

In the previous lesson you learnt that volcanicity leads to the formation of various landforms including volcanoes.

a. Describe volcanoes according to their period of activity.

b. Make a classification of the volcanoes according to their nature of volcanic eruptions.

A. Classification based on periodicity/ activity of eruptions:

- **Active volcanoes:** These are volcanoes which constantly eject volcanic lavas, gases, ashes and fragmental materials. They erupted very recently or are engaged in eruption. Examples are Nyiragongo and Nyamuragira in DRC, Ol Doinyo in Tanzania, Lengai, Etna and Stromboli (in Mediterranean Sea).
- **Dormant volcanoes:** These are the volcanoes which have taken long without erupting but still show signs of eruption. That is, they are quiet after their eruption for some time. However, they suddenly erupt violently and cause huge damage to human, animal and plant life around them. An example is Muhabura, Karisimbi, Gahinga and Bisoke in Rwanda, Vesuvious near Naples in Italy.
- **Extinct volcanoes:** These are the volcanoes that have taken a long time without erupting and show no signs of erupting in the future.. A good example is Mount Sabyinyo in Rwanda.

B. Classification of volcanoes basing on the nature of eruptions

Based on the nature of eruptions volcanoes are classified into explosive and quiet volcanoes. These include the following:

Explosive type of volcanoes: They are the volcanic eruptions that occur whereby the magma is violently ejected out of the Earth's crust through a central pipe (vent). This breaks and blows off crustal surface due to violent and explosive gases accumulated deep within the earth.

Explosive type of volcanoes are classified into the following:

- **Hawain type of volcanoes:** Such volcanoes erupt quietly due to less viscous lava and non-violent gas. A good example is Nyiragongo of DRC, Mihara in Japan, Etna of Italy, Kilauea of the southern Hawaii island.

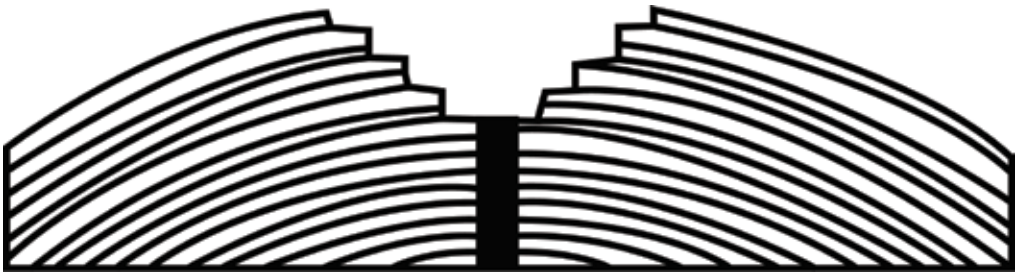


Figure 6.167: Hawain volcano

- **Strombolian type:** Such volcanoes erupt with moderate intensity. Besides lava, other volcanic materials like pumice, scoria and bombs are also ejected into the sky. e.g: Stromboli in Italy.

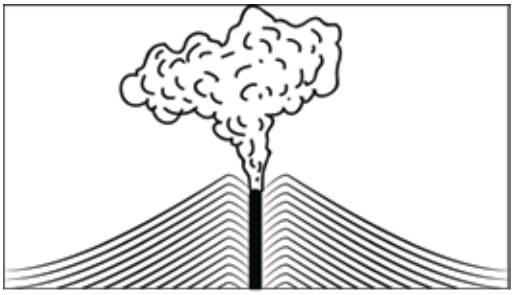


Figure 6.168: Strombolian volcano

- **Vulcanian type of volcanoes:** Such volcanoes erupt with great force and intensity. The lava is so viscous and pasty and it quickly solidifies and hardens. It crusts over the volcanic vents. e.g: Lipari in the Mediterranean Sea and Sakurajima in Japan.

Figure 6.169: Vulcanian volcano

- **Peleean type of volcanoes:** They are the most violent and explosive types of volcanoes. The ejected lava is extremely viscous; a large amount of gas, dust, ash,and lava fragments are blown out of the volcano crater. e.g: Pellee Volcano of the Martinique Island in the Caribbean Sea.

Figure 6.170: Peleean volcano

- **Visuvious type of volcanoes:** They are more or less similar to the Vulcanian and Strombolian type of volcanoes. The difference lies only in the intensity of the expulsion of lava and gases. There is a violent expulsion of the magma due to an enormous volume of explosive gases. A good example is the Plini volcano in Italy that erupted in 79 AD.

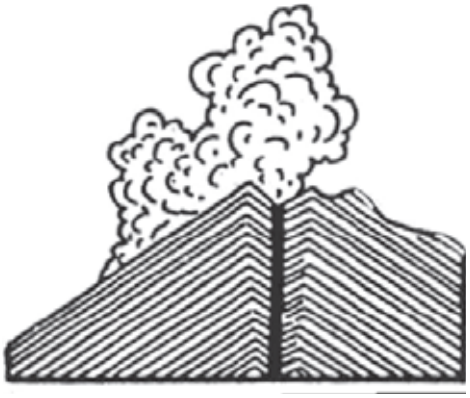


Figure 6.171: Visuvious volcano

Fissure eruption type or quit eruption type: These occur along the fracture, fault and fissure and there is slow upwelling of the magma from below and the resultant lava is spread over the ground surface. An example is the Laki fissure eruption of 1783 in Iceland.

Application activity 6.12

With specific examples from East Africa,

a. Identify and describe the extrusive volcanic landforms.

b. Categorize the volcanoes according to their period of activity.

6.13. Influence of volcanicity on drainage

Learning activity 6.13

Observe the photograph of Bisoke crater provided below and answer the questions that follow:

1. Identify the drainage feature occupying the top of this volcano.
2. How did the volcanicity influence the formation of the mentioned drainage feature?

The volcanicity influences the drainage system in a given area in different ways as follows:

- Some seasonal rivers originate from the craters and flow down slope. A typical example is Susa River in Rwanda.
- Crater or caldera of volcanoes may be filled with water to form lakes. Good examples in Rwanda are the lakes located on Bisoke, Muhabura and Kalisimbi

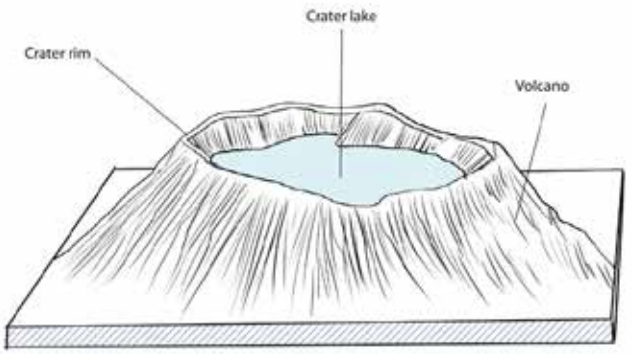


Figure 6.172: Crater Lake on the top of a volcano

– Some rivers may change their courses due to volcanicity. For example, before the Rwandan volcanoes came into existence, Nyabarongo River was flowing northward and then when volcanoes came in place, the river changed its course and went southward.

– It leads to the formation of lava dammed lakes. E.g. Burera and Ruhondo.

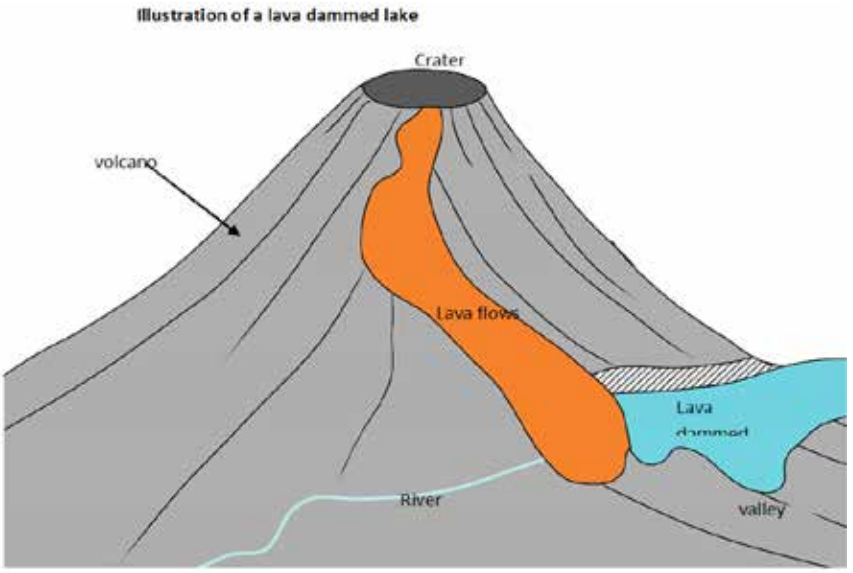


Figure 6.173: Lava dammed lake

Application activity 6.13

With the help of a sketch of topographical map of Rwanda, examine the relevance of volcanicity on the drainage system of Rwanda.

6.14. Impact of volcanicity on humans

Learning activity 6.14

Using your own experience, textbooks and internet, research on the impact of volcanicity on the social economic development of a country.

Volcanicity has both negative and positive impacts on human life. They include:

Positive impacts

- Volcanicity is associated with rich (fertile) volcanic soils that stimulate agriculture;
- Volcanicity lead to the production of geothermal heat and geothermal energy;
- Volcanicity stimulate the mining of metal ore deposits (including gold, silver, copper, tin, iron, lead, wolfram and zinc);
- Volcanicity leads to the formation of crater and lava dammed lakes that stimulate fishing and water transport. A typical example is in Burera and Ruhondo lakes in North Rwanda;
- Industrial materials like building stone, Sulphur, pumice and clay are provided by volcanic features;
- Volcanicity leads to the formation of waterfalls that facilitate the generation of electricity (HEP). Good examples are Ntaruka and Mukungwa Hydro-power plants in North Rwanda.
- Volcanoes play a great role in the modification of climate which supports various human activities such as agriculture.
- The hot springs are used for medicinal purposes, especially in the treatment of skin diseases.

Negative impacts

- Volcanic eruptions cause heavy damage to human lives and property through outpouring of lava, fallout of volcanic materials, speeding lava flows etc.
- Too much volcanic materials also lead to the diversion and blocking of drainage systems and floods.
- The poisonous gases produced during the eruptions may cause acid rain;
- Sometimes volcanic eruptions are followed by heavy rainfall. The heavy rain mixes with falling volcanic dusts and gases to cause mudflows or lahar;
- Volcanic eruptions may generate tsunamis and seismic waves causing death to human beings;

- It contributes to the deglaciation because of increasing temperature. The melt water results in the occurrence of floods and their effects.
- Large quantities of volcanic dust and ashes produced during volcanic eruptions have been associated with weather and climatic changes. reduces visibility.
- Volcanic eruption affects weather patterns. It is possible that increased volcanic activity was one of the factors responsible for the little ice Age.
- It off balances the ecosystems and biodiversity in the areas where vulcanism takes place. For example, Scientists believe that volcanic eruptions and fallout of dusts and ash, may cause the extinction of several animal and plant species. Based on this hypothesis the mass extinction of dinosaurs about 60 million years ago has been linked to an increased volcanic activity.

Application activity 6.14

1. Examine the significance of volcanicity to the economic development of the areas found in volcanic regions.
2. Assess the role played by volcanicity in the development of the following economic activities in Rwanda:
    a. Tourism industry.
    b. Agriculture
    c. Power and energy

6.15. World distribution of volcanoes

Learning activity 6.15

1. Conduct your own research and draw the world sketch map showing areas mostly affected by vulcanicity.
2. Locate the volcanic regions on the East Africa map.

There are three major belts or zones of volcanoes in the world. These are:

a. **Circum-Pacific belt:** volcanic zones of the convergent oceanic plate margins, including the volcanoes of the Eastern and Western coastal areas of the Pacific Ocean. This includes island arcs and festoons off the East coast of Asia and of the volcanic islands scattered over the Pacific Ocean. This volcanic belt is also called "The fire girdle of the Pacific or the Fire ring of the Pacific".

b. **Mid-continental belt**, also known as 'the volcanic zones of convergent continental plate margins'. This belt includes the volcanoes of the Alpine mountain chains and the Mediterranean Sea, and the volcanoes of the faulted zone of Eastern Africa.

c. **Mid-Atlantic belt:** This includes the volcanoes along the Mid-Atlantic ridge which represents the splitting zone of plates. In other words, two plates diverge in opposite directions from the mid-oceanic ridge. Thus, volcanoes of fissure eruption type occur along the constructive or divergent plate margins.

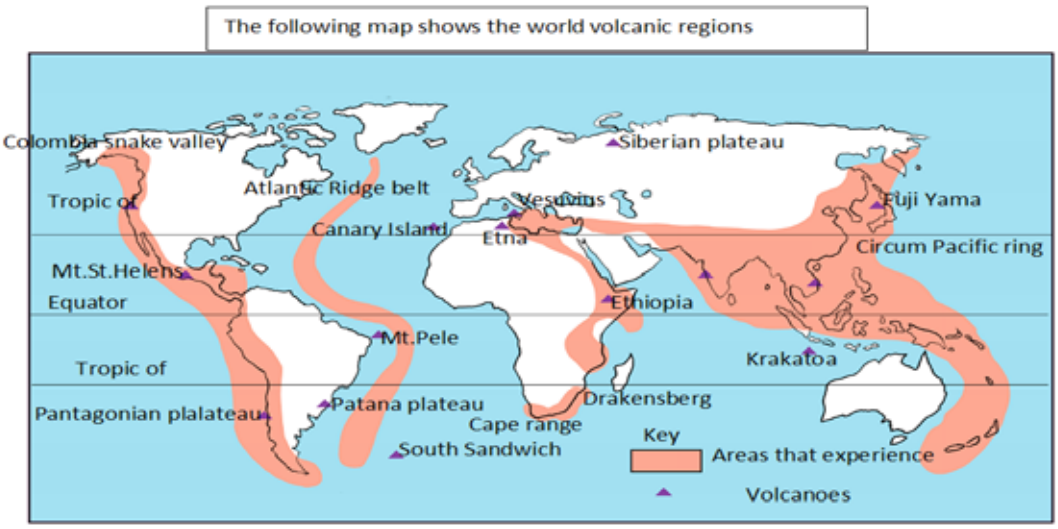


Figure 6.174 Volcanic region of the world

Application activity 6.15:

Locate and describe the major volcanoes of the world on the world sketch map.

6.16. Meaning of Earthquake and its related concepts

Learning activity 6.16

Read the passage about earthquakes occurrence and provide answers to the questions that follow.

Earthquakes occur when masses of rock in Earth's crust slip and slide against one another. This kind of movement is most common along a fault, a break in a body of crustal rocks that can extend for kilometers or even hundreds of kilometers. When pieces of crustal rock suddenly slip and move, they release enormous amounts of energy, which then propagates through the crust as seismic waves.

At the Earth's surface, these waves cause the ground to shake and vibrate, sometimes violently. Geologists classify seismic waves into two broad categories:

body and surface waves. **Body waves**, which include Primary and Secondary waves, travel through the Earth's interior. **Primary waves** resemble sound waves, which means they compress and expand the materials as they pass. **Secondary waves** resemble water waves, which means they move the materials up and down. Primary waves travel through both the solids and liquids, while Secondary waves only travel through the solids.

1. Identify the internal process explained in the above passage
2. Explain how those processes occur.
3. Explain the types of seismic waves explained in the above passage.
4. Conduct a research and find the meaning of the following terminologies:
   - Hypocentre
   - Epicentre
   - Earthquake
   - Focus
   - Tremor
   - Magnitude
   - Intensity

An earthquake is a sudden tremble or shaking of the ground caused by abrupt release of energy from crustal rocks; a motion of the ground surface, ranging from a faint tremor to a wild motion capable of shaking buildings and causing gaping fissures in the ground.

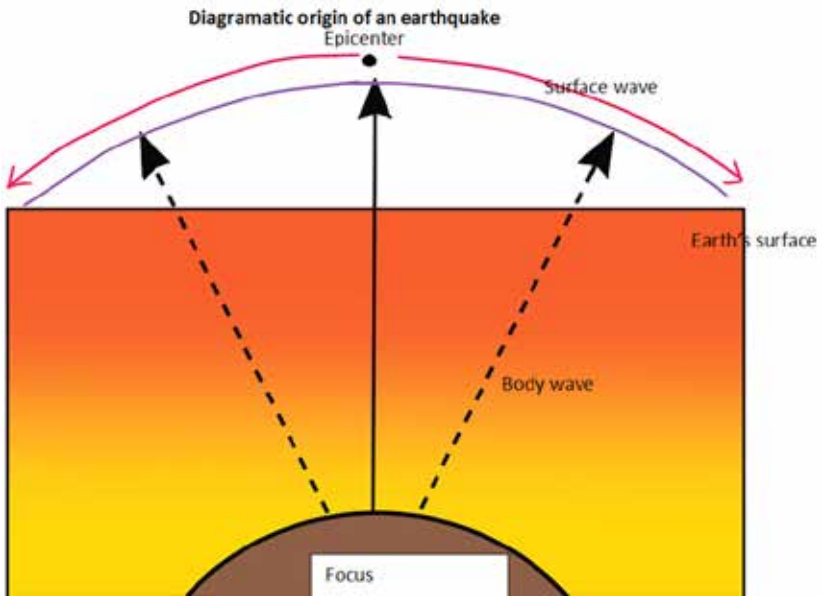


Figure 6.175. Focus and epicentre

Description of the terminologies associated with Earthquakes:

a. **Focus or hypocentre:** It is the place of origin of the earthquake and it is always hidden inside the earth. It is also considered as the place of the occurrence of an earthquake. The deepest focus has been measured at the depth of 700 km from the earth's surface.

b. **Epicentre:** It is a place on the ground surface which is perpendicular to the focus. That place is the first to experience seismic event.

c. **Magnitude:** It is a measure of the amount of energy released during an earthquake. It may be expressed using several magnitude scales such as Richter scale and the Mercalli scale.

d. **Intensity:** It is a number (e.g. V for Mercalli scale and 5 for Richter scale) describing the severity of an earthquake in terms of its effects on the earth's surface, humans and structures such as buildings.

e. **Tremors** or temblor is the perceptible shaking of the surface of the Earth, resulting from the sudden release of energy in the earth's crust that creates seismic waves.

f. **Measurement of the Earthquakes:**

   The intensity or strength of an earthquake is measured using either the Richter scale or the Mercalli scale. The Richter scale range between 0 and 9. But in the real sense, the scale has no upper limit because it is a logarithmic scale.

The world's largest and most intensive earthquake recorded had a magnitude of 8.9. The second method of measuring the intensity of an earthquake was invented by Giuseppe Mercalli and it is called Mercalli scale. The intensity is estimated basing on the destruction made by an earthquake. The instrument used in measuring earthquake is seismometer or seismograph.

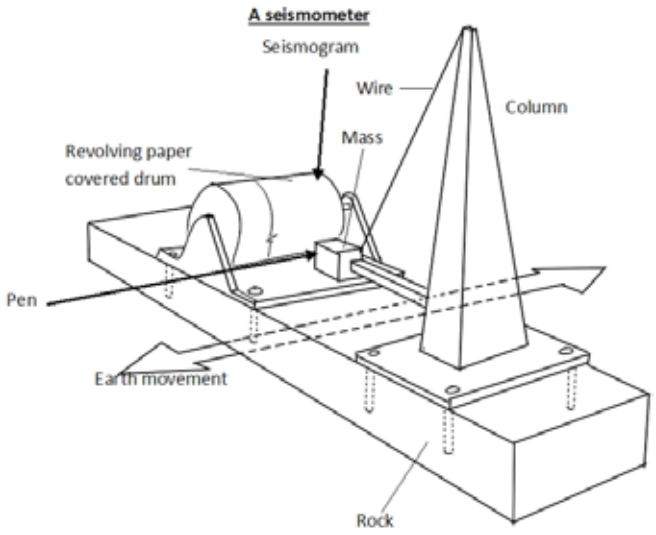


Figure 6.176: Seismometer

Mercalli intensity	Equivalent Richter magnitude	shaking	Witness observations
I	1.0 to 2.0	Not felt	Felt by very few people; barely noticeable
II	2.0 to 3.0	Weak	Felt by a few people, especially on upper floors
III	3.0 to 4.0	Weak	Noticeable indoors, especially on upper floors, but may not be recognized as an earthquake.
IV	4.0	Light	Felt by many indoors, few outdoors may feel like a heavy truck is passing by.
V	4.0 to 5.0	Moderate	Felt by almost everyone, some people awakened. Small objects moved, trees and poles may shake.
VI	5.0 to 6.0	Strong	Felt by everyone. Difficult to stand. Some heavy furniture moved and some plaster falls. Chimneys may be slightly damaged.
VII	6.0	Very strong	Slight to moderate damage in well built, ordinary structures. Considerable damage to poorly built structures. Some walls may fall.

VIII	6.0 to 7.0	Severe	Little damage in specially built structures. Considerable damage to ordinary buildings, severe damage to poorly built structures. Some walls collapse.
IX	7.0	Violent	Considerable damage to specially built structures, buildings shifted off foundations. Ground cracked noticeably. Wholesale destruction. Landslides occur.
X	7.0 to 8.	Extreme	Most masonry and frame structures and their foundations destroyed. Ground badly cracked. Landslides. Wholesale destruction.
XI	8.0	Extreme	Total damage. Few, if any, structures standing. Bridges destroyed. Wide cracks in the ground. Waves seen on the ground.
XII	8.0 or greater	Very extreme	Total damage. Waves seen on the ground. Objects thrown up into the air.

Application activity 6.16

Through internet, journals, textbooks and magazines search on the earthquakes which affected Western Rwanda in past years. Then answer the following:

1. Name the epicentre of the earthquake which took place in Rwanda in February, 2007 and August, 2015.
2. Give the intensity on Richter scale of these earthquakes

6.17. Causes, consequences and measures of earthquakes

Learning activity 6.17

1. Describe what you observe in he picture above.
2. Suggest the causes of the phenomenon shown on the picture above.
3. Explain the consequences of the phenomenon presented in the picture above.
4. Propose measures that can be taken to curb the effects of the hazard/ disaster presented in the picture above.

6.17.1. Causes of earthquakes

Earthquakes are caused by both natural and human factors as follows:

Natural causes of earthquakes

Earthquakes arising from natural causes include:

- Natural earthquakes are caused by natural processes or they are a result of endogenic forces. Good examples are the earthquakes which took place in Rwanda in February 2007 and August 2015.
- Volcanic earthquakes are caused by volcanic eruptions of explosive and fissure types. Generally, volcanic earthquakes are confined to volcanic areas. The intensity and magnitude of volcanic eruptions is usually high. Examples are the earthquakes caused by violent explosions of Krakatoa volcano in 1883 and Etna volcano in 1963.

- Tectonic earthquakes occur because of the dislocation of crustal rock blocks during faulting. Such earthquakes are severe and disastrous. Examples are the 1872 and 1906 earthquakes of California (USA); 1923 earthquake of Sagami Bay (Japan); 2001 earthquake of Gujarat in India.
- Isostatic earthquakes are triggered by sudden disturbance in the isostatic balance at the regional level due to an imbalance in geological processes. Generally, earthquakes occurring in the active zones of mountains fall in this category.
- Plutonic earthquakes are deep-focus earthquakes, which occur at greater depths. The centres (focus) of these earthquakes are generally deep, ranging from 240km to 670km.

Human causes of earthquakes

The earthquakes may also result from human activities such as:

- Pumping water from underground aquifers, oil reserves; deep underground mining;
- Blasting of rocks by dynamites for purposes of the construction (of dams and reservoirs, roads);
- Nuclear explosions;
- Storage of huge volumes of water in big reservoirs.

6.17.2 Consequences of earthquakes

Earthquakes are known to have the following consequences where they occur:

- Loss of life and destruction of property happen when violent shaking of the land causes cracks on walls and making the buildings to collapse. Vegetation and the landscape are not spared either.
- Outbreaks of fires occur where the earthquakes destroy oil and gas pipelines.
- Tsunamis are huge and destructive sea waves caused by Earthquakes.
- Landslides occur when the Earthquakes happen. These are sudden movements of large masses of rock and soil downhill.
- Displacement of crustal rocks. This is caused by Earthquakes. It takes place vertically and laterally, leading to the damage of transport and communication lines such as roads, railways, etc.

6.17.3. Measures to curb earthquake effects

It is true that earthquakes lead to the loss of lives and property. Though they cannot be stopped from occurring, there are several things people can do to reduce such losses. Such measures include:

- Building houses in a way that they are more resistant to earthquakes.
- During an earthquake and when one is inside a building, he should drop to the floor and wait until the shaking is over ; and it is safe to move out of the building.
- When one is outside, he hould stay there or move away from buildings and streetlights.
- If trapped under a collapsed, structure do not light a match or move about. Tap on a pipe or wall so that rescuers may get to locate you.
- When the shaking stops, look around to make sure that it is safe to move. Then leave the building.

Application activity 6.17

It has been noticed that the Western part of Rwanda experiences earthquakes at a great extent compared to other regions.

a. Suggest why that part of Rwanda experiences such a disaster.

b. What do you think are the effects of such a catastrophe/disaster on any region where it occurs?

c. Assume that you are in charge of disasters management and preparedness; suggest the measures that should be taken to control earthquakes.

6.18. World distribution of Earthquakes

Learning activity 6.18

The most active region in the world associated with Earthquakes corresponds to the margins of the Pacific Ocean. Earthquakes with large magnitudes take place along this zone in the Americas from the Aleutian Islands to Southern Chile and from the Kamchatka peninsula in Asia to New Zealand. Besides shallow earthquakes throughout most of this long region, intermediate and deep shocks take place along the margin of Central and South America and on the other side of the Pacific. This include s the long systems of the island arcs (Aleutians, the Kuriles, Japan the Philippines). Another large seismically active region is known as the Mediterranean-Alpine-Himalayas region which extends from West to East from the Azores to the Eastern coast of Asia. This region is related to the boundary between the plates of Eurasia (to the North) and Africa, Arabia, and India-Australia (to the South). A third seismic region is formed by Earthquakes located in the oceanic ridges that form the boundaries of oceanic plates such as the Mid-Atlantic Ridges, East Pacific Rise, etc.

1. Identify the areas affected by Earthquake in the passage above.
2. On the sketch of world map, mark and label the areas that are mostly affected by earthquakes.

The following are the major seismic zones of the world:

a. Circum-Pacific Belt or Ring of Fire surrounding the Pacific Ocean.

b. Mid-Continental Belt representing epicentres located along the Alpine Himalayan chains of European and Northern Africa and epicentres of East African fault zone.

c. Mid-Atlantic Belt representing the earthquakes located along the mid-Atlantic Ridge and its off-shoots. The high-quality seismicity maps showed that narrow belts of epicentres coincide almost exactly with the crest of mid-Atlantic (ridge), the east Pacific, and other oceanic ridges where plates separate.

d. Volcanic regions of the convergent Oceanic plate margins. These include the volcanoes of the Eastern and Western coastal areas of the Pacific Ocean, island arcs and festoons off the East coast of Asia and the volcanic islands scattered over the Pacific Ocean. This volcanic belt is also called "the fire girdle of the Pacific or the fire ring of the Pacific.

The major seismic zones of the world

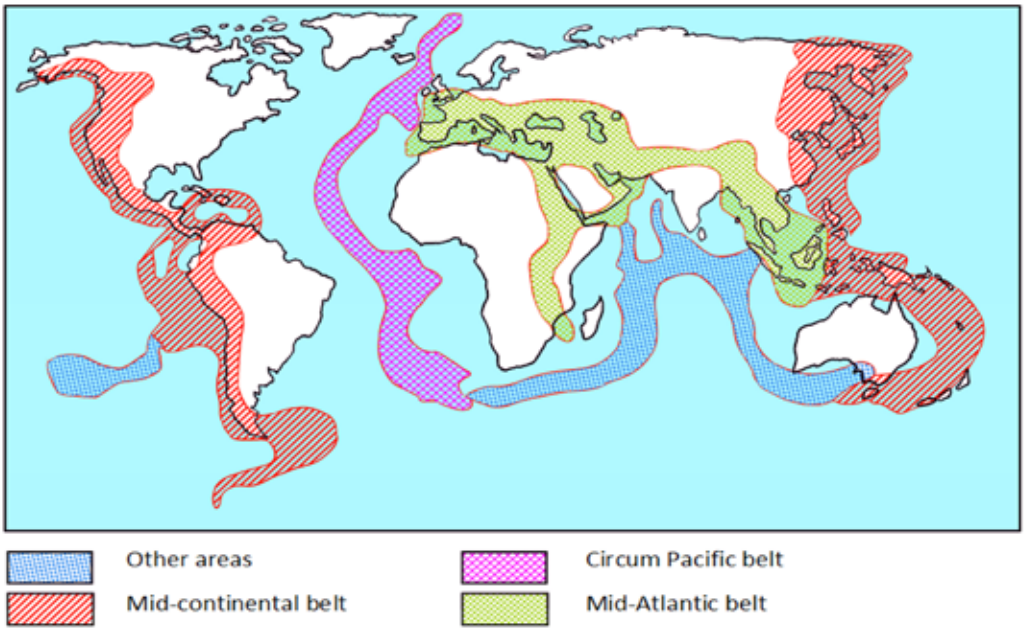


Figure 6.177: Major seismic zones of the world

e. Zones of subduction are the biggest crash scene on the earth. These boundaries mark the collision between two of the planet's tectonic plates. The plates are pieces of crust that slowly move across the mantle's surface over millions of years. When two tectonic plates meet at a subduction zone, one bends and slides underneath the other curving downwards into the mantle.

Application activity 6.18

With reference and help of a seismic sketch map of Africa, identify the East African areas that are mostly affected by earthquakes.

End unit assessment 6.1

1. Discuss the impact of faulted landforms on the East African landscape and drainage.
2. Explain the significance of folded relief features in the socio-economic development of East Africa.
3. With specific examples, explain the importance of warping on drainage systems of Africa.
4. To what extent has vulcanicity shaped the nature of landscape of East Africa?
5. Critically examine the effects of either Tsunami in Japan or earthquake in Haiti on the World economic development.
6. Assume that you are appointed Director General of Rwanda Environmental Management Authority (REMA), what are the measures you will take to reinforce the conservation of the basin lakes and wetlands found in Eastern province.

UNIT 7
SOILS

UNIT 7: SOILS

Key Unit Competence:

By the end of this unit, I should be able to investigate the different constituents and morphological properties of soil.

Introductory activity

Soil is the upper layer of the earth in which plants grow. It may be also defined as the loose and unconsolidated material that is derived from the disintegration of rocks that form the uppermost layer of the earth's crust. Soil is made up of water, air, organic matter or humus (derived from remains of plants and animals); inorganic matter (derived from non-living materials, for example, minerals).

a. Using the experiences gathered from previous classes on soils, explain the soil constituents.

b. Describe the morphological properties of soil.

c. Explain what makes soil to be more productive.

7.1. Soil constituents

Learning activity 7.1

Using previous knowledge learnt in Geography textbooks and other sources of geographical information;

a. Define soil.

b. Name the constituents/components of soil.

c. Draw a pie chart showing the approximate composition of soil.

Soil is defined as a superficial covering on the earth's crust having been derived from both inorganic and organic materials of the Earth's crust. Soil is not merely a group of mineral particles. It also has a biological system of living organisms and some other components. It is a complex of five components:

- **Inorganic materials:** A matrix of mineral particles derived from varying degrees of breakdown of the parent-rocks through weathering. These particles vary in shape and size. They include the following:

  a. Silica: In this context we can give an example of sand.

  b. Silicate: This is predominant in clay and as an example we can talk about aluminium silicate.

  c. Oxides: These are product of metal rust and mineral oxidation, for example iron oxides.

  Inorganic matter provides important plant nutrients; determine soil aeration, soil texture and drainage. It also gives support to the plants. Inorganic matter makes up 45% of the soil.

- **Organic matter or humus:** It is made up of animal and plant wastes and decomposed animals and plants living in the soil. This forms the humus which is found on the surface of the earth. The humus is black or dark-brown in colour and it is formed from the breakdown of organic matter. Organic matter makes up 5% of the soil. It provides the soil with important benefits which include the following:
  - It enhances the soil's ability to hold and store water;
  - It improves the soil structure;
  - It reduces eluviation of soluble minerals from the top soil;
  - It helps in soil aeration.
- **Soil water and moisture:** This refers to all the water contained in the soil together with its dissolved solids, liquids and gases. Soil water is held by capillary and absorptive forces both between and at the surface of soil particles. Soil water is a dilute solution of many organic and inorganic compounds, which is the source of plant mineral nutrients. The movement of water and dissolved minerals is called leaching, and the water is called gravity water. Water also moves upward in soil by capillary action. The water containing dissolved minerals is called capillary water. The soil water makes up 25% of the soil and it occupies the pore spaces in the soil. Soil water are useful in the following ways:
  - The soil water dissolves various substances for example salts that are derived from plant or animal remains forming solutions;
  - The soil water helps plant to absorb minerals from the soils;
  - The soil water washes away highly soluble minerals from the upper

to the lower layers (leaching);

- The soil water brings soluble minerals from the lower to the upper horizons of soil through capillarity;
- The soil water is very important in the sense that it provides a medium within which most of the chemical processes of the soil formation take place;
- The soil water provides a medium through which living organisms and soil bacteria operate during the decomposition of organic matter.

- **The soil air:** it occupies the pore space between soil particles, which is not filled with water. The soil is normally lower in oxygen and higher in carbon dioxide content. The soil air includes gases from biological activity and chemical reactions. The air or gases make up 25% of the soil. The air in the soil is important in the following ways:
  - It facilitates plant growth by supplying oxygen to the root hairs;
  - It supports micro-organisms which are found in the soil;
  - It helps in the process of weathering known as oxidation which is responsible for breaking down rocks to form soils.
- **Biological system or living organisms and bacteria:** The living organisms and bacteria help to decompose the organic matter into humus. This is sometimes classified together with organic matter/humus

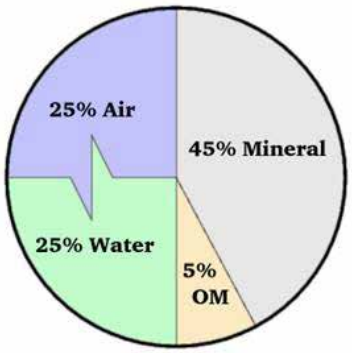


Figure 7. 178. Approximate percentages of soil constituents

Application activity: 7.1

Carry out a tour around your school then observe critically the nature of the soil constituents and then describe them.

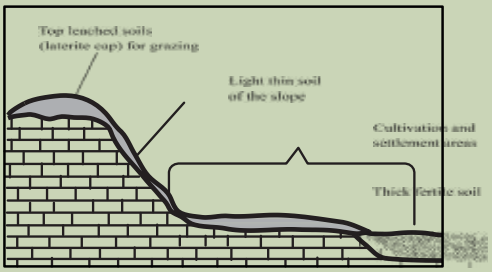
7.2. Morphological properties, soil profile, soil catena and fertility of the soil

Learning activity 7.2

Observe the following illustrations and answer the questions that follow:

A

B



C

D

E

F

1. From your observation of the above illustrations, which picture represents:

   i) Soil structure ; (ii) Soil texture (iii) Soil colour (iv) Soil profile

   (v) Soil catena (vi) Soil porosity.

2. Differentiate soil profile from soil catena.
3. Differentiate soil structure from soil texture.

Soil properties refer to the chemical and physical characteristics of the soil and these include mainly: structure, texture, colour, porosity, pH and consistency.

7.2.1. Soil properties

The main properties of the soil include the following:

Soil structure: This is the arrangement of the individual soil particles. Soil structure varies in size and shape. On the basis of the shape, the following types of soil structure exist: granular, prismatic, platy, columnar and blocky.

Granular and crumb: They are individual particles of sand, silt and clay grouped together in small, nearly spherical grains. Water circulates very easily through such soils. They are commonly found in the A-horizon of the soil profile.

Platy: It is made up of soil particles aggregated in thin plates or sheets piled horizontally on one another. It is commonly found in forest soils, in part of the A-horizon.

Prismatic: The soil particles are formed into vertical prism-like particles. Water circulates with greater difficulty and drainage is poor. They are commonly found in the B-horizon where clay has accumulated.

Columnar: It is similar to prismatic but the particles are rounded at the top.

Blocky: These are soil particles that cling together in irregular square or angular blocks having more or less sharp edges. Relatively large blocks indicate that the soil resists penetration and movement of water. They are commonly found in the B-horizon where clay has accumulated;

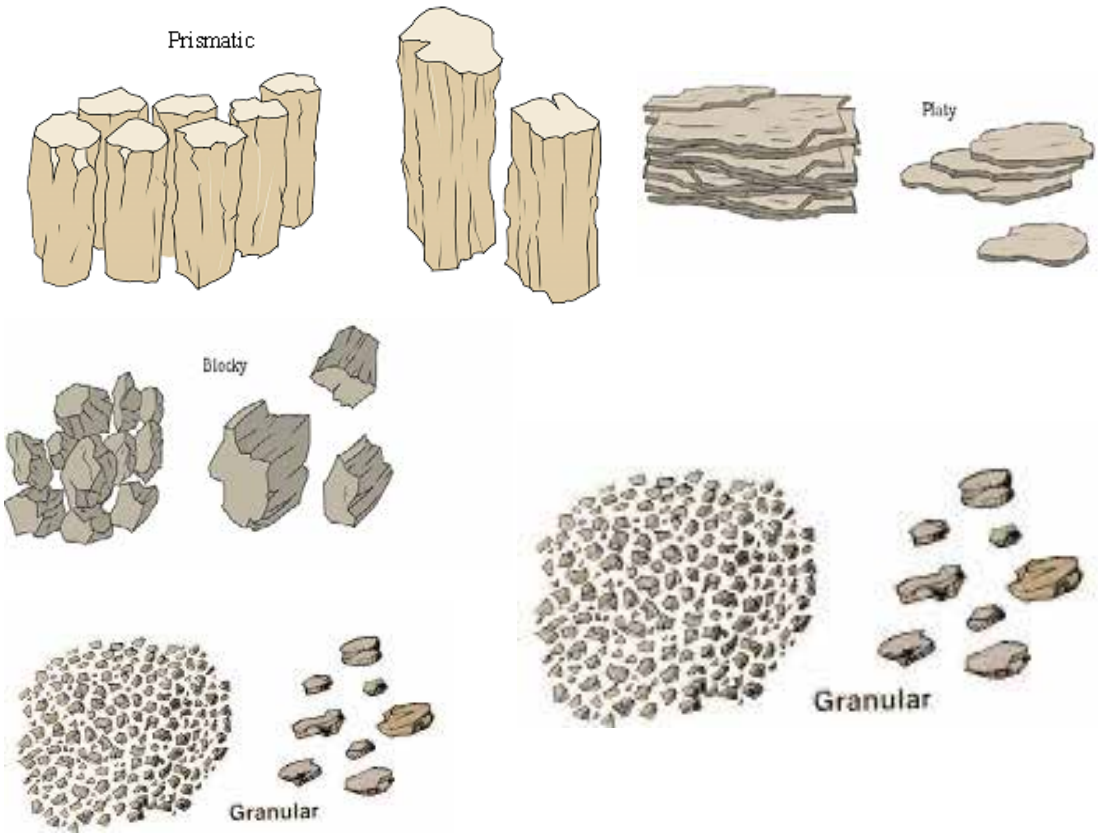


Figure 7.179: Soil structural types

Soil texture: This is the proportion of sand, silt and clay within a soil. The soil particles can be grouped according to size. Particles that are larger than sand are grouped as stones. Soil texture is important due to the following reasons:

- Soil texture influences the amount of air and water available within the soil. Silt and clay soils have a high water holding capacity. Sandy soils have a low water holding capacity.
- It also influences the amount of water and the ability of the roots to pass through it.
- It determines the easiness with which plant roots penetrate the soil.
- It determines the soil's ability to retain humus from being washed away.
- It influences the aeration of the soil.

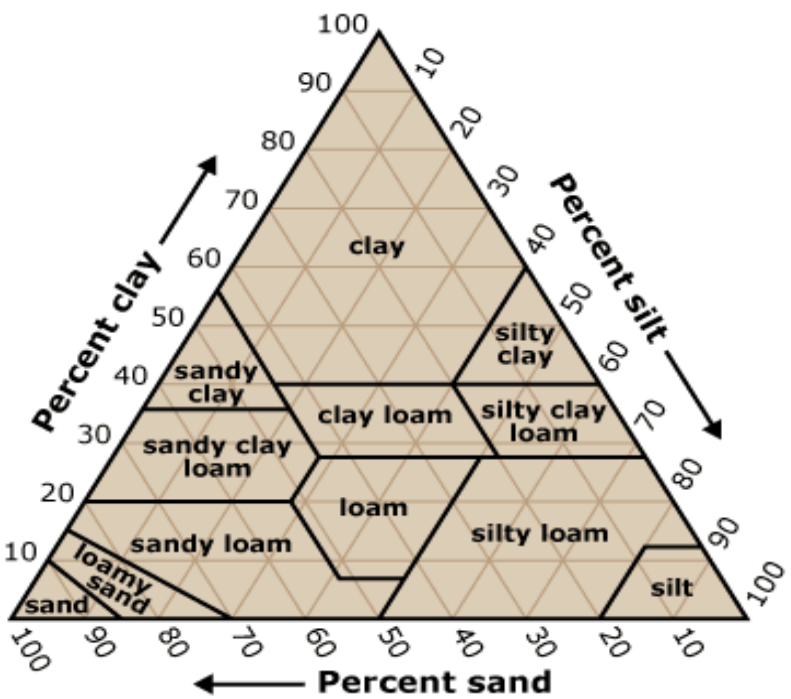


Figure 7. 180: Soil textural types

Soil colour: It is the property of the soil that is easily identified through seeing. The colour of a soil depends on the parent material making up the soil. The soil colour is influenced by the parent rock, organic matter, moisture content and minerals. Soils have a variety of colours. They include red, yellow, black, grey, white and brown. A soil that is black or dark brown has high organic matter content. Soils that are reddish brown are well drained whereas grey soils are infertile.

Soil Porosity/permeability: This refers to the number of pore spaces in the soil. The pore spaces relate to the portion of the soil space occupied by air and water. This is determined by the arrangement of the soil particles. Soils vary in porosity. Soils with large pores, for example sand are porous while clay is non-porous.

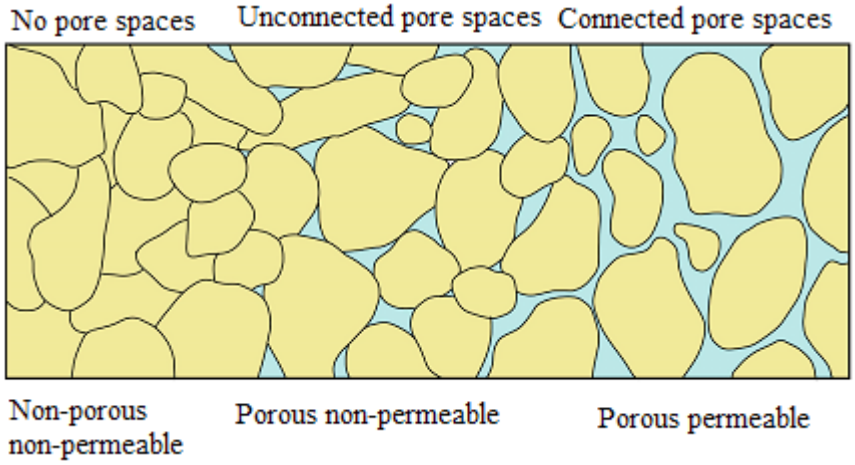


Figure 7.181: Porosity and Permeability of soil

Soil pH (potential for Hydrogen): Soil pH is measured by a pH scale or chart numbered from 1 to 14. Soil pH is an indicator of the acidity or alkalinity of soil. It is also known as soil reaction. Numbers from 1 to 6.9 indicate acidity; number 7 indicates neutral state, while 8 to 14 indicate alkalinity. A soil pH of below 7 shows that the soil is acidic. Acidity of the soil increases from PH 6.9 to 0.A soil pH of 7 shows that the soil is neutral. A PH of above 7 shows that the soil is alkaline. Alkalinity of the soil increases from pH 7 to 14.

See the figure below.

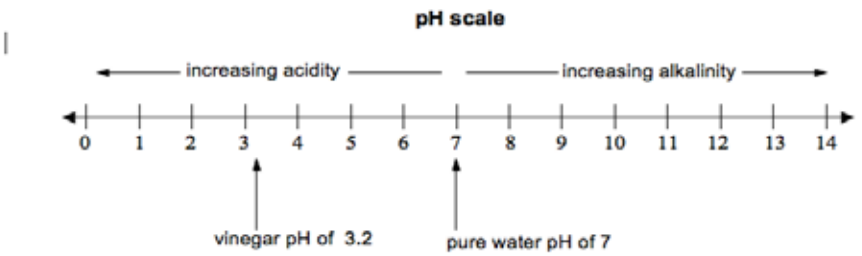


Figure 6.182: The pH scale

Soil consistency: This is the strength with which soil materials are held together or the resistance of soils to deformation and rupture. Soil consistency also refers to the easiness with which individual particles of soil can be rushed. This is done by the fingers or a cultivation tool. Soil consistency depends on the soil moisture content. Soil consistency is determined using wet, moist and dry soil samples.

Thickness (depth): In very dry regions, the soils are usually thin. In sub-humid regions soils are generally thick. Thin soils are not good for agriculture. Thick soils are good for agriculture (above 1 m of depth).

Soil moisture: This is the water in the soil. It is determined by soil texture and structure. Soil water helps in the movement of minerals up and down the layers of soil. Clay soils, for example, keep water for long. They become water-logged. Sandy soils allow water to pass easily. They are well drained.

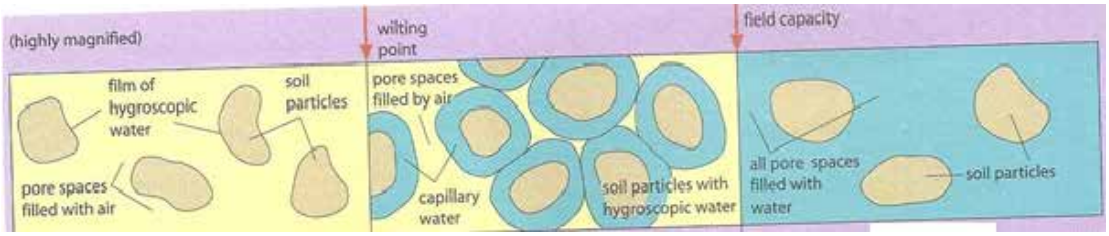


Figure 7. 183: Availability of soil moisture for plants use

Soil temperature: This is the degree of warmth or coldness in the soil. Soil temperature affects the germination of seeds and plant growth. It also influences soil moisture, air and availability of plant nutrients.

Soil air: This occupies the pore (or open) spaces that are not filled by water. It is controlled by drainage and soil texture. Poorly drained soils have little air. This is because the pores are filled with water.

Soil nutrients: These are chemical elements found in the soil. They help in plant growth and ensure the soil remains fertile. The three main nutrients are nitrogen (N), phosphorus (P) and potassium (K). Together they make up the trio known as NPK. Other important nutrients are calcium, magnesium and sulphur. Plants also need small quantities of iron, manganese, zinc, copper, boron and molybdenum, known as trace elements because only traces are needed by the plant.

Soil depth: The depth of soil profile from the top to parent material or bedrock or to the layer of obstacles for roots. It differs significantly for different soil types. It is one of basic criterions used in soil classification. Soils can be very shallow (less than 25 cm), shallow (25 cm - 50 cm), moderately deep (50 cm - 90 cm), deep (90cm - 150 cm) and very deep (more than 150 cm).

Soil density: It is expressed in two well accepted concepts as particle density and bulk density. In the metric system, particle density can be expressed in terms of mega grams per cubic meter (Mg/m3).

Soil salinity is the salt content in the soil; the process of increasing the salt content is known as salinization. Salts occur naturally within soils and water. **Salinization** can be caused by natural processes such as mineral weathering or by the gradual withdrawal of an ocean. It can also come about through artificial processes such as irrigation.

7.2.2. Soil profile and catena

a. Soil profile

Soil profile refers to the vertical arrangement of the soil in layers from the ground/surface to the parent rock/bedrock or mother rock. It can be as little as 10 cm thick in some places or as deep as several meters in others. The layers are known as soil horizons. They are marked using letters A, B, C and D.

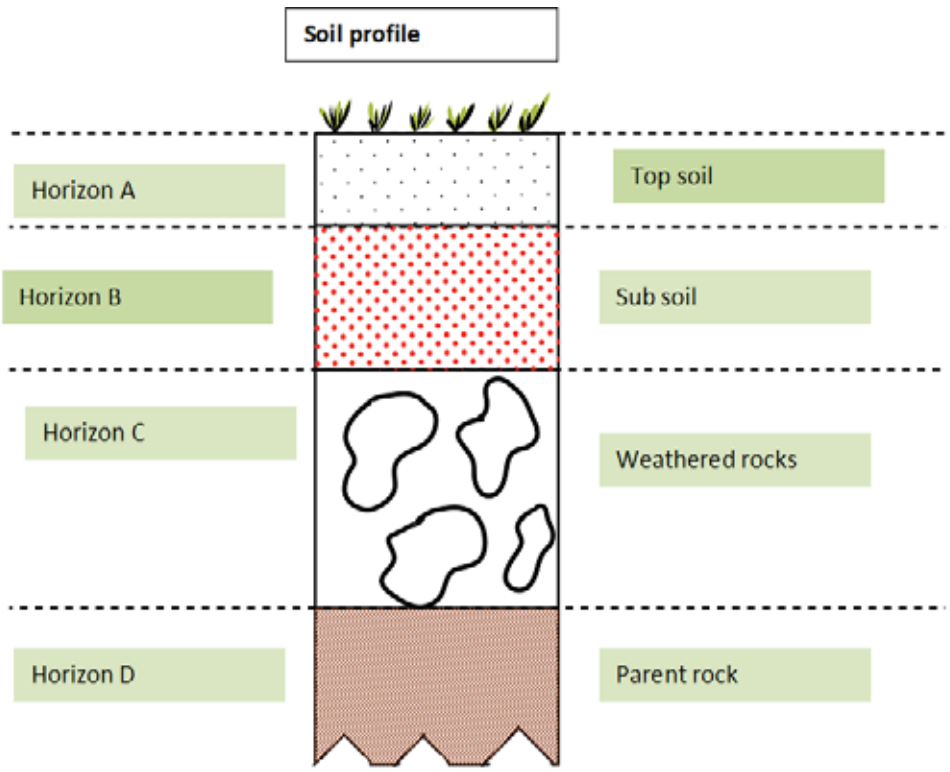


Figure 7.184: Soil profile

i. Horizon O: This layer is also known as the superficial layer. This layer includes organic litter, such as fallen leaves and twigs. These are fresh or partially decomposed organic matter. This zone has two sub-layers:

O1: This is the uppermost layer consisting of freshly fallen dead organic matter such as leaves, branches, flowers, fruits and dead parts of animals.

O2: This layer lies just below the O1 layer. Here, organic matter is found under different stages of decomposition.

ii. Horizon A: This layer is also known as the top soil. It refers to the upper layer of

soil, nearest the surface (Horizon O). This is where biological activities and humus content are at their maximum. This layer is rich in silica or other resistant minerals. It is the zone more affected by the leaching of soluble material and by the downward movement like minerals. Hence, this layer is known as the zone of 'eluviation'. This horizon is divided into two sub-layers:

A1: This is dark and rich in organic matter, called 'humus'. This layer has a mixture of finely divided organic matter and the mineral elements.

A2: This layer is of light colour, with more sand particles and little organic matter. In regions of heavy rainfall, the mineral elements are rapidly lost downwards in this region. This is also known as podzolic or eluvial (E) or zone of leaching.

iii. Horizon B: This is called the sub soil. It is the layer below the top soil. Its colour is determined by the parent rock and presence of organic matter. It has fewer living organisms and is rich in clay deposits.

iv. Horizon C: This is the layer with recently weathered materials. It has low organic matter. It is the zone of deposition.

v. Horizon D: This is the parent rock. It contains the rock which is resistant to weathering.

b. Soil catena:

Soil catena is a sequence of different soil profiles that occur down a slope. It shows the changes that take place in the soil from the top to the bottom of the slope. A long the slope, different soils develop. These are influenced by climate and angle of slope.

Upland areas have deep soils. This results from heavy weathering due to high rainfall and temperature. In those regions, the rain water reaches deep leading to a high degree of leaching. This makes the soils to become very mature. Thick layer of humus is developed in areas of thick vegetation.

Along the slopes, the soils are thin. This is caused by movement of materials by gravitational forces. The soils are dry and less developed due to high runoff water on the slope. The run off is the rain water that moves freely down the slope. The soil profiles here have no top soil.

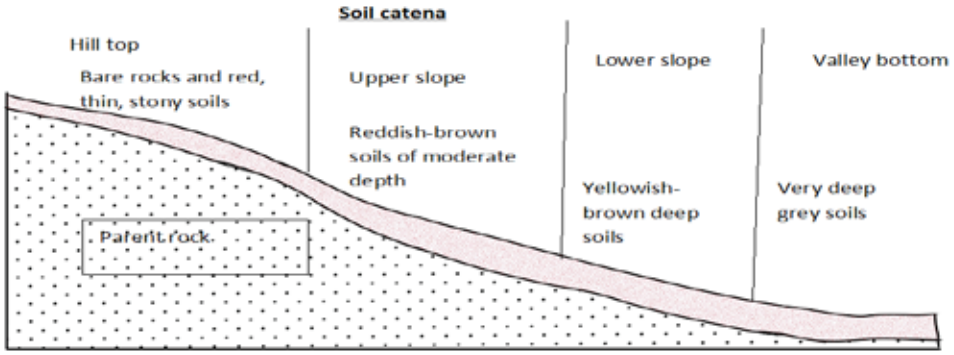


Figure 7.185: Soil catena

A soil catena consists of three main divisions called complexes namely: Elluvial complex, the colluvial complex and the illuvial complex.

- The elluvial complex: This is the upper convex slope where weathered materials are washed out downwards. It includes the summit and free face of the hill. Erosion predominates the free face hence; the soils are skeletal and with shallow soil profile.
- The colluvial complex: This is the lower concave slope where there is gradual deposition of eroded material. The soil of the colluvial complex is thus moderately drained and retains certain moisture hence, supports agriculture and grazing.
- The illuvial complex: This occupies the valley bottoms where fine materials are washed by seepage out outflow.

Soil catena is important in the following ways:

- The soil catena (elluvial complex) is used for settlement;
- The soil catena is used for rock quarrying for construction especially on free face which has no vegetation;
- The valley bottoms are used for brick lying, e.g Ruliba Clay Works along River Nyabarongo in Rwanda;
- The illuvial complex is used for agriculture due to the deep soil profile derived from deposition;
- The valley bottoms are used for rice growing and growth of vegetables and yams, etc.

7.2.3. Soil fertility

Soil fertility is the ability of soil to support plant growth. Fertile soil is the one that is rich in nutrients that plants use to grow. Examples of these nutrients are nitrogen, phosphorus and potassium.

Factors affecting soil fertility

The following are the major factors affecting soil fertility:

- Mineral matter: A matrix of mineral particles derived from varying degrees of breakdown of the parent-rocks. The fertility of soil depends on the type of mother rock to which the rock was derived.
- Organic matter or humus: The fertility of soil depends on the amount of organic matter or humus available in soil. The higher amount of organic matter reflects the higher level of soil fertility.
- Soil water or soil solution: the required optimum amount of water depends on the type of crops to be grown in specific area. Some crops such as rice require much more amount of water while the crops like sweet potatoes, cassava required low quantity of water.
- Soil nutrients: these are chemical elements found in the soil. They help in plant growth and ensure the soil remains fertile.
- Thickness (depth): Thin soils are not good for agriculture. Thick soils are good for agriculture (above 1 m of depth).
- Soil permeability: This is the ability of the soil to allow water to pass through it. Permeable soils are much more fertile than non-permeable soils.
- Soil texture: This refers to the size of soil particles. Clay loam soil are much fertile than other soil.
- Soil acidity and alkalinity: The basic soils are much more fertile than acidic soils.

Application activity 7.2:

1. Basing on the knowledge and skills acquired from the above lesson, differentiate soil porosity in Eastern Rwanda from those of Northern Rwanda.
2. With the help of diagrams differentiate soil profile from soil catena.
3. Identify the factors influencing soil fertility

End unit assessment

1. Conduct a field work study around your school and collect soil samples then study those samples to identify their constituents.
2. Describe the soil catena using diagram.
3. Distinguish:
   a. Soil structure and soil texture
   b. Soil colour and Soil PH

UNIT 8

WEATHER AND CLIMATE OF THE WORLD

UNIT 8: WEATHER AND CLIMATE OF THE WORLD

Key unit competence:

By the end of this unit, I should be able to appreciate the importance of the atmosphere, weather and the impact of climate on the environment and human activities in the world.

Introductory activity:

Read the following passage and answer the questions that follow:

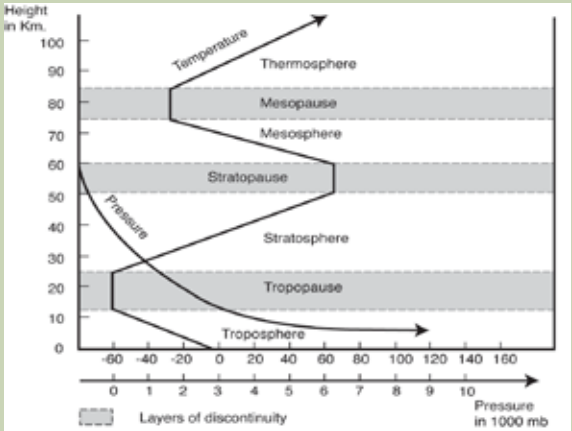
The climate is defined as the average weather conditions of an area in terms of temperature, atmospheric pressure, wind direction and wind speed, moisture, cloudiness, precipitation, and sunshine for a standard period of 30 years. Due to its high altitude, Rwanda enjoys a tropical temperate climate. The average annual temperature ranges between 16 and 20° C, without significant variations. Rainfall is abundant although it has some irregularities. Winds are blowing with a speed of 1-3 m/s. With an economy that is dominantly supported by agriculture.

1. Referring to the passage above distinguish climate from weather.
2. Identify the relationship between weather, climate and atmosphere on earth's surface.
3. Examine the influence of climate on the environment and socio-economic development of Rwanda.

8.1. The atmosphere

Learning activity 8.1

Observe the provided figure below and give answers to the questions that follow:



1. Comment on the structure shown above.
2. Describe different layers shown in the figure above.
3. Examine the relevance of atmosphere to human?

8.1.1. Meaning of the atmosphere

The atmosphere is the envelope of gases surrounding the earth. It contains the gases that support all forms of life on earth. This envelope of air is dense at the sea level. It thins out with increase in altitude.

8.1.2. The structure of the atmosphere

The atmosphere is a mixture of various gases surrounding the earth. It provides all gases that are essential for sustaining all life forms on the earth. Based on temperature variation, the atmosphere is made up of four layers: the troposphere, the stratosphere, the mesosphere and the thermosphere. On the basis of chemical composition; the atmosphere is composed of two layers: the homosphere and the heterosphere.

Thermal characteristics of atmosphere

The atmosphere is made up of four vertical layers. These are: troposphere, stratosphere, mesosphere and thermosphere.

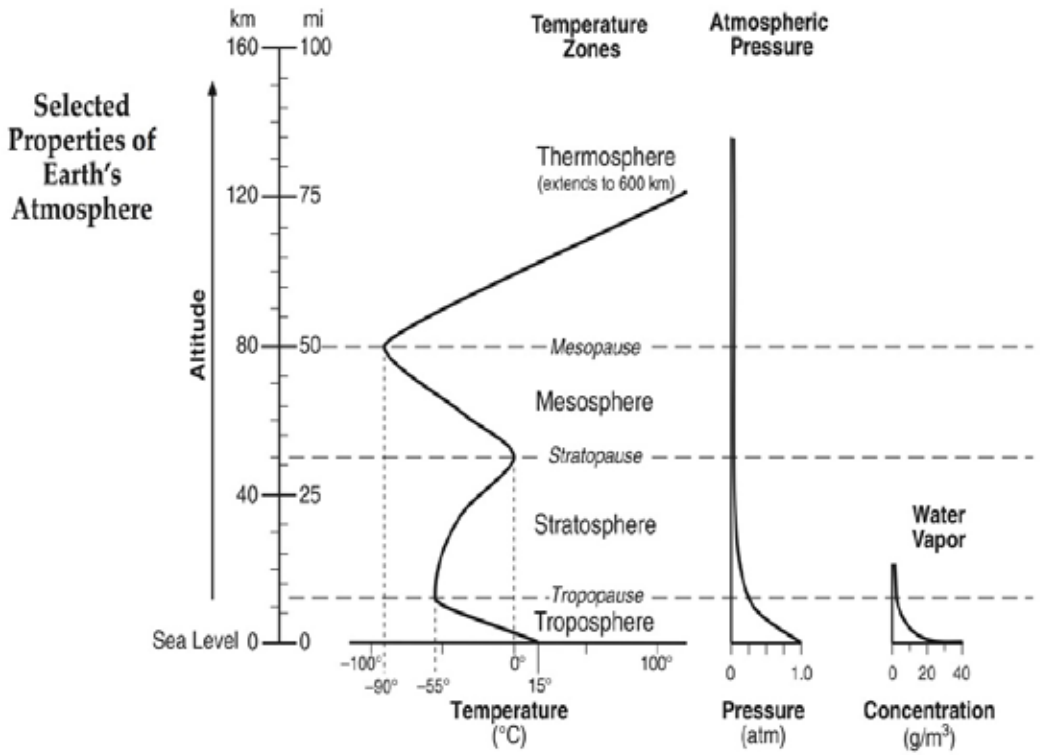


Figure 8.186: The structure of the Atmosphere

Troposphere

Climatically, the troposphere is the most important because all the elements of weather and weather phenomena occur in this layer (e.g. evaporation, condensation, and precipitation of different forms like fog, cloud, dew, frost, rainfall, snowfall, thunder, lightning, atmosphere storms, etc.). This layer contains about 75% of gaseous mass of the atmosphere, most of water vapour, aerosols and pollutants.

It is characterized by the following:

- It is the lowest layer of the atmosphere.
- The upper limit of the troposphere is called the tropopause.
- The temperature decreases with altitude at the rate of 6.5°C per km or 3.6°F/1000ft.
- The atmospheric pressure decreases also with altitude and reaches to 100 millibars and 250 millibars over the equator and poles respectively at tropopause.
- It lies between 10 km and 20 km above the sea level.
- All weather phenomena occur in this layer. These are evaporation, condensation and precipitation. Condensation is the conversion of vapour or gas into a liquid of different forms. Precipitation is water that falls to the ground as rainfall, snow or hail.
- The height of tropopause is 17 km over Equator and 9 to 10 km over the poles.

Stratosphere:

The stratosphere is the layer which is extending from 16 to 50 km above the sea level.

It is characterized by the following:

- There is increase of temperature due to absorption of ultraviolet solar radiation by ozone layer and lesser density of air.
- There is nearly absence of weather phenomena because of dry air and rare occurrence of clouds.
- The lower portion of the stratosphere having maximum concentration of ozone is called ozonosphere, which is confined between the heights of 15 to 35 km from sea level. Depletion of ozone would result in the rise of temperature of the ground surface and lower atmosphere. The main causes of ozone destruction are halogenated gases called chlorofluorocarbons (CFCs: chlorine, fluorine and carbon). This results to global warming, acid rain, melting of continental glaciers and rise in sea level, skin cancer, poisonous smoke, decrease in photosynthesis, ecological disaster and ecosystem instability.
- The upper limit of the stratosphere is known as stratopause.

Mesosphere

- The mesosphere extends between 50 km and 80 km.
- Temperature decreases as height increases. In fact, the rise of temperature with increasing height in the stratosphere stops at the stratopause.
- At the uppermost limit of the mesosphere (80 km), the temperature drops at -80° C and may go down as low as - 100° C to -133° Celsius at mesopause.
- This layer is characterized by very low air pressure ranging between 1.0 millibar at 50 km altitude representing stratopause, and 0.01 millibars at the mesopause (between 90 and 100 km).

Thermosphere

It extends from 80 km to 640 km. It is composed of Ionosphere and Exosphere.

The ionosphere consists of the following ionized layers:

- D layer: reflects low-frequency radio waves but absorbs medium and high-frequency waves. Being closely associated with solar radiation, it disappears as soon as the sun sets.
- E layer: The E-layer is also called the Kennelly-Heaviside layer. It reflects the medium and high-frequency radio waves. It is much better defined than the D layer. It is produced by ultraviolet photons from the sun rays interacting with nitrogen molecular. This layer also does not exist at night.
- Sporadic E-layer: This layer occurs ttunder special circumstances. It is believed that this sporadic layer is caused by meteors and by the same processes that cause aurora lights. This layer reflects very high frequency radio waves.
- E2 layer is generally found at the height of 150 km and is produced due to the reaction of ultra-violet solar photons with oxygen molecules. This layer also disappears during the night times.
- F layer consists of two sub-layers e.g. F1 and F2 layers (150 km-380 km) are collectively called the Appleton layer. These layers reflect medium and high frequency radio waves back to the earth.
- G layer (400 km and above) most probably persists day and night but is not detectable.

The exosphere represents the uppermost layer of the atmosphere. The density becomes extremely low. The temperature reaches 5568° C at its outer limit, but this temperature is entirely different from the air temperature of the earth's surface as it is never felt. The atmosphere above the ionosphere is called the outer atmosphere and it is made of exosphere and the magnetosphere.

8.1.3. Composition of atmosphere

Basically, the atmosphere is composed of three major constituents, namely: gases, water vapour, and aerosols.

a. Gases

The main gases are shown in the table below:

Gas	Percentage of volume
Nitrogen (N2)	78.1
Oxygen (O2)	20.9
Argon (A1)	0.93
Carbon dioxide (CO2)	0.03
Neon (Ne)	0.0018
Helium (He)	0.0005
Methane (CH4)	0.0002
Krypton (Kr)	0.00011
Nitrous oxide	0.00005
Hydrogen (H2)	0.00005
Xenon (X2)	0.0000087
Ozone (O3)	-

The following are the most important gases:

1. **Nitrogen**, which is about 78.1% of the total gases. Nitrogen is for all life forms. It is an important part of amino acids which make up proteins.

   Nitrogen (N) is one of the building blocks of life: it is essential for all plants and animals to survive. Nitrogen (N2) makes up almost 78.1% of our atmosphere. Humans and most other species on earth require nitrogen in a "fixed," reactive form.

   Life depends on nitrogen, which is a basic ingredient in amino acids that make up all proteins. While a substantial percentage of the atmosphere is comprised of nitrogen gas, it must be processed into a soluble form. This is done via a nitrogen cycle that occurs in the soil. Then plants and the animals that eat them can obtain dietary nitrogen.

   Plants with nitrogen deficiencies look weak. Their leaves, which should be healthy and green, may look wilted and yellow. Animals and people get dietary nitrogen by eating protein-rich foods like milk, eggs, fish, beef and legumes. Nitrogen, carbon, hydrogen and oxygen are found in amino acids, which are the main structures of every protein.

The nitrogen cycle involves:

- Transfer of atmospheric nitrogen into soils (known as nitrogen fixation);
- Mineralization, nitrification and transfer of nitrogen from soils to plants.
- Denitrification and return of nitrogen to the atmosphere. It helps the oxygen in combustion; it also helps indirectly in oxidation of some elements.

2. **Oxygen:** This makes up 20.9% of gases in the atmosphere. The molecular oxygen (O2) mostly occurs up to the height of 60 km in the lower atmosphere. It is produced through photosynthesis. This is the process by which green plants use sunlight, carbon dioxide and water to make their own food. It is one of the main elements that make up air, and it is necessary for the survival of all plants and animals e.g. animals breathe in oxygen.

3. **Carbon dioxide** represents 0.03% of the total atmospheric gases. The gaseous carbon (CO2) plays two significant roles:
   - Carbon dioxide helps in the process of photosynthesis where carbon, hydrogen, and oxygen are combined by the autotrophic green plants of terrestrial and marine ecosystem. This is assisted by sunlight that enables the formation of the organic compounds.
   - Carbon dioxide is transparent to incoming shortwave solar radiation. It is opaque to outgoing long wave terrestrial radiation. It is evident that carbon dioxide is most significant greenhouse gas. The concentration carbon dioxide increases due to the anthropogenic activities, namely the burning of fossil fuels and wood and deforestation which lead to probable climate change through global warming.

4. **Ozone (O3):** It is defined as "a three-atom isotope of oxygen (O3) or merely a triatomic form of oxygen (O3). It is formed with the separation of (O2). Then, these separated oxygen atoms (O) are combined with Oxygen molecules (O2) and thus ozone (O3) is formed. It is a life-saving gas because it filters the incoming shortwave solar radiation and absorbs ultraviolet rays. Therefore, the ozone layer protects the earth from becoming too hot. It is known as the earth's umbrella to all organisms in the biospheric ecosystem against their exposure to ultraviolet solar radiation. The highest concentration of ozone is between the altitudes of 12 km and 35km in stratosphere; the said zone is also called ozonosphere.

   a. **Water vapour:** Liquid water turns into vapour through the process of evaporation. The content of water vapour decreases with the altitude in the atmosphere. More than 90% of the water vapour in the atmosphere is found up to a height of 5 km. The moisture content in the atmosphere creates clouds, fogs, rainfall, frost, snowfall and other forms of precipitation.

b. Aerosols: These are suspended solid particles and liquid droplets. These particles are from various sources like volcanic eruptions, desert dust, spores and pollen. The concentration of these particles decreases with increasing altitude in the atmosphere.

8.1.4. Importance of the atmosphere

The atmosphere is important for the following reasons:

- It protects living things from harmful ultraviolet rays of the sun. This role is played by the ozone layer. The atmosphere serves as a protective shield against radiation and cosmic rays.
- Dense layers of molecular gases also absorb cosmic rays, gamma rays and x-rays, preventing these energetic particles from striking living things and causing mutations and other genetic damage.
- Even during a solar flare, which can greatly increase the damaging output of the sun, the atmosphere is able to block most of its harmful effects.
- It helps to regulate the heat during the day and night. On earth, however, molecules in the atmosphere absorb the sun's energy as it arrives, spreading that warmth across the planet. The molecules also trap reflected energy from the surface, preventing the night side of the planet from becoming too cold.
- The Earth's atmosphere protects and sustains the planet's inhabitants by providing warmth and absorbing harmful solar rays.
- The atmosphere traps the sun's energy and sends off many of the dangers of space.
- It provides the various gases that are useful to living things. These include oxygen.
- It provides precipitation that helps to sustain life on earth.
- The atmosphere is made of gases that are essential for photosynthesis and respiration, among other life activities.
- The atmosphere is a crucial part of the water cycle. It is an important reservoir for water and the source of precipitation.
- The atmosphere moderates Earth's temperature because greenhouse gases absorb heat.
- Atmosphere contains the oxygen and carbon dioxide, which living things need to survive.
- The atmosphere also serves an important purpose as a medium for the movement of water. Vapour evaporates out of oceans, condenses as it cools and falls as rain. Hence, providing life-giving moisture to otherwise dry areas of the continents. Without an atmosphere, it would simply boil away into space, or remain frozen in pockets below the surface of the planet.

Application activity 8.1

1. a. Explain why the atmosphere should be conserved.

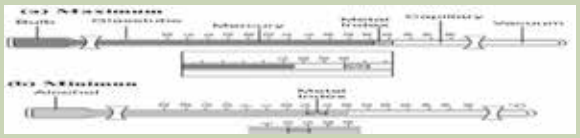
   b. Describe how atmosphere should be conserved.

2. Identify the susceptible sources of aerosols in your area.

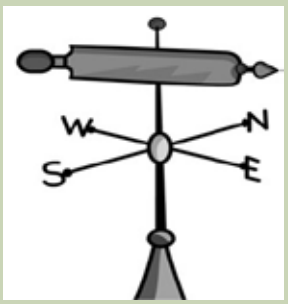
8.2 Elements of weather and climate

Learning activity 8.2

Observe the pictures provided below and answer the questions that follow:

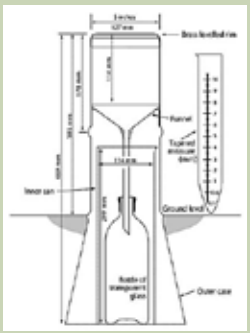


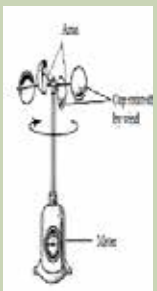
A



B

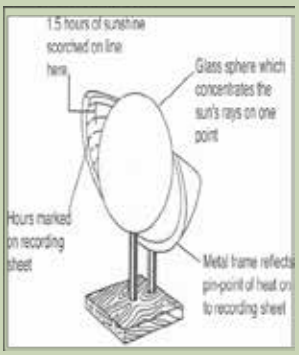
C.





D

E



F

Identify the instruments marked by letters A, B, C, D, E and F above and describe their roles.

Definition of weather and climate

Weather can be defined as the state of the atmosphere at any given time. This state is about temperature, atmospheric pressure, wind speed and direction, moisture, cloud cover, precipitation, and sunshine. Weather keeps changing all the time. The change is from hour to hour and day to day.

Climate is an average weather conditions over a long period of time (about 30 years). It is measured by assessing the patterns of variation in temperature, humidity, atmospheric pressure, precipitations, wind speed and direction.

The elements of weather and climate: Weather and climate are made up of many elements. The main ones are temperature, precipitation, wind, atmospheric humidity, clouds, sunshine and atmospheric pressure.

8.2.1. Temperature

Learning activity 8.2.1

Read the context below and answer the questions that follow:

When people migrate from Bugesera to Musanze they are required to change clothing style. Some of them say that it is necessary to put on jackets due to climatic conditions of that area.

1. Why is there constant change of clothing style from Bugesera to Musanze?
2. Identify the weather condition that led people to put on jackets in Musanze while in Bugesera they put on tee-shirts.
3. What may be the possible causes/factors responsible for that constant change?

Temperature is the degree of heating and cooling of the atmosphere at a given area and time. The sun is the source of heat to the atmosphere.

Factors influencing temperature variation

Temperatures change from place to place. These changes are influenced by the following factors:

Latitude or distance from the Equator: The temperature of a place depends on the amount of sunshine reaching there. The amount of sunshine received decreases as one moves away from the Equator.

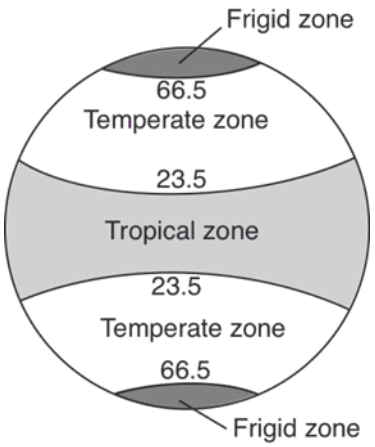


Figure 8.187: Variations of temperatures with latitude

Altitude: Temperatures decrease with increasing height from the earth's surface. This is at the average rate of 6.5°C per 1km or 1000 metres ascent.

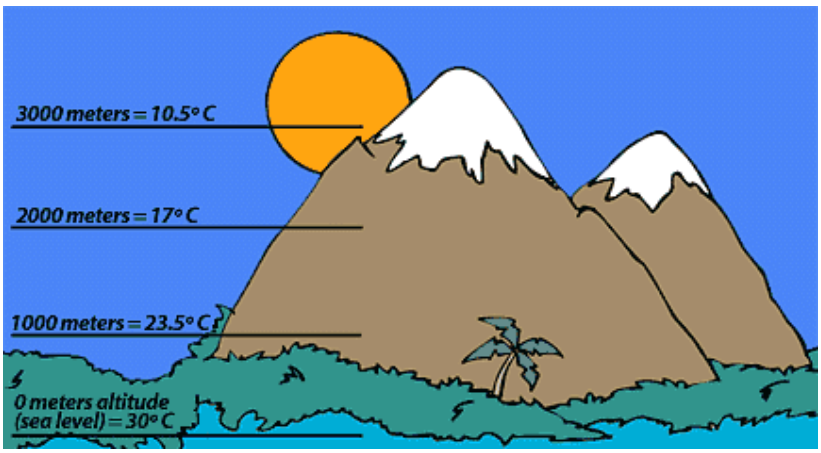


Figure 8.188: Variations of temperatures with altitude

Distance from the sea: Places on the coast are affected by land and sea breezes. Therefore, they have low temperature. Places that are far away from the coast have high temperature.

Prevailing winds: Winds blowing from low latitudes to high latitudes raise the temperature of the regions where they reach. Winds blowing from high latitudes to low latitudes lower the temperature.

Nature of land and water: The contrasting nature of land and water surfaces in relation to the incoming shortwave solar radiation largely affects the spatial and temporal distribution of temperature. It may be pointed out that land becomes warm and cold more quickly than the water body. The following reasons explain the differential rate of heating and cooling of land and water.

- The sun's rays penetrate to a depth of only one meter in land because it is opaque, but they penetrate to greater depth of several meters in water because it is transparent to solar radiation.
- Heat is concentrated at a place where the process of redistribution of heat by conduction is very slow because the land surface is static.
- There is more evaporation from the seas and the Oceans and hence more heat is spent in this process. This results in oceans getting less insolation than the land surface. On the other hand, there is less evaporation from the land surface because of very limited amount of water.
- The reflection (albedo) of incoming solar radiation is more over oceanic water surface than over land surface and thus water receives less insolation than land.
- Oceanic areas are generally clouded and hence they receive less insolation than land surface. But clouds absorb outgoing terrestrial radiation and counter-radiate heat back to the earth's surface.

Nature of ground surface: The nature of ground surface in terms of colour, vegetation, and land use practices affects distribution of temperature. Areas under vegetation absorb more heat from the sun than those without vegetation.

Nature of ground slope: The slopes facing the sun receive more heat from the sun because its rays reach the surface more or less straight. These areas have higher temperature than those not facing the sun.

Cloud cover: The amount of cloud cover affects temperature. It is observed that night time temperature during clear sky is much less than clouded nights. Cloudy nights and days are warmer than cloudless nights and days.

Ocean currents: The warm Ocean currents flowing from tropical areas to temperate and cold zones raise the average temperature in the affected areas. For example, the Gulf Stream raises the average temperature of the coastal areas of north-western Europe while Kuroshio warm current raises the temperature of Japanese coasts.

Mountain barriers: Mountains block the movements of air from one place to another. This has an influence on temperature on both sides of the mountain.

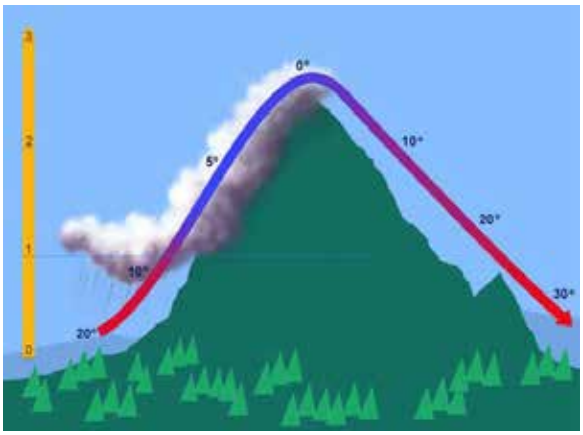


Figure 8.189: Impact of mountains on temperature variations

Measurement and recording of temperature

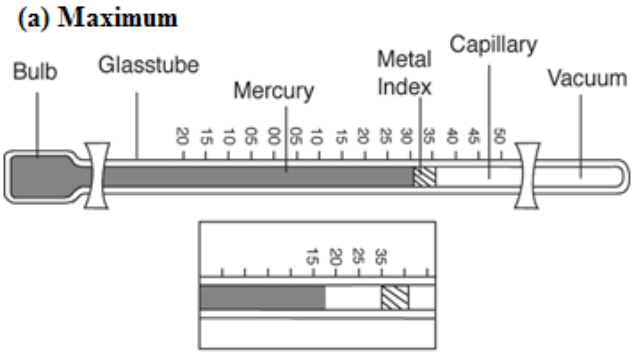
The instrument used for recording temperature is called a thermometer. Temperature is measured in degrees:

Celsius (°C), Fahrenheit (°F) or Kelvin (K).

Where {°F = $\frac{9}{5}$ 0C +32 and 0C = $\frac{5}{9}$ (°F-32)} while 0°C = 273K

There are three types of thermometers. These are:

- Maximum thermometer (records the highest temperature of the day).
- Minimum thermometer (records the lowest temperature of the day).
- Six's thermometer (records both maximum and minimum temperature of the day).



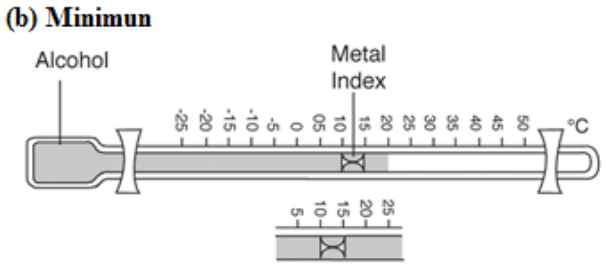


Figure 8.190: Maximum and minimum thermometers

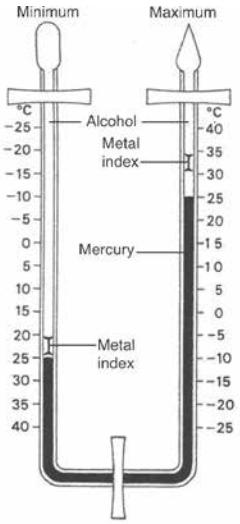


Figure 8.191: Sixth's thermometer

Terms related to temperature

- **Mean (average) temperature**

The following are types of average temperature:

Diurnal average (the average temperature within 24 hours of the day)

From the table above, the diurnal mean temperature is 18.4°C. This is got by adding the daily temperatures and dividing the total by 24 (hours).

- The highest temperature recorded within 24 hours is called the **maximum daily temperature**. It is 22°C (from the above table).
- The lowest temperature recorded within 24 hours is called the **minimum daily temperature.** It is 16°C (from the above table).
- **Monthly mean temperature:** This is the sum of mean daily temperatures for a given month divided by the number of days of that month.

– **Annual mean temperature:** This is the mean temperature of 12 months of the year.

Months	J	Feb	Mar	Ap	May	June	July	Aug	Sept	Oct	Nov	Dec	Average
Temperatures (°C)	10	11	12	13	15	16	16	16	16	15	13	11	13.6

In the table above, the mean annual temperature is 13.6°C.

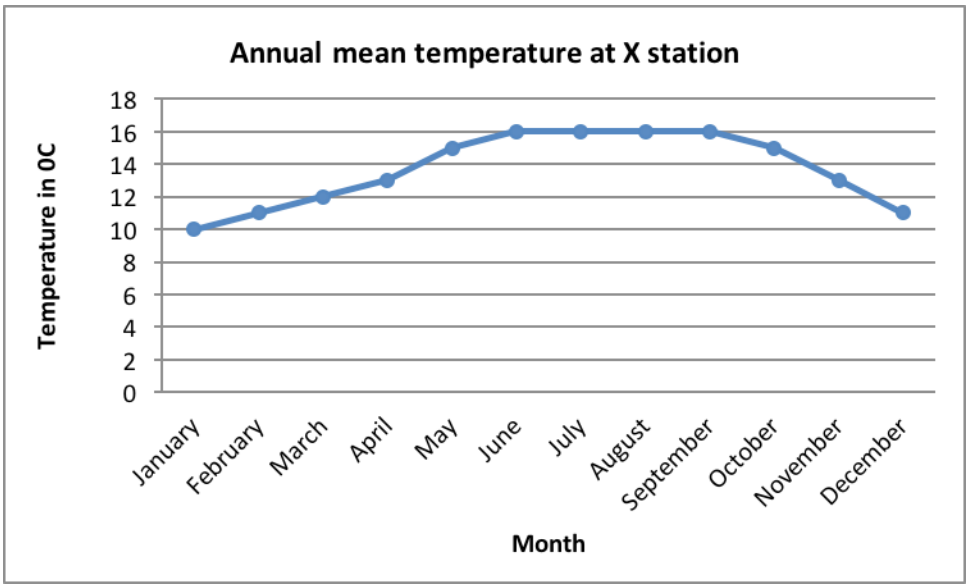


Figure 8.192: Annual temperatures diagram

– **Temperature range**
  – The difference between the maximum and minimum temperatures of the day is called daily range of temperature. Therefore, it is 22°C - 16°C = 6°C (from the above table showing the daily temperature variations).
  – The difference between the maximum and minimum temperatures of the month is called monthly range of temperature.
  – The difference between maximum and minimum temperatures of the year is called annual range of temperature. Therefore, it is16°C - 10°C = 6°C (from the above table showing the annual temperature variations).

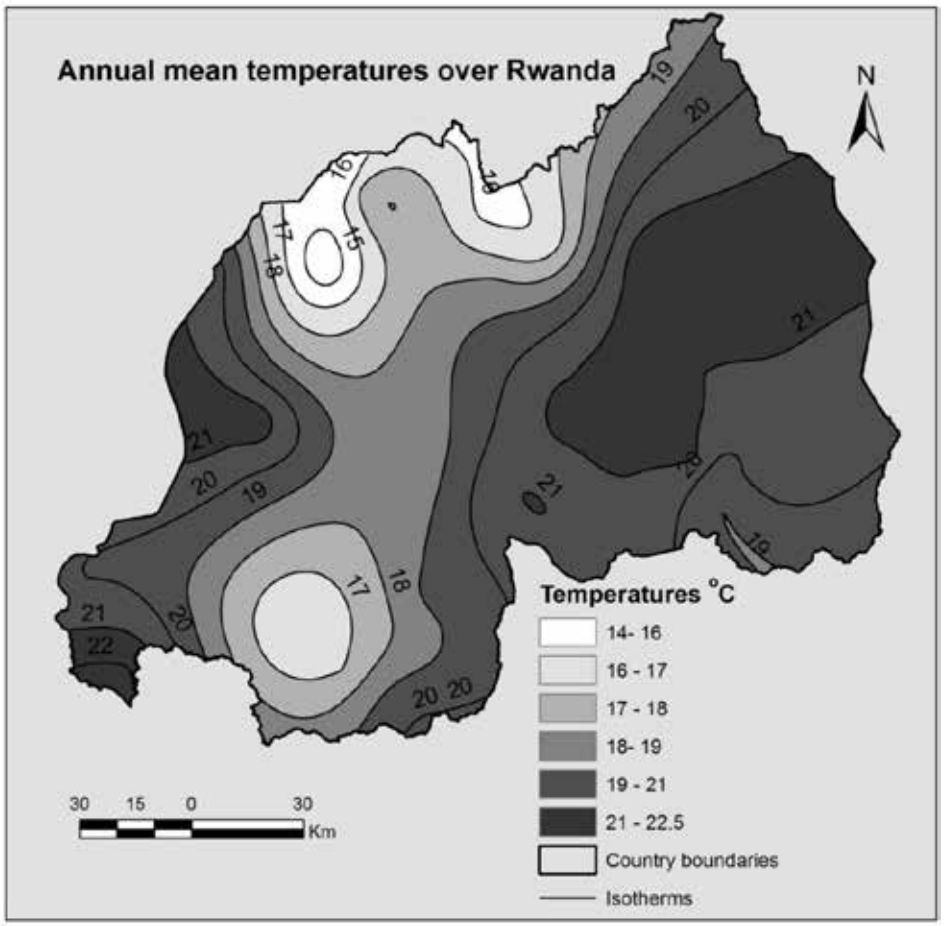


Figure 8.193: Map of annual temperatures of Rwanda

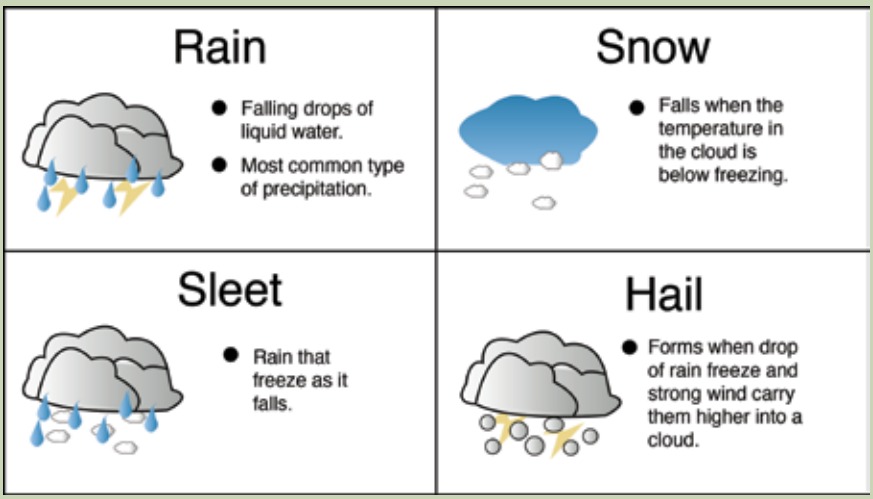
- **Impact of temperature on the environment**
  - The following are the major impacts of temperature on the environment:
  - A rise in global temperatures could lead to an increase of evapo-transpiration. This could eventually lead to the rise in amount of rainfall which impact on environment positively or negatively.
  - A rise of temperature leads to melting of glaciers in polar and mountainous regions or ice-capped highlands.
  - An increase in temperature leads to global warming which impacts negatively on the environment.
  - As the earth gets warmer, plants and animals that need to live in cold places like on mountain tops or in the Arctic, might not have a suitable place to live. If the Earth keeps getting warmer up to one fourth; all plants and animals could become extinct within 100 years.

– Animals are changing migration patterns and plants are changing the dates of activity.
– The sea level has been rising more quickly over the last century as a result of temperature change
– Precipitation (rain and snowfall) has increased across the globe; on average as a result of temperature change.

8.2.2. Precipitation

Learning activity 8.2.2

Observe the following picture and answer the following questions:



1. Identify the types of precipitation shown on the above picture.
2. Distinguish the formation of rain from that of snow.

a. Meaning and forms of precipitation

Precipitation is any form of liquid or solid water particles that fall from the atmosphere and reach the earth surface. The following are main forms of precipitations:

Rainfall is the most widespread and important form of precipitation. It occurs when there is enough moisture in the air that condenses above freezing point. Rain is liquid water, in form of raindrops with diameter of more than 5 mm with 8,000,000 cloud droplets. This is formed of droplets that have condensed from atmospheric water vapour and then becomes heavy enough to fall under gravity. Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on the Earth.

Snow: It is formed when condensation occurs below freezing point (less than 0°C). The fall of snowflakes is called snow-fall. Snowflakes are formed when air temperature is greater than -5°C but less than 0°C. A snowfall is 'precipitation of white and opaque grains of ice'.

Drizzle: It is defined as the fall of numerous uniform tiny droplets of water having diameter of less than 0.5 mm. Drizzles fall continuously from low status clouds, but the total amount of water received at the ground surface is significant.

Fog: This is a cloud layer lying in contact and very close to the surface of the earth or sea.

Frost: It is defined as transformation of gaseous form of water (water vapour) directly into solid form (the process being called sublimation) at the ground surface, in the soils and in the air, layer just lying over the ground surface due to condensation occurring below freezing point.

Hail: It consists of large pellets or spheres (balls) of ice. Hail is a form of solid precipitation wherein small balls or pieces of ice, known as hailstones, have a diameter of 5 mm to 50 mm. In contrast, ice pellets (sleet; sometimes called small hail) have a diameter less than 5 mm.

Sleet: It refers to mixture of snow and rain.

Ice pellets are snow grains, transparent or translucent grains of ice which are formed when condensation takes place below freezing point. The diameter of ice pellets is up to 5 mm and shape of the pallets is highly irregular depending upon the conditions of condensation.

Dew: These are droplets of water that are deposited on the ground. As the exposed surface cools by radiating its heat, atmospheric moisture condenses at a rate greater than that at which it can evaporate, resulting in the formation of water droplets. When temperatures are low enough, dew takes the form of ice; this form is called frost.

Rime: It is an opaque thin, white layer of ice that forms when the air temperature is below the freezing point of water, especially outside at night.

b. The water cycle

The **water cycle** also known as the **hydrological cycle** or the **hydrologic cycle** describes the continuous movement of water on, above and below the surface of the Earth. The water moves from one reservoir to another, such as from river to ocean, or from the Ocean to the atmosphere, by the physical processes of evaporation, condensation, precipitation, infiltration, surface runoff and subsurface flow. In doing so, the water goes through different forms: liquid, solid (ice) and vapour. The following are the main components of water cycle:

- **Evaporation** of water from Ocean, sea, lakes, rivers, ponds and transpiration from the leaves of plants through insolation (solar energy).
- **Conversion of water into water vapour** or humidity (first and second phases are almost the same).
- **Horizontal transport of atmospheric moisture** over the Oceans and the continents by atmospheric circulation (advection).
- **Condensation:** The transformation of water vapour into solid form. This takes place when the dew point is below freezing point to form snowfall, and when dew point is above freezing point to turn the water vapour into liquid form (i.e. above 0°C temperature of the air), is called condensation.
- **Precipitation** (either in liquid form as rain water, or in solid form as snow and ice and other minor forms of dew, fogs etc.).
- **Runoff and infiltration:** Eventual transfer of water received at the earth's surface to the Oceans via various routes and hydrological processes. Some portion of rainwater received at the ground surface enters the soil zone through infiltration and thus forms soil moisture storage. This portion of water reappears as seepage and springs through flow and interflow.
- **Percolation:** This is a portion of infiltrated water which percolates further downward to form groundwater storage. While other portion moves upward as capillary rise to reach 'soil moisture storage. Other quantity is routed further downward through deep transfer and enters the underlying bedrocks.

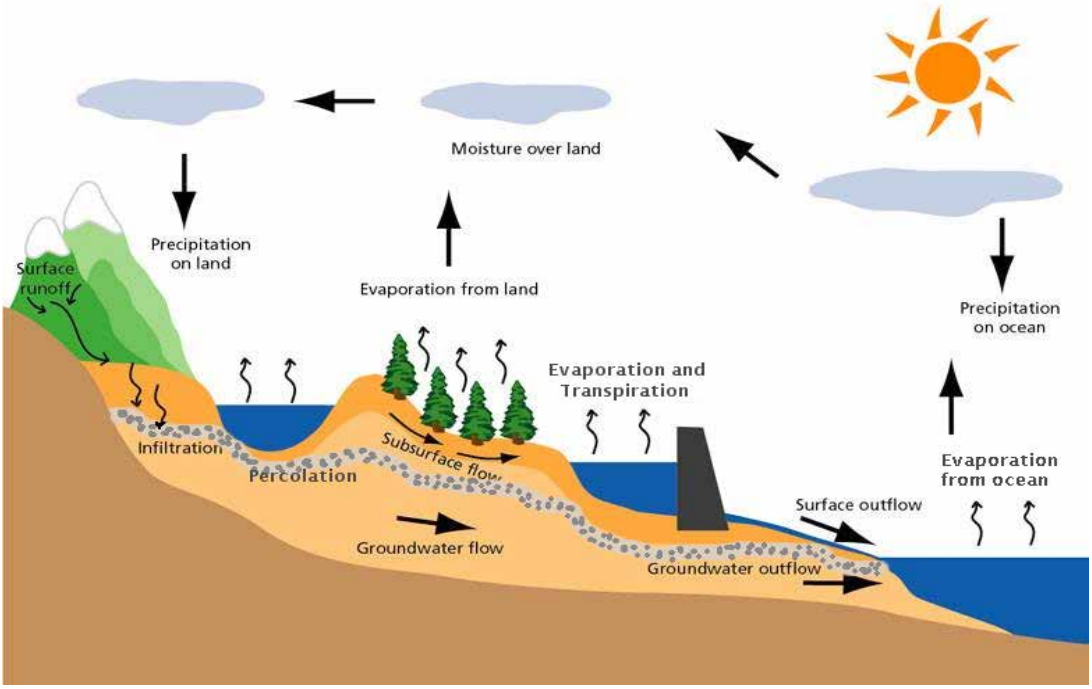


Figure 8.194: The water cycle

c. Types of rainfall

Rainfall is precipitation in form of droplets. The following are the major forms of rainfall.

1. **Convectional rainfall:** It occurs when the earth's surface is heated by the sun. The warm air rises, and it is replaced by the cold air. As the air rises, the pressure on it decreases, expands and cools. Further cooling makes the moisture in it to condense and form clouds. It later falls as rain. Two conditions are necessary to cause convectional precipitation:

– Abundant supply of moisture through evaporation to the air. So that relative humidity becomes highly supersaturated, and

– Intense heating of ground surface through incoming shortwave electromagnetic solar radiation (that is, insolation heating). After super saturation of the air, follows condensation and clouds formation (cumulonimbus clouds) and then rainfall is formed.

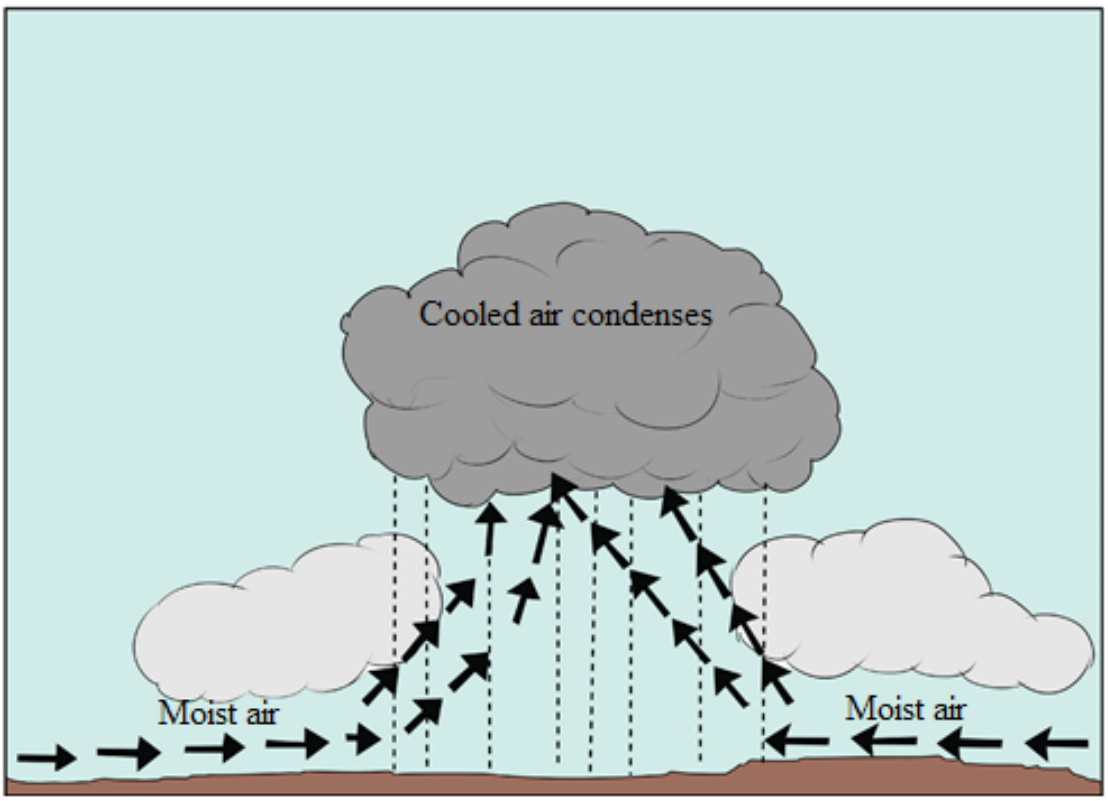


Figure 8.195: Convectional rainfall

Convectional rainfall has the following characteristics:

- Convectional rainfall occurs daily in the afternoon in the equatorial regions.
- It has a short duration but occurs in form of heavy showers (heavy downpour).
- It occurs through thick dark and extensive cumulonimbus clouds.
- It is accompanied by thunder and lightning.
- It causes a lot of runoff.
- Convectional rainfall supports luxurious evergreen rain forests in the equatorial regions.
- In temperate regions, it is slow and of longer duration so that most of rainwater infiltrates into soils.
- Convectional rainfall in hot deserts is not regular, it only occurs suddenly.

2. **Orographic rainfall:** this type of rainfall occurs when a water body is heated by the sun. The heating causes evaporation. Moist air from the sea is blown over a hill or mountain side. The rising causes it to expand and cool. It condenses and forms clouds. Rainfall occurs on the wind ward side of the mountain. This is the side facing the moist wind. The opposite side known as leeward side is dry.

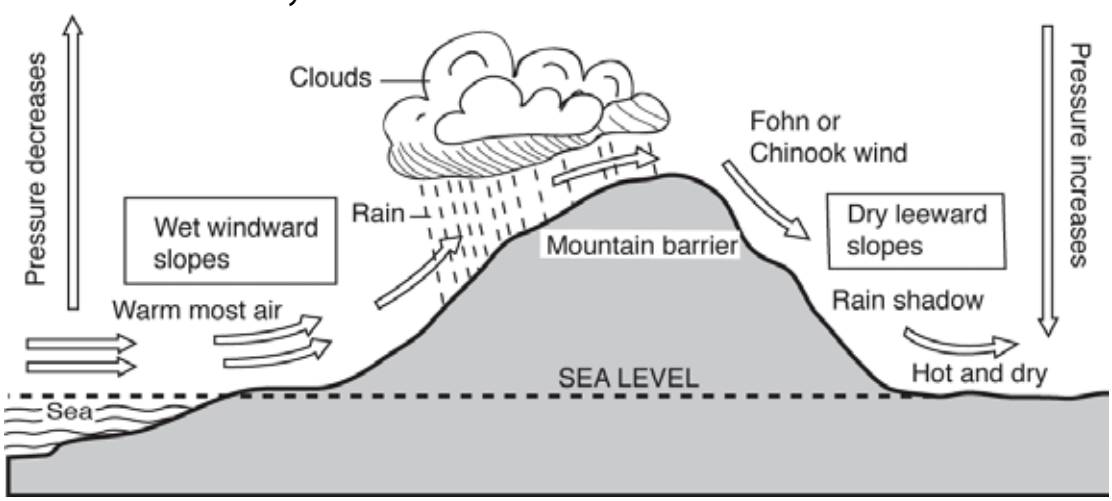


Figure 8.196: Orographic rainfall

The following conditions are necessary for the orographic rainfall to occur:

- There should be a mountain barrier across the wind direction, so that the moist air is forced on a barrier (an obstruction) to move upward.
- If mountains are very close and parallel to the sea coasts, they become effective barriers. Such assists the moisture-laden winds coming from over the Oceans to rise upward and soon becoming saturated.

- The height of mountains also affects the form and amount of orographic rainfall. Mountains or highlands near the seas or water bodies of reasonable height play a great role in formation of rainfall. Even low height coastal mountains are associated with rainfall formation since the moist air becomes saturated at very low height. On the other hand, the inland mountains should be of higher height because the air after covering long distances loses much of its moisture content.
- There should be enough moisture content in the air.

3. **Cyclonic or frontal rainfall** Cyclonic or frontal rainfall occurs when air masses of different temperatures meet. One is warm and the other is cold. The warm air is forced over the cool air. As the warm air rises, the moisture in it is cooled. It condenses and falls as rain.

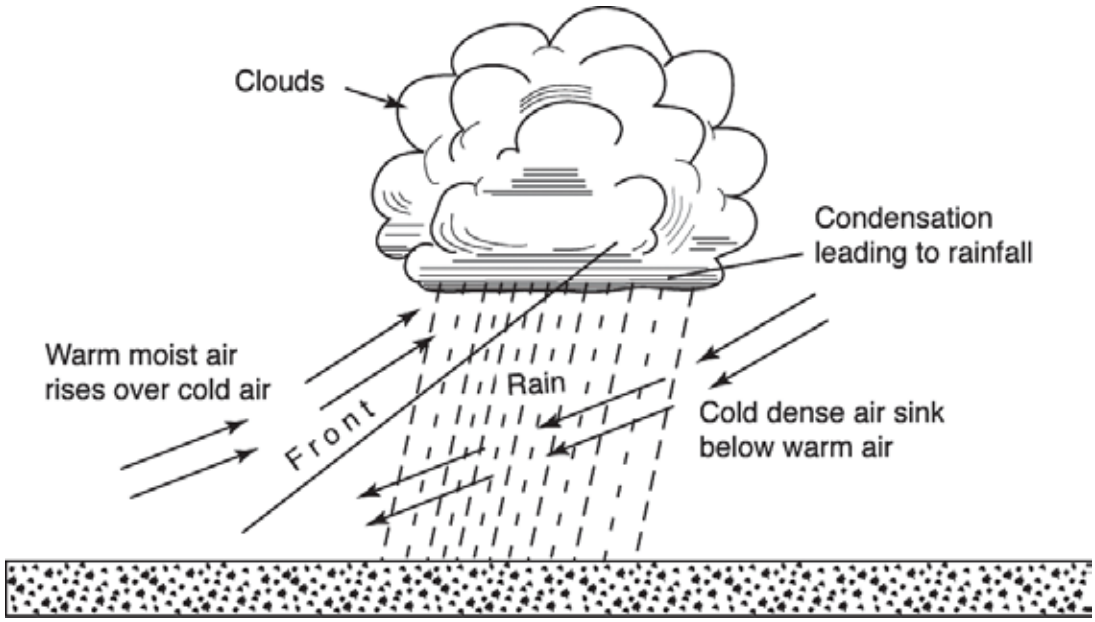


Figure 8.197: Cyclonic or frontal rainfall

Rainfall associated with ITCZ (Inter Tropical Convergence Zone) results from convergence of cold and warm air masses from the Southern and Northern hemispheres respectively in the equatorial zone. The following are the key conditions for frontal rainfall to occur:

- The moisture content of the air is supposed to be positively correlated with rainfall
- The convergent or divergent air circulation determines the ascent or descent of air and its adiabatic cooling or heating. This in turn determines the amount of precipitation.
- Topographic conditions present both favourable and unfavourable conditions for precipitation (presence of mountain, near coastal land, etc.)

– Distance from the source of moisture determines the amount of precipitation in different areas.

d. Factors influencing rainfall formation

The spatial and temporal distribution of precipitation over the globe is controlled by the following conditions:

– **Moisture content of the air:** The atmospheric moisture depends on evaporation of water or ice through the input of heat energy. The regions having high temperature and abundance of surface water, and wide-open Oceanic surfaces for evaporation, receive higher amount of annual rainfall. Equatorial regions are typical examples of such places.

– **The convergent or divergent air circulation:** The convergent or divergent air circulation determines the ascent or descent of air and its adiabatic cooling or heating which in turn determines the amount of precipitation. The convergence of two contrasting air masses creates frontal activity. In this case, warm air mass is pushed upward by underlying cold air mass resulting into uplifting of warm and moist air mass. The overlying warm and moist air is cooled, and precipitation occurs after condensation. On the other hand, divergent circulation allows descent of air from above and creates anticyclonic condition and atmospheric stability resulting into dry weather. Such situation develops in the subtropical high-pressure area. Therefore, this explain why most of the hot deserts of the world are found in this zone.

– **Topographic conditions:** Topographic conditions present both favourable and unfavourable conditions for precipitation. If the mountain barriers parallel to the coastal lands and there is onshore moist air, the moist air is forced by mountains to ascend and condense hence yielding precipitation. The leeward side would be dry while the windward side would experience rainfall.

– **Distance from the source of moisture:** Distance from the source of moisture determines the amount of rainfall in different areas. As the distance from the source of moisture (oceans, seas, rivers) increases, the moisture content reduces and hence the amount of precipitation decreases.

e. Measurement and recording of rainfall

Rainfall is measured using a rain gauge. Many different types of rain-gauge have been designed and used. Most consist of a circular collector and a funnel that channels the collected rain into a measuring mechanism or into a cylinder where it may be measured later. The entrance to the gauge through the funnel is narrow to avoid debris clogging the mechanism and undesirable evaporation in hot weather. To make the rainfall measurement, the observer empties the collected rain into a graduated glass rain measure.

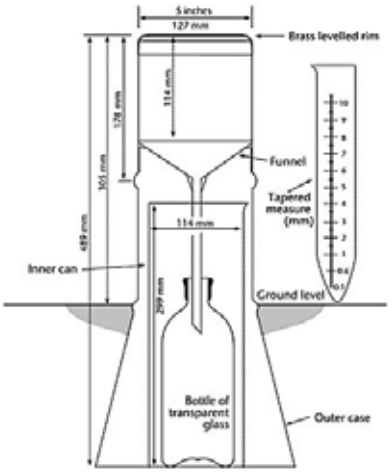


Figure 8.198: Rainfall gauge

f. Terms related to rainfall

The data obtained from the weather station can be used to calculate the following:

- **Daily rainfall total:** This is the amount of rainfall recorded in a day.
- **Monthly rainfall total:** This is the total amount of rainfall received in a month. It is obtained by calculating the sum of daily rainfall totals in the month.
- **The mean monthly totals:** This is the average rainfall received per month in a year. It is obtained by adding the total monthly rainfall received over a given period (preferably 30 years) and dividing by the number of years.
- **The annual rainfall total:** This is the total amount of rainfall received in a year. It is obtained by finding the sum of all the monthly rainfall totals for 12 months.
- **Mean annual rainfall:** This is the average total annual rainfall received in an area. It is obtained by adding the total annual rainfall received over a given period (preferably 30 years) and dividing by the number of years.

Example of rainfall distribution on diagrams

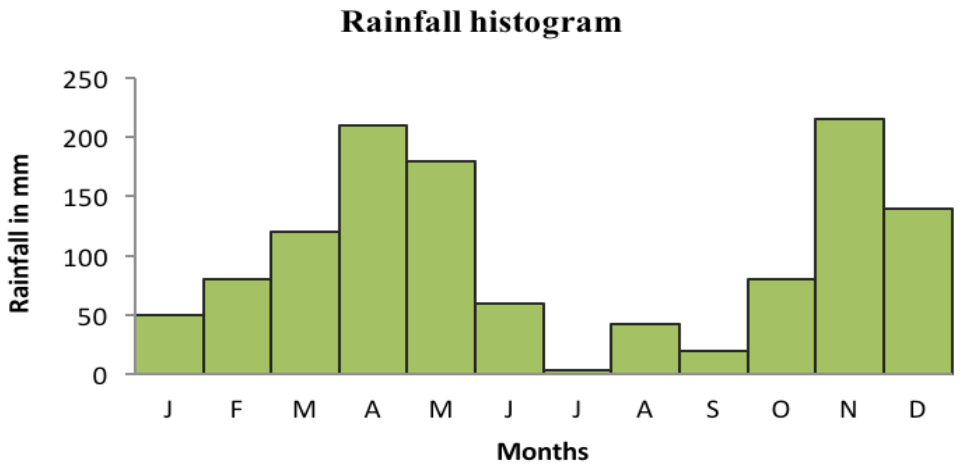


Figure 8.199: Mean monthly totals

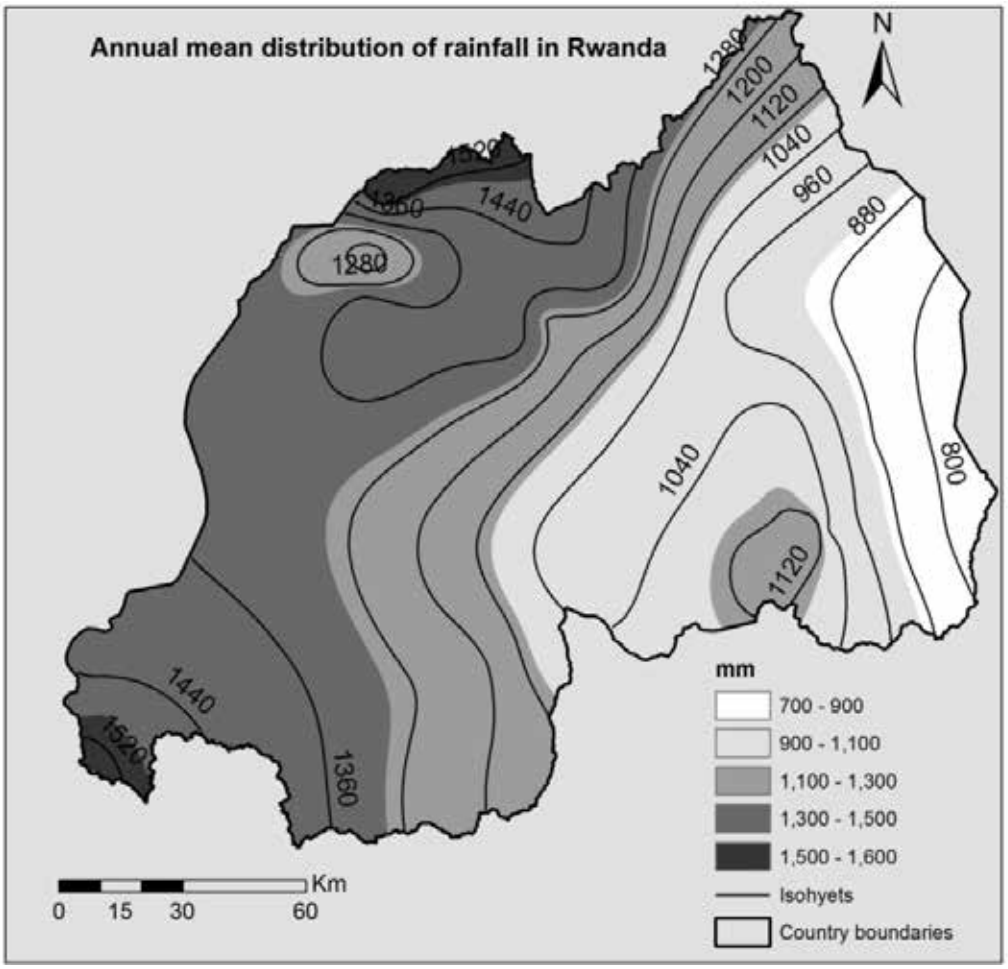


Figure 8.200: Annual distribution of rainfall over Rwanda (Isohyets)

8.2.3. Winds

Learning activity 8.2.3

Observe carefully the picture provided below:

1. Explain the phenomenon occurring on the above picture.
2. Describe the factors causing the mentioned phenomenon in (1).
3. Suggest the instrument used to record the direction and speed of wind.

(i) Meaning of wind

Wind is air in motion above the surface of the earth. It is caused by differences in atmospheric or barometric pressure. Air moves from areas of high barometric or atmospheric pressure to areas of low pressure.

(ii) Measurement and recoding of wind direction

The wind direction is measured with help of a wind vane and wind sock.

Wind vane: It consists of a horizontal rotating arm pivoted on a vertical shaft. The rotating arm has a tail at one end and a pointer at the other. When the wind blows, the arm swings and points to the direction the wind is blowing from. The wind is named after this direction.

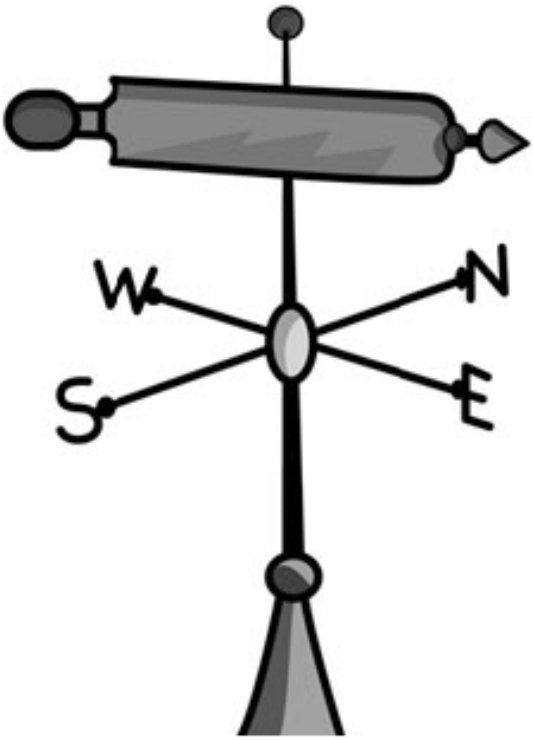


Figure 8.201: A wind vane

Wind sock: It is common in airstrips. It consists of a cylindrical cloth bag tied to a mast. It always points towards the direction at which the wind is blowing.

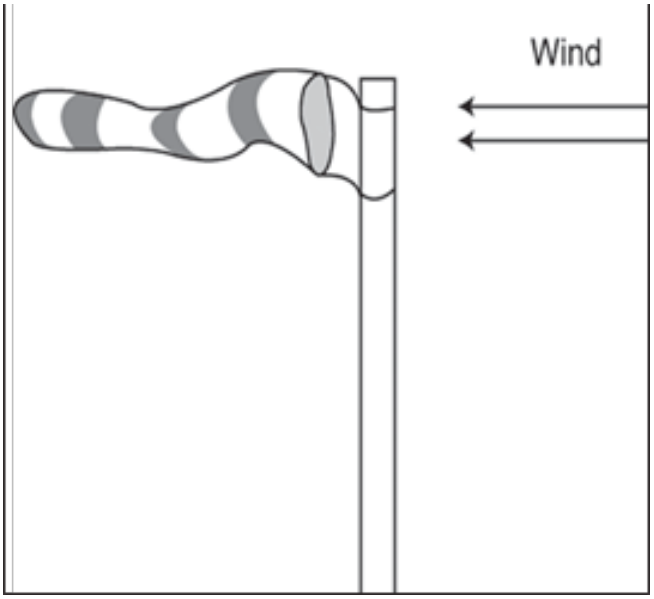


Figure 8.202: A wind sock

(iii) Measurement of wind speed

The speed of wind is measured using an anemometer. This consists of three or four metal cups fixed to metal arms that rotate freely on a vertical shaft. When there is wind, the cups rotate. The stronger the wind, the faster the rotation will be. The speed of rotation is recorded on a meter. Wind speed is measured in kilometres per hour. The regions with the same wind speed are called isotachs.

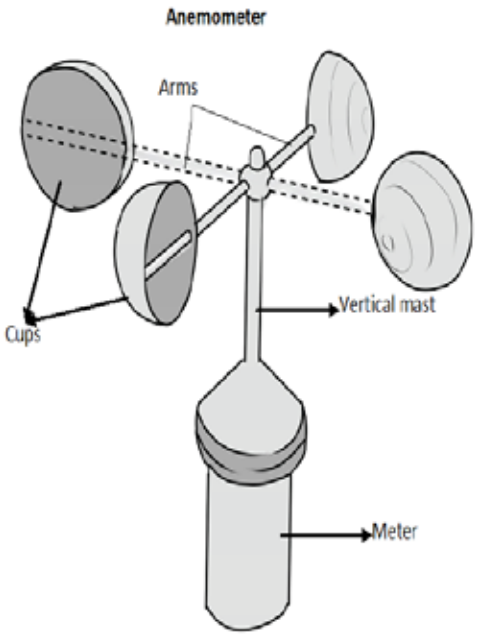


Figure 8. 203: An anemometer

(iv) Factors influencing the nature and movement of winds

The following are the main factors that affect wind direction:

1. **The pressure-gradient force:** Air flows from areas of higher atmospheric/barometric pressure to areas of lower pressure. This is the pressure gradient force that sets the air in motion and causes it to move with increasing speed down the gradient. The heating of the earth's surface is uneven which causes the continual generation of these pressure differences. The greater the atmospheric/barometric pressure difference over a certain horizontal distance, the greater the force and therefore, the stronger the wind.

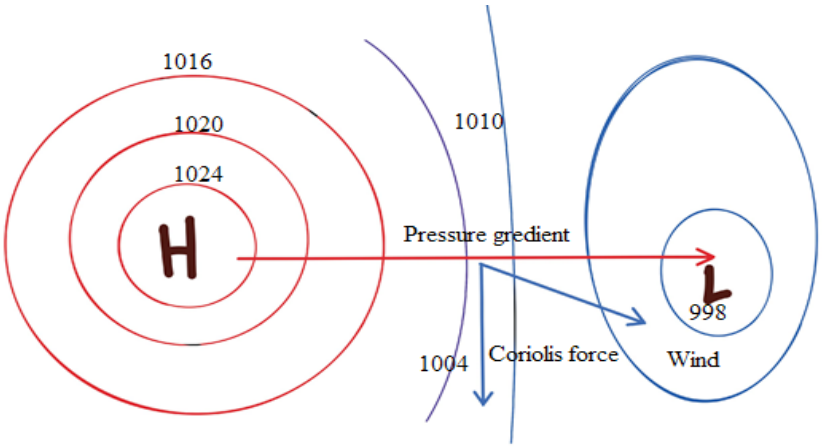


Figure 8.204: Pressure gradient force and the Coriolis Effect on wind

2. **The Coriolis force:** Winds are deflected to the right in the Northern Hemisphere and to the left in the Southern. The Coriolis force is directed at right angles to the direction of air flow. It does not affect the wind speed, only the wind direction. However, the stronger the wind, the greater the deflecting force. There is no deflection of winds at the equator, but it increases to its maximum at the poles.

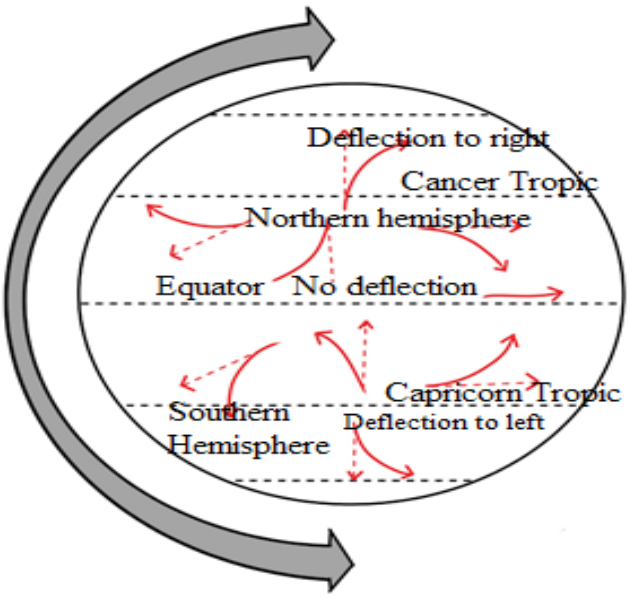


Figure 8.205: Deflection of wind direction by Coriolis force

3. **Frictional force:** The irregularities of the earth's surface offer resistance to the wind motion in form of friction. This force determines the angle at which air will flow across the isobars, as well as the speed at which it will move. It may also alter wind direction

4. **Centripetal Acceleration:** Due to inward acceleration of air towards the centre of rotation on the rotating earth, it is possible for the air to maintain a curved path (parallel to the isobars), about a local axis of high or low pressure. It is known as centripetal acceleration.

(v) Types of winds

The following are the main types of winds:

- Winds blowing almost in the same directions throughout the year are called permanent winds or planetary winds.
- Winds which change their directions according to the season are called seasonal winds (e.g. monsoon winds).
- Winds which change the directions according to the time of the day are called breezes (sea breezes and land breezes, mountain breezes and valley breezes).
- Winds which blow in a particular locality are called local winds (e.g. Chinook, Sirocco, Harmattan, Mistral…).

1. Permanent winds or planetary winds

These winds blow from high pressure belts to low pressure belts.

- **Easterlies:** There are winds which blow from East to West. These are found in both inter-tropical zone and polar zone. The winds blowing in intertropical zone are also called trade winds.
- **Westerlies:** These types of winds blow from West to East. They are found in the temperate zone between tropics and sub-polar zone.

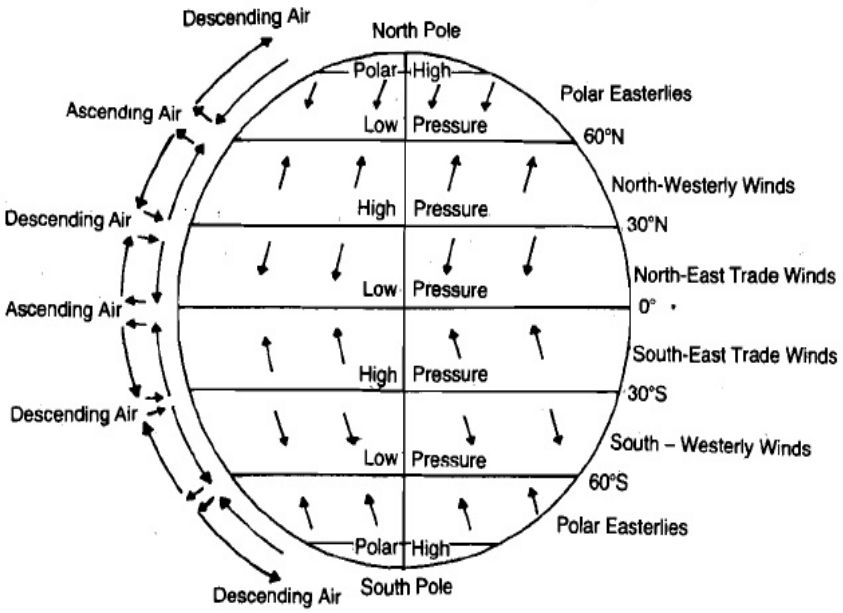


Figure 8.206: planetary winds

2. Seasonal winds or monsoon winds

Seasonal winds are large-scale surface winds which reverse their directions at least twice a year. Monsoons result from unequal distribution of land and water. They also result from the seasonal heating of the land and oceans. During winter, there is high pressure on the land due to low temperature. Therefore, the air blows from the land (Asia) to the Ocean (Indian Ocean).

This situation is reversed during the summer. High temperature develops over the Ocean, with low pressure over land. Therefore, winds blow from high pressure areas (over the Ocean) to the low-pressure areas (over the land).

Therefore, during summer, they blow from the Ocean (water) to the continent (land).

These winds are found in the following areas:

- In Asia: India Pakistan, Bangladesh, Myanmar (Burma), Thailand, Laos, Cambodia, North and South Vietnam, Southern China, Philippines.
- Northern coastal areas of Australia.
- South-West coast of Africa including the coasts of Guinea, Sierra Leone, Liberia and Ivory Coast; Eastern Africa and western Madagascar.
- North-East coast of Latin America e.g. East Venezuela, Guyana, Surinam, French Guyana, and North-East Brazil, Puerto Rico, Dominican Republic in the Caribbean Island, parts of Central American and South East USA.

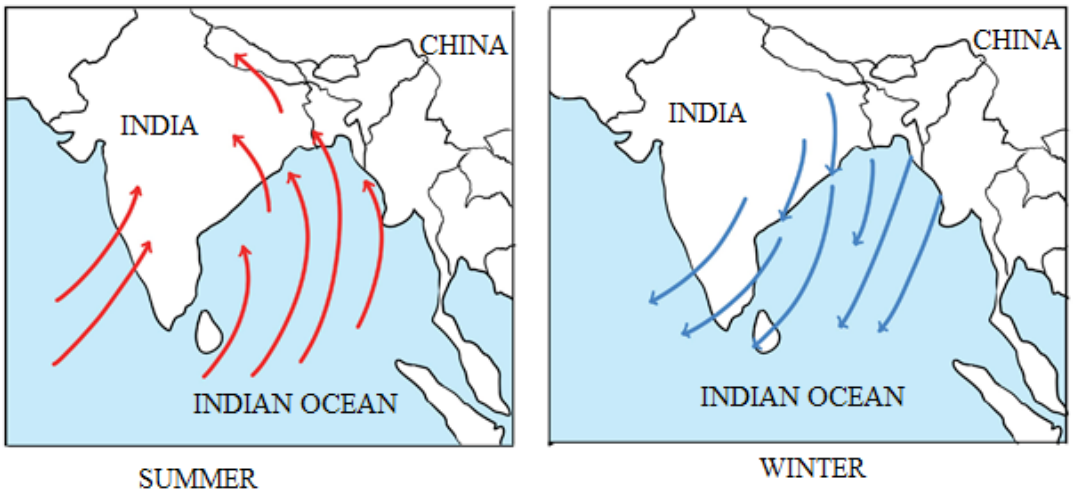


Figure 8.207: Monsoon winds' direction from/to Indian Ocean

3. Diurnal local winds

These are winds that are caused by daily temperature and pressure variations. They occur because of the heating and cooling during the day and night, plus the difference in the pressures over land and water.

- **Sea breezes:** Land heats up faster than the sea during the day. Air over the land, therefore, becomes warmer than over the sea. The lighter and warmer air rises. The cooler and heavier air from the sea moves over the land to replace the rising air. This movement of air causes a sea breeze.

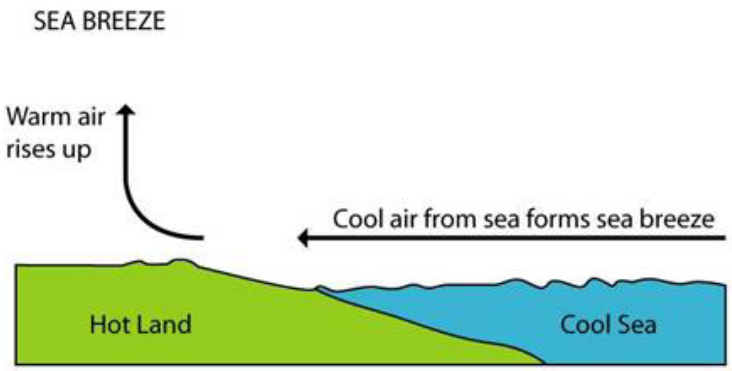


Figure 8. 208: Sea breeze

- **Land breezes:** At night, the land cools faster than the sea. The air over the land becomes cooler and heavier than the air above the sea. The warmer air over the sea is lighter. It rises while the cooler heavier air over the land moves to replace it. This creates an air current called a land breeze.

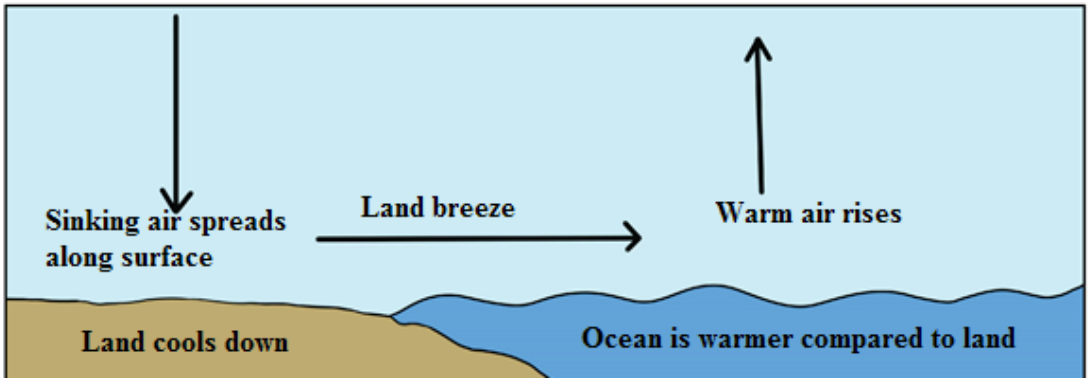


Figure 8.209: Land breezes

– **Valley breezes:** The slopes and floors of valleys are heated more at daytime. The warm air moves up the slope or upwards. This movement creates what is called a valley breeze or anabatic wind.

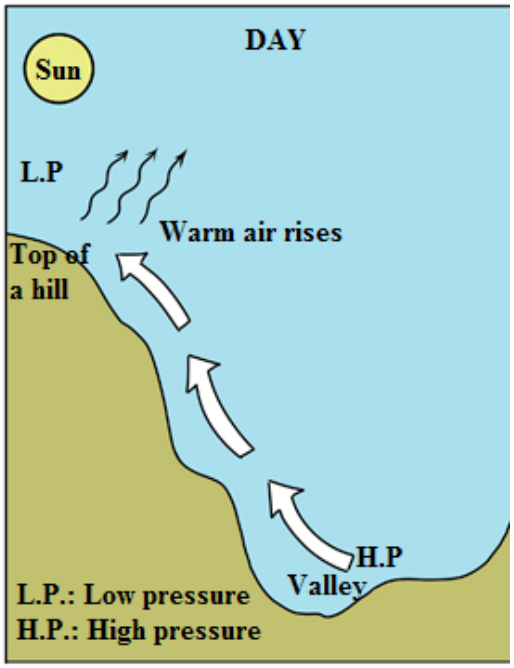


Figure 8.210: valley breezes

Mountain breezes: During the night, the hill slopes lose heat faster. The valleys remain warmer. A low-pressure gradient is created in the valley. Air current moves down the valley to form what is known as a mountain breeze. It is also called katabatic wind. This explains why some valley floors have frost at night.

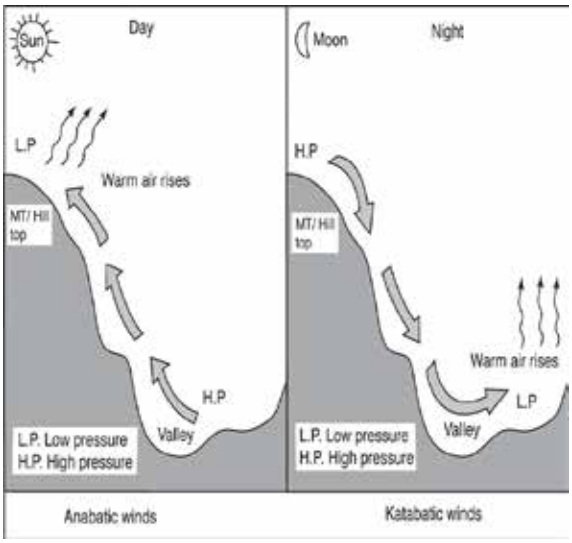


Figure 8.211: Mountain breezes

4. Non-periodic/local winds

These fall into two groups depending on their temperature (hot and cold winds). They are found in different areas of the world.

- **Hot local winds:** Examples are Chinook, Sharmal, Foehn, Khamsin, Harmattan, Sirocco, Simoom, Norwester, Santa Anna, Brickfielder, and Loo.
- **Cold local winds:** Examples are Mistral, Purga, Bora, Bise, Blizzard, Laventer, Northers and Pampero.

    i. **Chinook or Foehn winds:** These occur when strong regional winds pass over a mountain range. They cool as they rise, dropping moisture on the windward side of the mountain. They descend on the leeward side as cold dry wind. As they go down, they are heated. They can absorb more moisture. Chinook is the name used in the United States of America over Rockies. In Switzerland over the Alps, they are called Foehn winds.

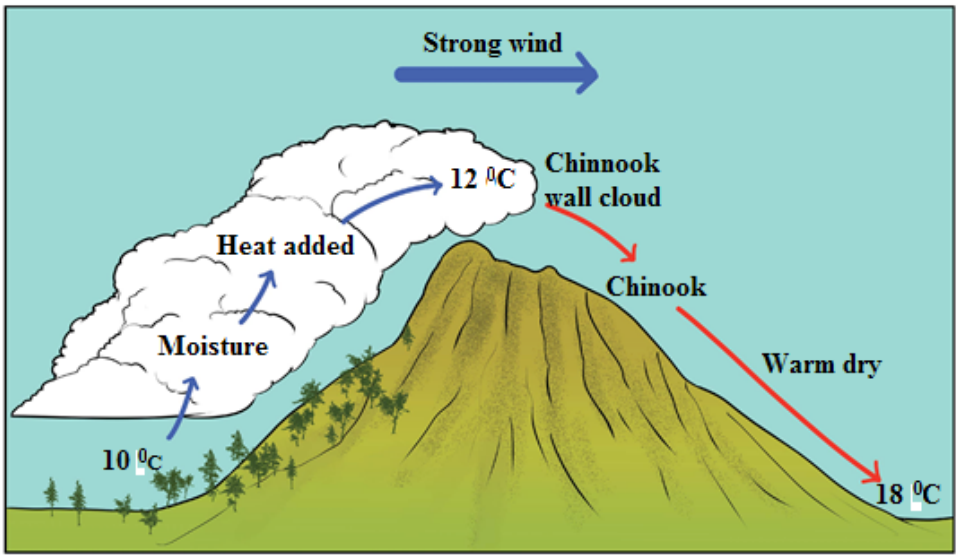


Figure 8.212: Chinook winds

These are other non-periodical local winds:

- **Hurricanes:** These are revolving tropical storms of the Caribbean Sea and Gulf of Mexico. They occur in the Eastern parts of the Pacific Ocean along the coasts of Mexico, Guatemala, Hondulas, Nicaragua, Costa Rica and Panama. Hurricanes occur from August to October.
- **Harmattan:** These are warm and dry winds blowing from North-East and East to West in the Eastern parts of the Sahara desert. These winds are very dry because of their journey over the Sahara desert. They pick up sand as they blow.
- **Sirocco:** This is a warm, dry and dusty local wind. It blows Northwards from the Sahara Desert and crosses the Mediterranean Sea to Italy and Spain.
- **Typhons:** The tropical cyclones in the west Pacific and China sea are known as Typhoons. They occur from June to December. It is an increase low-pressure system which produces violent winds and heavy rains. The magnitude and intensity of typhoons generally exceed those of hurricanes.
- **Mistral:** This is a cold local wind which blows in Spain and France from North-West to South-East. It is more common and effective during winter.
- **Tornadoes:** Tornado is a rapidly rotating column of air developed around a very intense low- pressure centre. It is associated with a dark funnel-shaped cloud with extremely violent winds, i.e. more than 400 km per hour, accompanied by down pours/heavy rainfall.
- **Bora:** This is a very cold and dry North-Easterly wind which blows along the shores of the Adriatic Sea.

– **Blizzard:** This is a violent stormy cold wind that carries with it dry snow. It is common in Siberia, Canada and the USA.

vi. Influence of winds on weather conditions and human activities

Influence of winds on weather conditions

– The way the air moves affects the weather of underlying places. Winds move heat and cold temperatures from one place to another, transporting conditions from one geographical zone to another.

– Without wind, weather would not exist. Wind and ocean currents are the vehicles of water vapour leading to cloud formation which yield rainfall. Heat or/and cool air masses are moved from one area of the globe to another, creating weather variations within specific climate zones.

– The wind direction will have an important influence on the expected weather. Wind direction changes often accompany changes in the weather.

– The wind speed and direction can give the clues to the expected weather conditions.

Influence of winds on human activities

– The winds with high speed cause the destructions of physical and human-made environment (e.g. Hurricanes, tornadoes, typhoon, etc.).

– Most of time the tall trees are bent according to the wind directions.

– Exposure of growing plants to hot wind results in dwarfing due to desiccation/dryness of plant tissue and reduced growth.

– Wind increases crop water requirements by increasing evapotranspiration due to removal of accumulated humid air near the leaves.

– Calm to moderate wind favour dew deposition needed under condition of soil moisture stress.

– Moderate wind aids effective pollination. Heavy wind during flowering reduces pollination, causes flower shed, increases sterility and reduces fruit set in all crops.

– Wind speed more than 50 km per hour leads to destruction of crops leading to heavy loss.

– In coastal areas, winds carrying salt sprays can have harmful effect on susceptible crops.

– Soil and sand particles blown by wind strike the leaves and other plant parts making punctures, abrasions, scratches and tear the leaves into pieces and strips. It well marked in maize, sugarcane and banana.

– The turbulence created by wind increase carbon dioxide supply and the increase in photosynthesis.

- The hot and dry wind makes the cells expanding and early maturity. Therefore, this results into the dwarfing of plants.
- The coastal area affected by strong winds faces the challenge of high salinity due to salt particles drawn and deposited on the mainland. This makes the soil unsuitable for growing plants.
- The crops on the windward slopes yield more.

vii. Air masses

1. Meaning of air masses

Air mass may be defined as a large body of air whose physical properties, especially temperature, moisture content, and lapse rate (of temperature) are uniform horizontally for hundreds of kilometres.

2. Types of the air masses

Based on geographical location of air masses, Trewartha classifies them into the following two broad categories:

- **Polar air masses**. This type is subdivided into continental air masses and Maritime Air masses.
    a. **Continental polar air masses:** These are characterized by cold temperatures and little moisture. They are found on the continent mostly in the polar zones such as Northern portions of the United States. These conditions usually result from the invasion of cold arctic air masses that originate from the snow-covered regions of northern Canada.
    b. **Maritime polar air masses:** These are cool, moist, and unstable. Some maritime polar air masses originate as continental polar air masses over Asia and move westward over the Pacific, collecting warmth and moisture from the Ocean.
- **Tropical air masses:** These are also subdivided into continental and maritime air masses.
    a. **Continental Tropical Air Mass:** The source region for this type is the desert Southwest, the high plains and Mexico with relation to the United States. The air has low dew points and warm to hot afternoon temperatures but with mild night time temperature. Skies are generally clear in Continental Tropical Air mass.
    b. **Maritime Tropical Air Mass:** This originates over the warm waters of the tropics and Gulf of Mexico, where heat and moisture are transferred to the overlying air from the waters below. The Northward movement of tropical air masses transports warm moist air into the United States, increasing the potential for precipitation.

3. Characteristics of the air masses

The basic characteristic features of air masses include the following:

- Air masses can either be cold or warm depending on the source region.
- They can be maritime (originating over oceans) or continental in nature depending on the trajectory taken.
- Air masses have specific direction of movement from fixed source region.
- Air masses move from one region to another following the pattern of barometric pressure. (From areas of high pressure to areas of Low pressure.)
- Throughout the air body there is unvarying humidity content with the same characteristics.
- Air masses usually have uniform temperature characteristics over a long distance.
- Air masses are independent even when they come into contact with each other, do not merge into each other but retain their identity.
- Air massess are directly connected or associated with the planetary wind systems. That is, every air mass is related with one or the other permanent wind belt.

4. The formation of the air masses

The air masses are formed from extensive and broadly uniform areas. The nature and properties of the originating areas largely determine the temperature and moisture characteristics of air masses. An ideal source region of air mass must possess the following essential conditions.

- There must be extensive and homogeneous earth's surface so that it may possess uniform temperature and moisture conditions. The source region should be either land surface such as a desert or Ocean surface.
- There should not be convergence of air, rather there should be divergence of air flow. This is important for the air to stay over the region for longer period to have the ability of having uniform temperature and humidity.
- Atmospheric conditions should be stable for considerable long period of time. This is necessary because the air must attain the characteristics of the surface.

5. Effects of air masses on the environment

- When air masses hover for a while over a surface area with uniform humidity and temperature, it takes on the characteristics of the area below, and influences the environment of that area.
- When two air masses of different properties meet, the cold air pushes the hot air upwards. The uplifted moist air condenses to yield rainfall or precipitation.

- There is formation of a stationary front especially when neither air mass displaces the other. This leads to formation of clouds that yield varying kinds of precipitation.
- Maritime air masses are associated with humid conditions. This is because as air travels over the Oceans it picks moisture that is later dropped in form of precipitation. Therefore, it produces the warm and humid conditions in the areas they bathe.
- The continental air masses lead to formation of dry weather. This is because the continents just can't compete with the Oceans when it comes to moisture. The continental air masses produce dry, cold weather in the winter and pleasant weather conditions in the summer.
- When the air is lifted over an obstacle like a mountain, such lifting is known as orographic lifting. This leads to occurrence of varying weather conditions. The windward side receives rainfall while the leeward, becomes dry.

6. Cyclones:

1. Meaning of cyclone

A cyclone is a large-scale air mass that rotates around strong centres of low pressure. This is usually characterized by inward spiralling winds that rotate Anti-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere of the Earth.

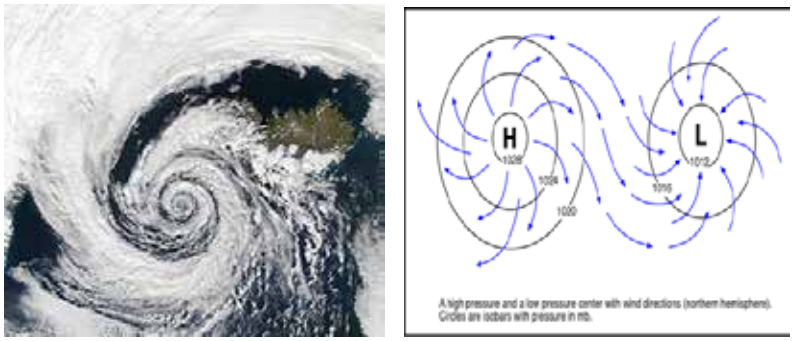


Figure 8.213: A movement of a cyclone in the Northern Hemisphere

2. Areas of cyclones in the world

Most large-scale cyclonic circulations are centred on areas of low atmospheric pressure. The main cyclones are tropical cyclones which are the typhoon of the Pacific Ocean and hurricane of Atlantic; cold- polar cyclones and extra tropical cyclones.

There are six general regions of occurrence:

- The Caribbean Sea and Gulf of Mexico.
- The Northwest Pacific from the Philippines to the China Sea.
- The Pacific Ocean west of Mexico.

– The South Indian Ocean east of Madagascar.
– The North Indian Ocean in the Bay of Bengal and
– The Arabian Sea.

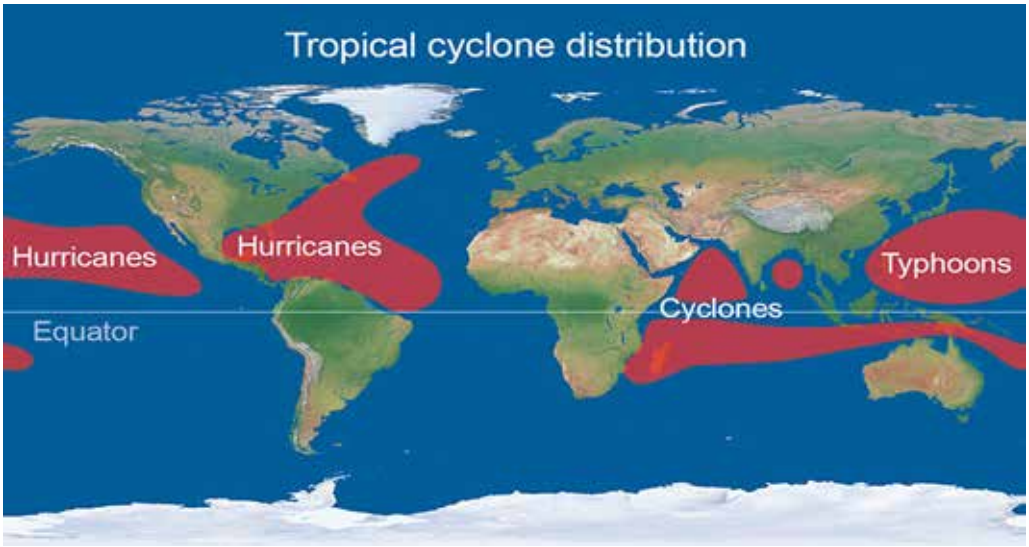


Figure 8.214: Areas of tropical cyclones in the world

3. Characteristics of cyclones

– A cyclone is simply an area of low pressure around which the winds blow counter clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.
– Cyclones form and grow near the front.
– Cyclones (lows) are cloudy, wet, and stormy.
– The largest low-pressure systems are cold-core polar cyclones and extra tropical cyclones which lie on the synoptic scale.
– Warm-core cyclones such as tropical cyclones and subtropical cyclones also lie within the synoptic scale.
– Upper level cyclones can exist without the presence of a surface low.
– Tropical cyclones form due to latent heat driven by significant thunderstorm activity. In this case, humidity plays a great role in generation of this heat that drives the whole wind system.
– Cyclones can transition between extra tropical, subtropical, and tropical phases under the right conditions.

4. Formation of cyclones (depressions)

Tropical cyclones develop due to two factors as explained here under;

- When two differing air masses of varying characteristics in terms of temperature and humidity meet over the surface of the Ocean. Or sometimes when there is the local heating from the surface especially of the Ocean water that creates the area of intense low pressure.
- Winds of varying characteristics move towards this low pressure and yet hardly mix up. But instead, start circulating and spinning in a spiral nature around an area of low pressure.
- As earier said, when two varying air masses meet, the warm air rises over the cold air and the moisture contained therein undergoes the process of condensetion and leading to terretial rainfall.ely
- Through the process of condesetion latent heat is released and it is this energy that facilitates the rotation and spiral nature of the cyclone.
- Over the tropical maritime/Oceans, the intense heating creates an area of low pressure and the cold air masses rush towards this area and setting the creation of a tropical cyclone as the humidity increases and latent heat generated.

5. Effects of cyclones on the environment

- There are several effects of cyclones on the environment. These are explained hereunder:
- Tropical cyclones are associated with heavy rain, strong wind, large storm surges and tornadoes.
- They trigger landslides and mudslides. This is because of the heavy rainfall that comes along with the tropical cyclones.
- They cause destruction of vegetation and wildlife in general. This is because of the stormy nature of the rainfall associated with cyclones. Therefore, trees break down and their canopies completely trimmed off.
- They cause severe erosion especially along the coastal regions that are usually most hit by tropical cyclones. Especially the removal and reshaping of the sand dunes.

Anticyclone:

Meaning of anticyclone

An anticyclone is known as a large-scale circulation of winds around a central region of high atmospheric pressure. The winds blow clockwise in the northern hemisphere and counter clockwise in the southern hemisphere.

Areas of Anticyclone

The classification of anticyclones is based on their location or areas where they occur. They are categorized into four classes which are described hereunder:

- **The subtropical Highs:** The subtropical highs are large, elongated, very deep anti- cyclones situated at tropical regions.
- **The polar continental Highs:** The polar continental highs (anticyclones) are prominent over Northern continents in winter. The conditions of Alaska, western Canada and Rocky Mountains are most favourable for their development.
- **High within the cyclone Series:** Anticyclones with small horizontal extent are sometimes present between the individual members of the cyclone family.
- **The polar highs:** These polar highs occur at the end of a temperate cyclone.

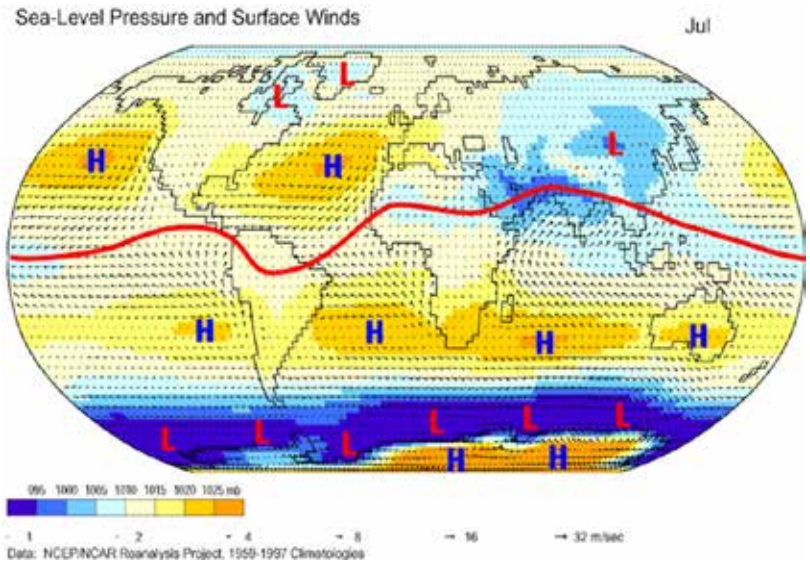


Figure 8.215: Areas of anticyclones (H) in the world

Occurrence of anticyclones

The anticyclones occur in sub-tropical high-pressure, belt extending between the latitudes of 250-350 and in Polar Regions in both Hemispheres.

Characteristics of anticyclones

The 'highs' or 'anticyclones' are characterized by divergent wind circulation. Whereby, winds blow from the centre outwardly in clockwise direction in the northern hemisphere and anti-clockwise in the southern hemisphere. The high-pressure systems are indicative of dry weather conditions. Therefore, anticyclones are called weather less phenomena.

The anticyclones have different characteristics depending on the season of the year:

Characteristics of summer anticyclones	Characteristics of winter anticyclones
Few or no clouds. Strong sunshine will make it hot.	Cloudless skies
Light winds.	There is a drop-in temperature, making the days cold and the nights even colder due to lack of cloud cover.
Cooling of ground leading to morning mist.	Fog and frost forming at night.
Warm moist air rising from the ground forming thunderstorms.	Cold air from Asia bringing snow to Europe.

Effects of anticyclones on the environment

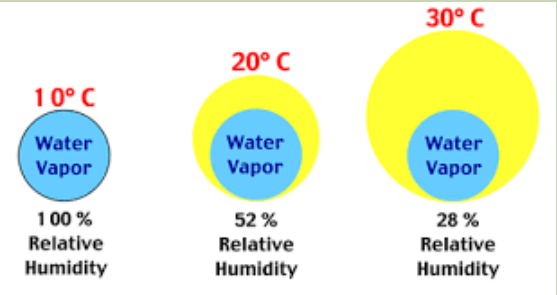
The following are the major effects of Anticyclones on the environment:

- Descending and divergence movements of the anticyclones result into cloudless skies leading to dry weather conditions. These dry weather conditions may result into drought in the affected areas.
- The Anticyclones have been one of the causes of hot deserts of the world, especially in the western parts of the continents near the tropics.
- The cloudless skies over the areas affected by anticyclones result into the reception of higher amount of solar radiation on the earth's surface. This makes the soil to become drier and vegetation experiences the water shortage.
- The anticyclone makes the temperature range to be higher because the days are hot, and nights are very cold. This has negative impact on the vegetation and other living things.

8.2.4. Atmospheric humidity

Learning activity 8.2.4

Observe the diagram below and give answer to the questions that follow:



1. With reference to the knowledge and skills acquired from previous lessons; differentiate the above types of atmospheric humidity.
2. Explain the significance of atmospheric humidity to the environment.

i. Meaning of atmospheric humidity

Atmospheric humidity is the amount of water vapour in the atmosphere. The water comes as a result of evaporation and transpiration by plants. It also comes from volcanic activity through hot springs. The water vapour determines the amount of precipitation in an area.

ii. Measurement and recording of humidity

Atmospheric humidity is measured using a hygrometer. It consists of a system of levers linked to a pen and record chart or graph paper. Within it, are threads of human hair. When humidity rises, the threads absorb moisture and become longer. When humidity falls, they dry and become shorter. The levers make these movements appear large. The pen records them on the graph paper.

Figure 8.216: Hygrometer

iii. Types of atmospheric humidity

The following are the main types of the atmospheric humidity:

1. **Absolute humidity:** Absolute humidity is defined as amount of water vapour per unit volume of air at a given temperature. It is expressed in gram per cubic meter volume of air (gr/m3). Absolute humidity changes with changing temperature. For example, it is 1gr/m3 at - 200C in cold continental area during winter season while it will be more than 30 gr / m3 at 200 C in maritime equatorial region.
2. **Relative humidity:** Relative humidity is defined as a ratio of the air's actual water vapour content compared with the amount of water vapour air can hold at that temperature and pressure.
3. **Relative humidity** is generally expressed as percentage. Relative humidity is calculated as follows:

Relative humidity $= \frac{Absolute\ humidity}{humidity\ capacity} X100 \frac{Absolute\ humidity}{humidity\ capacity} X100$ or

$$Relative\ Humidity = \frac{actual\ vapor\ density}{saturation\ vapor\ density} x100\%$$

The most common units for vapour density are gm/m3. For example, if the actual vapour density is 10 g/m3 at 20°C, compared to the saturation vapour density at that temperature of 17.3 g/m3, then the relative humidity is

$$R.H. = \frac{10g\ /\ m^3}{17.3g\ /\ m^3} x100\% = 57.8\%$$

iv. Factors influencing atmospheric humidity

The following factors affect humidity:

- **Temperature:** An increase in the temperature of the air increases its ability to hold moisture.
- **Amount of water available:** There is more evaporation over the Ocean than the land. Therefore, there is more moisture over the Ocean than the land.
- **Wind-speed:** Evaporation depends on the speed of wind. When the winds are light, a thin layer of air just above the surface gets almost full of moisture. When the wind speed is high, the air has less moisture.

- **Area of the evaporating surface:** Larger areas where evaporation occurs increase the rate of evaporation.
- **Air-pressure:** Evaporation is also affected by the atmospheric pressure exerted on the exposed surface of water. Low pressure on open surfaces of the liquid results in higher rates of evaporation.
- **Composition of water:** The rate of evaporation is always greater over fresh water than over salty water.

v. The significance of humidity to the environment

- Humidity drives most of the observable weather phenomena starting with clouds, fog, rain, storms and finally to such dramatic weather conditions such as hurricanes.
- It facilitates the weather fore casting. It is not possible to forecast the weather exactly without precise knowledge of humidity in all the layers of the atmosphere.
- Correct relative humidity is important for our well-being and health.
- It enables the hydrological cycle to operate normally. It enables much water in form of vapour to be kept or stored in the atmosphere. Such is condensed later to form precipitation.
- Humidity plays a great role in stabilising climate of various areas. This is because of its regulating ability that prevents the occurrence of extreme levels of temperatures.
- It affects many properties of air and of materials in contact with air.
- Water vapour is a key agent in both weather and climate, and it is an important atmospheric greenhouse gas. This plays part in regulating the Earth's temperature.
- Humidity measurements contribute both to achieving correct environmental conditions that sustain various ecosystems.

8.2.5. Cloud cover

Learning activity 8.2.5

Read critically the context below and answer the questions that follow: Daniella always wakes up and observes the horizon of the sky. One day, she observed the sky and found out that it was clear with white colour. She continues to take note of the daily occurrences of the nature of the sky. The next day she observed black colour in the sky, another day she found sky approaching the tops of hills and the last day of her last observation; she observed the sky being dark and reaching the ground. Now Daniella is asking herself what is happening in the sky.

Help Daniella to be satisfied with clear explanations to her question through answering the following questions:

1. Explain what causes the different colours that arise in the horizon of the sky.
2. Describe the effects of the last observation of Daniella to the environment.

i. Meaning of cloud

A cloud is an aggregation or grouping of moisture droplets and ice crystals that are suspended in the air. A cloud is made up of water droplets or ice particles suspended in the air. These particles have a diameter ranging between 20 mm and 50 mm.

ii. Types of clouds and their characteristics

Clouds are classified according to altitude and form. With regard to form, there are:

a. **Stratified clouds:** These are layered clouds. They look like blankets and cover large areas. They can give large amounts of rain or snow.

b. **Cumuliform clouds:** These have bubble-like bodies. They give rain over a small area.

With regard to altitude, clouds are classified as high clouds, middle clouds and low clouds.

a. **High clouds** (form above 6,000 m above the sea level). They look like feathers. They appear in separate groups in fair weather. In bad weather, they are joined together. The following are examples:

- Cirrus
- Cirrostratus
- Cirro-cumulus

b. Middle clouds (form between 4,000 and 6,000 metres). They are thick clouds. The following are examples:

- Alto-stratus
- Alto-cumulus

They are mostly distributed over the whole sky. They appear white or grey.

c. Low clouds (Form below 2,000 metres). They are usually shallow. The following are examples:

- Stratus: They are dense, low-lying fog-like clouds of dark grey colour. They are composed of several uniform layers.
- Strato-cumulus: They are generally associated with fair or clear weather but occasional rain or snow.
- Nimbo-stratus (Ns): They are middle and low clouds of dark colour. They are associated with rain.

d. Clouds with great vertical extent: They are found between 2,000 and 10,000 metres. They are white but may appear grey or black. They give heavy rainfall. The following are examples:

- Cumulus: They are very dense, widespread and dome-shaped. They also have flat bases and are associated with fair weather. These sometimes are characterised by thunder.
- Cumulo-nimbus: They are thunder-storm clouds. They show great vertical development/extent and produce heavy rains, snow or hailstorm accompanied by lightning, thunder and gusty winds. They appear like mountains or huge towers.

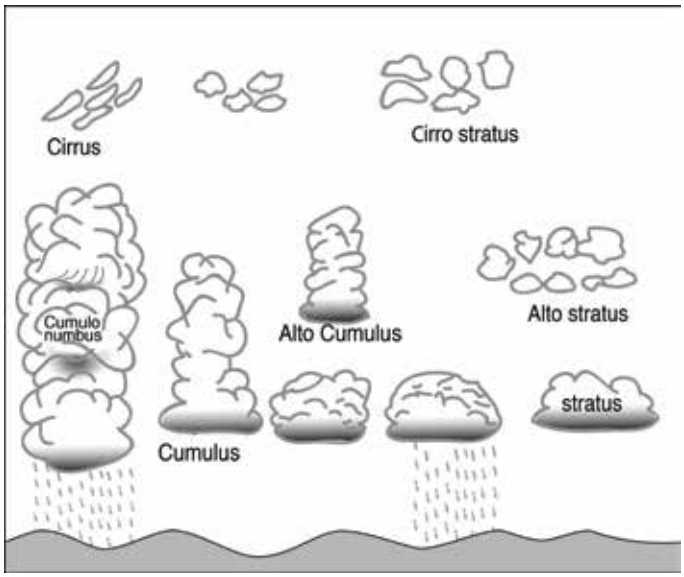


Figure 8.217: Types of clouds

iii. Factors influencing the formation and the shape of clouds

The sun plays a major role in formation of clouds. The first step of cloud formation is related to the rising of the air into the atmosphere. Such air must be moist or carrying water vapour that is later condensed to form clouds. The following are the major factors influencing the rise of air into the atmosphere:

Bottom of Form

Bottom of Form

- Sun: The sun heats the earth and thus the air rises, expands, and cools.
- Topography: Clouds are also formed when air encounters mountains or other topography. The air rises and cools, condensing to form clouds.
- Low pressure: This influences air to move towards the areas of low pressure. Therefore, different kinds of air of varying characteristics meet but not necessarily mixing up. The cold air forces the warm and moist air to rise and hence, cool and condensing to form clouds.
- Clouds can be formed when air rises along the slope of a mountain. This aids the moist air to reach the atmosphere where it cools down, condensing and as a result, clouds are formed.
- Warm and cold fronts: Weather fronts cause the rise of the air. Specifically, warm fronts make the air to condense because the warm air rises above the cold air. This results into the formation of clouds.

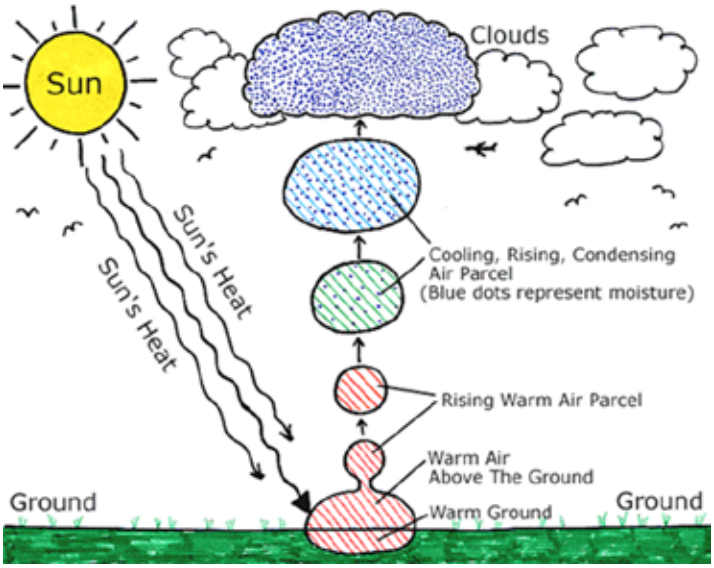


Figure 8. 218: Process of clouds formation

iv. Effects of clouds on weather

The clouds are much important on weather conditions prevailing in a given area as it is explained below:

- During the day, the earth is heated by the sun. If skies are clear, more heat reaches the earth's surface (as in the diagram below). This leads to warmer temperatures.

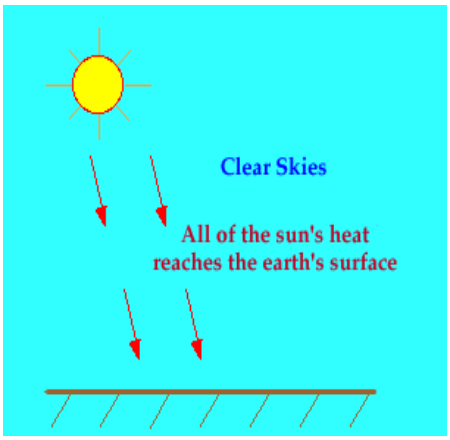


Figure 8.219: The earth's surface is much heated on clear skies

If skies are cloudy, some of the sun's rays are reflected off the cloud droplets back into space. Therefore, less of the sun's energy is able to reach the earth's surface. This causes the earth to heat up more slowly. This leads to cooler temperatures.

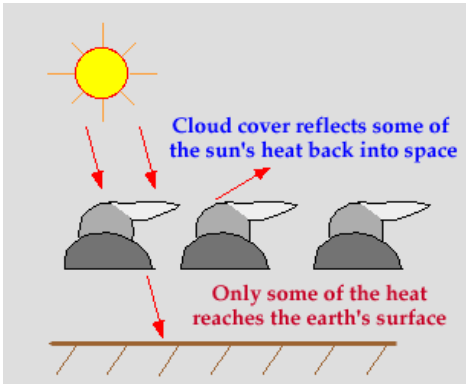


Figure 8.220: Much more sun's rays reflected on cloudy skies

Cloudy skies lead to existence of lower temperatures since much of the sun's isolation will be blocked from reaching the earth's surface. The clear skies during day, leads to increase in temperature. At night, cloud cover has the opposite effect. If skies are clear, heat emitted from the earth's surface freely escapes into space, resulting in colder temperatures.

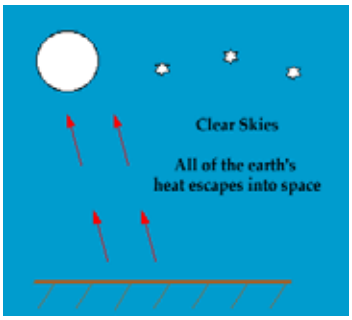


Figure 8.221: Much more earth's heat escaping into space on clear skies

If clouds are present, some of the heat emitted from the earth's surface is trapped by the clouds. This heat is reemitted back towards the earth. As a result, temperatures decrease more slowly than if the skies were clear.

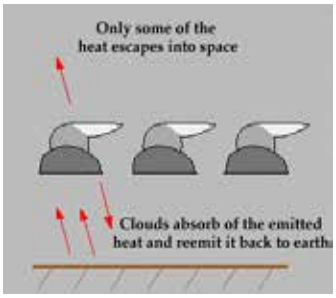
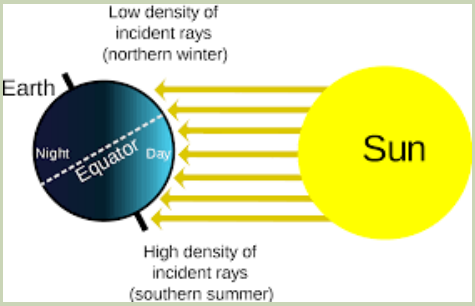


Figure 8.222: Limited earth's heat escaping into space on cloudy skies

8.2.6. Sunshine

Learning activity 8.2.6:

Observe the following illustration and give answers to the questions that follow:



1. Describe what is presented on the above illustration?
2. Arrows on the illustration show solar radiation reaching the earth surface, explain the factors influencing the amount of solar radiation in an area.
3. Explain the negative effects of solar radiation on the environment.

i. Meaning of sunshine

The sunshine is composed of two words: sun and shine; it means the period of shining of the sun. The sunshine is observed and recorded during the day time.

ii. Measurement and recording of sunshine

This is done using a Campbell-stokes sunshine recorder. The instrument records the duration and intensity of sunshine.

This is a glass sphere which is partially surrounded by a metal frame on which there is a sensitized or calibrated card. The card is graduated in hours and minutes. When the sun shines, the glass sphere focus the sun's rays on the card and as the sun moves across the sky, the rays burn a trace on the card. This only happens when the sun is shining. At the end of the day, the card is taken out and the length of trace is turned into hours and minutes, which represents the total amount of sunshine for the day. A line on the topographic map joining places of equal sunshine is called "Isohel".

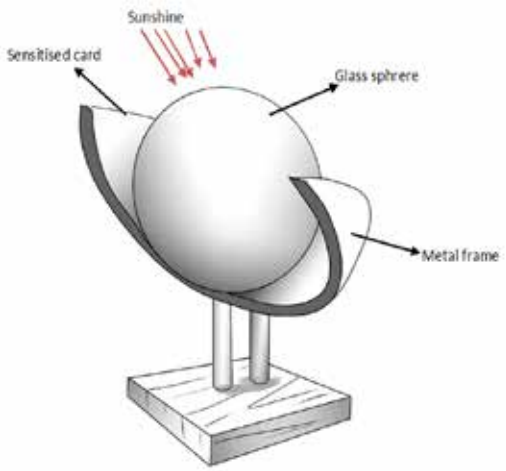


Figure 8.223: Sunshine recorder

iii. Factors influencing the amount of solar radiation

All parts of the world do not receive the same amount of solar radiation because of the following factors:

- **Angle of the sun's rays:** The angle between the rays of the sun and the tangent to the surface of the earth at a given place, largely determines the amount of insolation to be received at the place. The angle of the sun's rays decreases as one moves towards the poles. Vertical rays bring more solar radiation.

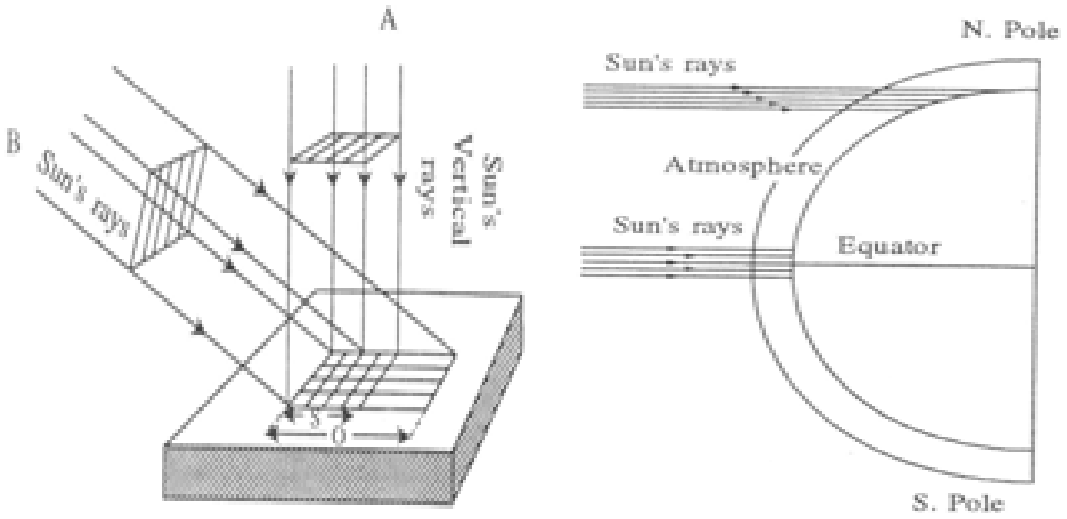


Figure 8.224: Angle of the sun's rays

- **Length of the day:** The shorter the duration of sunshine and longer the period of night. This results into lesser amount of solar radiation received at the earth's surface and vice versa. This happens due to spatial variations of the length of the day from the equator to the polar region, due to the inclination of the Earth's axis (Reference to the unit 4 on the consequences of revolution of the earth).
- **Distance between the Earth and the Sun:** The distance between the sun and the earth changes during the course of a year. This is because the Earth revolves around the sun in an elliptical orbit. The average distance between the sun and the earth is about 149 million km. At the time of perihelion (on January 3) the earth is nearest to the sun (147 million km) while at the time of aphelion (on July 4) it is farthest from the sun, that is, (152 million Km) away. At the time of perihelion, the earth should receive maximum insolation while at the time of aphelion it should receive minimum insolation.

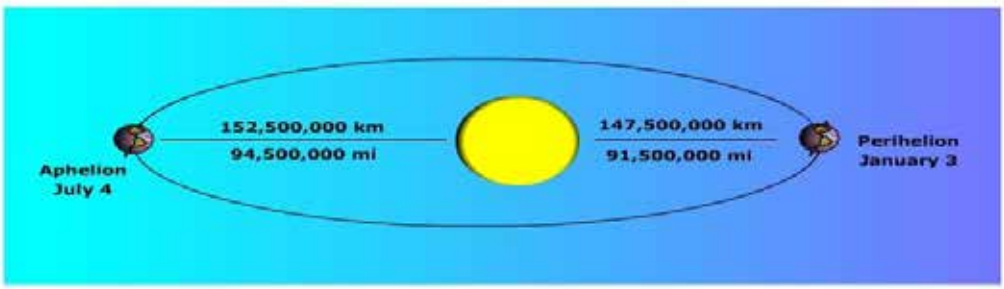


Figure 8.225: Relative distance between the sun and the earth

- **Sunspots:** Sunspots are defined as dark areas within the photosphere of the sun. They are created in the solar surface (photosphere) due to periodic disturbances and explosions. The increase and decrease of the number of sunspots is completed in a cycle of 11 to 24 years. It is believed that the energy radiated from the sun, increases when the number of sunspots rises and consequently the amount of solar radiation received at the earth's surface also upsurges. On the other hand, the amount of solar radiation received at the earth's surface decreases with decrease in the number of sunspots due to less emission of radiation from the sun.
- **Effects of the atmosphere:** As solar radiation travels a long distance from the sun to the earth's surface; there are some portions of the solar energy which are lost through the processes of reflection, diffusion, absorption and scattering.

iv. Influence of sunshine on the environment

The sunshine has both positive and negative effects on the environment as it is explained below:

Positive effects

- **Health benefits:** Humans require between 1,000 and 2,000 units of vitamin D daily for optimum health. The skin creates vitamin D naturally when exposed to solar radiation, and spending 10 or 15 minutes a day outside can give all body to stay healthy
- **Needed for photosynthesis:** Sunshine is needed in photosynthesis processes for autotrophy green plants and algae to produce the compounds necessary for their survival.
- **Disinfection:** Exposing bottled water to sunlight for six hours or more can kill many harmful pathogens, and developing nations often use this technique as a low-cost method of treating water supplies against common bacterial contaminants.
- **Production of energy:** Sunshine can produce the energy which may be used for different purposes.

Negative effects

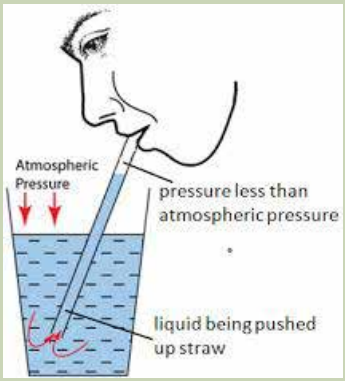
- **Skin Cancer:** The ultraviolet radiation present in sunlight can also cause damage to the human and animal skins. Short exposures to intense sunlight during the summer months can produce painful sunburns, while longer-term exposure to ultra violet can damage cells, altering the DNA and possibly leading to skin cancer.
- **Eye Damage:** Solar radiation can also prove harmful to the human and animal eyes.

– **Damaging the crops and other vegetation:** The excess of daily sunshine without rain for long-term, becomes harmful to crops and other vegetation because all water which would support the crops/vegetation evaporates.

8.2.7. Atmospheric pressure

Learning activity 8.2.7

Critically observe the following picture and answer the questions that follow:



1. With your observation what is taking place in experiment above?
2. Compare and contrast the pressure from the straw and pressure from atmosphere.
3. Explain the factors that can influence the distribution of atmospheric pressure at a given surface.

Meaning of atmospheric pressure

Atmospheric pressure is the force per unit area that is exerted against the Earth's surface by the weight of air above it. The unit area could be one square centimetre or one square meter. Atmospheric pressure is measured in terms of the height of mercury in the glass tube in a mercury barometer. The standard air pressure at sea level is 1013.25 mb or 29.92 inches or 760 mm at temperature of 15 °C at the latitude of 45°.

Measurement and recording of atmospheric pressure

The barometer is the instrument used to measure atmospheric pressure. There are two types of barometers: Mercury barometer and Aneroid barometer.

a. Mercury barometer

It is made of a one-meter-long glass tube. It is closed at one end and filled with mercury. The open end of the tube is then opened below the surface of mercury in a bowl. A vacuum is left above the mercury and the column is supported by the air pressure outside. Air pressure is obtained by observing the length of the mercury column.

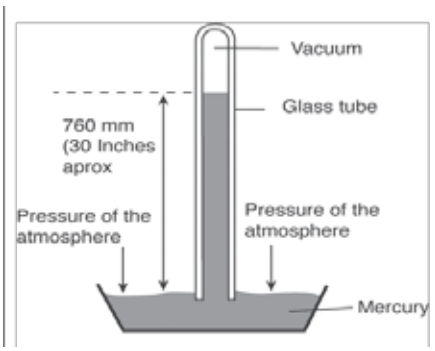


Figure 8.226: Mercury barometer

b. Aneroid barometer

Aneroid barometer is made of a small metal box which contains a very little amount of air. It expands and collapses under the influence of any change in atmospheric pressure. See the figure below.

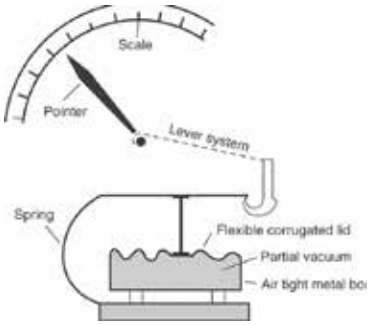


Figure 8.227: Aneroid barometer

Factors influencing the distribution of atmospheric pressure

The following factors influence atmospheric pressure:

- **Altitude:** Air pressure at sea level is higher than at the top of a mountain. This means that pressure decreases with increase in altitude. The pressure at the ground level is higher than that at the top of high mountains. This is because air at the ground level has to support the weight of the air above it, and the molecules in the bottom air must push outwards with a force equal to that

exerted by the air above it.

- **Temperature:** When air is heated, it expands. When this happens, the outward pressure of its molecules is spread over a large area. This means the pressure of the air decreases. The pressure of the air therefore rises when its temperature falls.
- **Latitude:** The earth is not a perfect sphere and therefore force of gravity varies according to latitude. This is at maximum at the poles and a minimum at the equator. Atmospheric pressure is therefore lower at the equator and higher at the poles. Therefore, Air pressure increases with latitude.
- **Season of the year:** Atmospheric pressure changes with seasons of the year being high over the cold continental interiors in winter and conversely low over the heated continents in summer.
- **The nature of earth's surface:** During the day, land heats up more than the water and hence air pressure is lower over land than the sea. Air blows from the sea to the land as a sea breeze. On the other hand, during the night, the land cools more quickly than the sea and hence air pressure is lower over the sea than land. Wind blows in from the land to the sea as a land breeze.

Pressure types

Air pressure is generally divided into two types. These are high pressure (HP: above 1013.25 mb), and low pressure (LP: below 1013.25 mb).

- **High pressure systems** are also called highs or anticyclones. They are characterized by highest air pressure in the center of almost closed isobars where pressure decreases from the center outwardly. The lowest pressure is found at the outer margin of the high-pressure system.
- **Low pressure systems** are also called low or simply L or cyclones or depressions. These are centres of low pressure, having increasing pressure outwardly. This has closed air circulation from outside towards the central low pressure in such a way that air blows inwardly in anti- clockwise in the northern hemisphere and clockwise in the southern hemisphere.

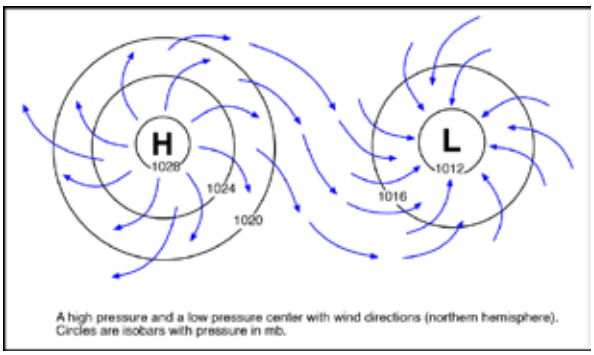


Figure 8.228: High and low pressure center

Location of different world pressure belts and their characteristics

There are seven pressure belts on the globe:

- **Equatorial low-pressure belt:** It is located on either side of the geographical equator in a zone extending between 5° N and 5° S latitudes. But this zone is not stationary because there is seasonal shift of this belt in relation to the northward (summer solstice) and southward (winter solstice) migration of the sun. The equatorial low-pressure belt represents the zone of convergence of North-East and South-East trade winds.
- **Sub-tropical high-pressure belt:** It extends between the latitudes of 25°-35° in both the hemispheres. The divergence movement is prevailing over the surface on that belt. The descending movement of winds results into the contraction of their volume, increases in density, and ultimately causes high pressure. Therefore, this explains why this zone is characterized by anticyclonic conditions which cause atmospheric stability and aridity.
- **Sub-polar low-pressure belt:** It is located between 60°-65° latitudes in both hemispheres. It may be noted that due to the great contrast of temperature of the continents and Oceans, during Northern summer, the low-pressure belt becomes discontinuous and is found in a few low-pressure cells. While in winter season the pressure increases, and the low-pressure belt becomes less regular.
- **Polar high-pressure belt:** Temperature remains below freezing point during most part of the year. This results into the high-pressure systems throughout the year. Winds blow from the polar high pressure to sub-polar low-pressure cells. These are called polar winds which are North-Easterly in the Northern hemisphere and South-Easterly in the Southern hemisphere.

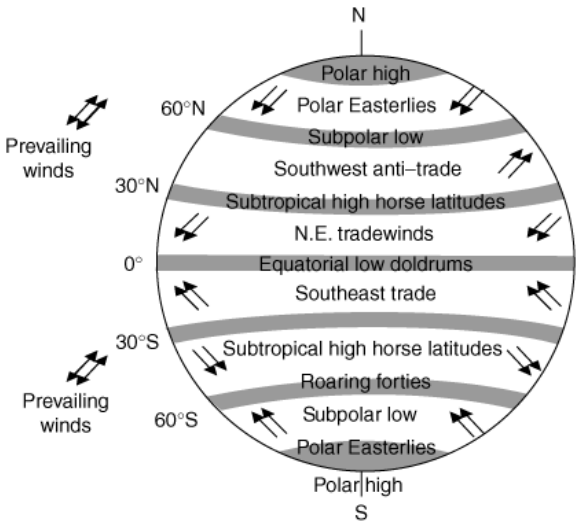


Figure 8.229: Horizontal and latitudinal distribution of pressure

Application activity 8.2

1. Observe carefully the table below showing rainfall and temperature data of Weather Station K in country

Months	J	F	M	A	M	J	J	A	S	O	N	D
Rainfallin mm	30	45	196	240	200	10	4	6	20	80	210	60
Temperature (^{o} c)	24	26	22	21	23	24	28	27	25	22	22	24

Answer the following questions:

a. What is the driest month of the year?
b. What is the wettest month of the year?
c. Calculate the total annual rainfall.
d. Calculate the mean annual temperature.
e. Draw the graph portraying the data in the above table.

2. Briefly explain the factors that influence weather and climate.
3. Walk around the school and observe the way the wind is blowing by movement of tree branches. Then describe the direction in which the wind is blowing.

8.3. Factors that influence world climate

Learning activity 8.3

Explain how the following influence climate of any region:

a. Latitude
b. Altitude
c. Water bodies

The following are the main factors influencing world climates:

– **Latitude:** The climate of a place is influenced by latitude. Temperature and precipitation are high near the equator while they are low at the polar zone. This is because of the amount of sunshine received at these places. The amount of sunshine received by the ground surface decreases away from the equator.

- **Altitude:** Temperature decreases with increasing in height from the earth's surface. Precipitation on the other hand increases with altitude. Temperatures at the top of mountains are very low. On the other hand, precipitation and humidity are very high.
- **Presence or absence of water bodies:** Places near a lake or sea have low temperatures. This is because of the cooling effect of air currents or breeze from the water bodies. Areas far away from water bodies have extreme weather conditions.
- **Vegetation:** Vegetation attracts precipitation and moderate temperatures. Through transpiration, clouds form near the forests and precipitation occurs. Transpiration is the evaporation of water from leaves and stems of plants. It rains a lot in the equatorial dense forests. In the deserts where there are few plants, it is dry and hot.
- **Human activities:** Pollution from industries affects the climate. Chemicals and gases that are released into the atmosphere cause acid rain. Cutting down of forests also affects the climate. Where forests are cut down in large numbers, reduced precipitation is recorded.
- **Ocean currents:** The warm ocean currents from tropical areas to cold zones raise the temperature in these areas. For example, the Gulf Stream increases the temperature of the coastal areas of North-Western Europe. While Kuroshio warm currents raise the temperature of the coasts of Japan.
- **Primary wind circulation** also called the primary atmospheric circulation is the main factor controlling the spatial distribution of climates in the world. This circulation involves flow patterns of permanent wind systems in latitudinal zones from the equator towards the poles. This primary wind circulation of Easterlies (trade winds) and Westerlies divide the world into three major zones. These include Intertropical zone, mid-latitude zone and sub-polar zones. In these areas winds blow from high pressure belts to low pressure belts.

The description the three primary wind circulation major zones:

- **Intertropical zone:** This is the zone where winds from subtropical high-pressure areas blow towards. It is an equatorial low-pressure area. Therefore, marks the zone of convergence that creates Intertropical fronts (ITF) or Intertropical Convergence (ITC). Then, the air near the equator is heated due to solar radiation, rises upward to yield enough rainfall in this zone.
- **Mid-Latitude zone:** Mid-latitude zonal circulation extends between 30° and 60° latitudes in the northern and the southern hemispheres. This zone is under the influence of subtropical high-pressure belt (300-350 latitudes). This belt separates two wind systems. Trade winds (Easterlies) and Westerlies. It is also apparent that the subtropical high-pressure belt is the source of the origin of trade winds. These blow towards equatorial low-pressure belt. On the other

hand, the westerlies blow towards sub-polar low-pressure belt. This is because winds always blow from high pressure to low pressure. This movement of winds makes the zone to be drier.

– **Sub-polar zone:** This zone is confined mostly between 600-900 latitudes in both hemispheres and is characterized by surface polar Easterly winds. Winds blow from the polar high pressure to sub-polar low-pressure cells. These are called polar winds which are North-Easterly in the northern hemisphere and South-Easterly in the Southern Hemisphere. Therefore, sub-polar low-pressure belt becomes convergence zone; where the front is formed to allow the air to rise upward to yield rainfall around this belt.

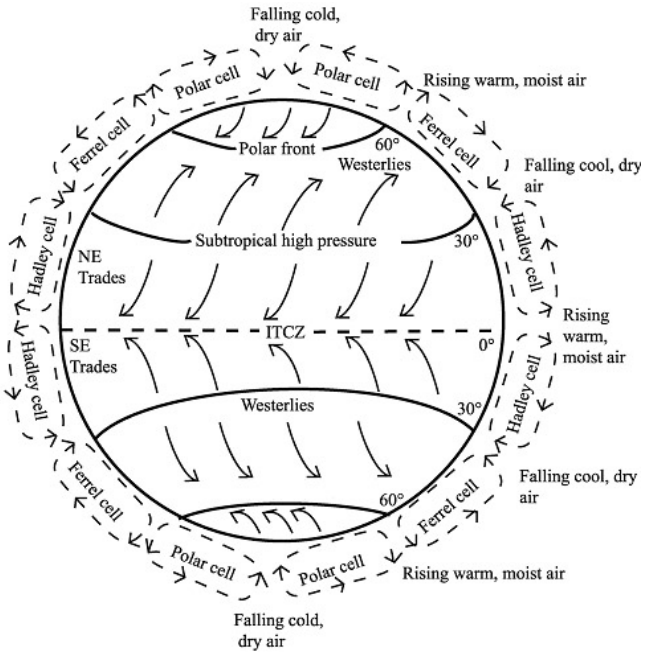


Figure 8.230: The generalized global pattern of planetary winds (surface and upper atmospheric air circulation)

– **Monsoons winds:** These are seasonal winds which reverse their direction at least twice a year. This results into the air blowing from the land to the Ocean in winter and from Ocean (water) to the land in summer. This situation makes the summer to be hot and wet and winter to be cold and dry in the affected areas.

Application activity 8.3

Read the following context and give feedback to the questions that follow:

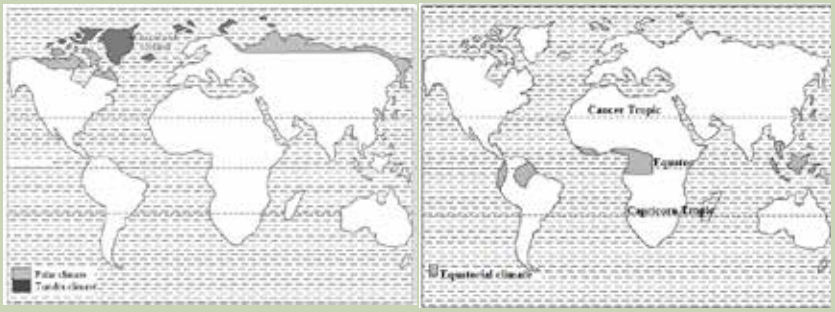
Generally, climate of any region or area is influenced by both physical factors (Latitude, altitude, water bodies, vegetation, ocean currents and aspect in relation to location) and human factors (pollution from industries, Chemicals released into the atmosphere, cutting down of forests /deforestation, over cultivation, overgrazing, land reclamation and construction).

Illustrate these geographical factors in Rwandan context.

8.4. Types of climate and their characteristics

Learning activity8.4

Observe the maps provided below and answer the questions that follow:



Q

P

X

Identify the types of climate shown by the maps Q, P and X and identify their characteristics

The classification of climatic zones is based on temperature and rainfall. There are three world climatic zones. These are: Tropical, Temperate and Cold zones.

8.4.1. Tropical zones

i. Equatorial climate

Equatorial climate is also called tropical wet climate or tropical rainforest climate. It is found along the equator extending from 5° to 10° South and North latitudes. Along the Eastern margin of continents, it spreads to 15° - 25° of latitudes. This type of climate is found specifically in the following regions:

- The Amazon River Basin in South America
- The Congo Basin and Guinea coast in Africa
- Malaysia, Indonesia and the Philippines Islands in South-Eastern Asia
- Eastern and Central America (parts of Panama, Costa Rica, Nicaragua, Honduras, British Honduras and Guatemala), some islands in the Western Colombia
- Coastal lowlands of Eastern Brazil
- Eastern Madagascar

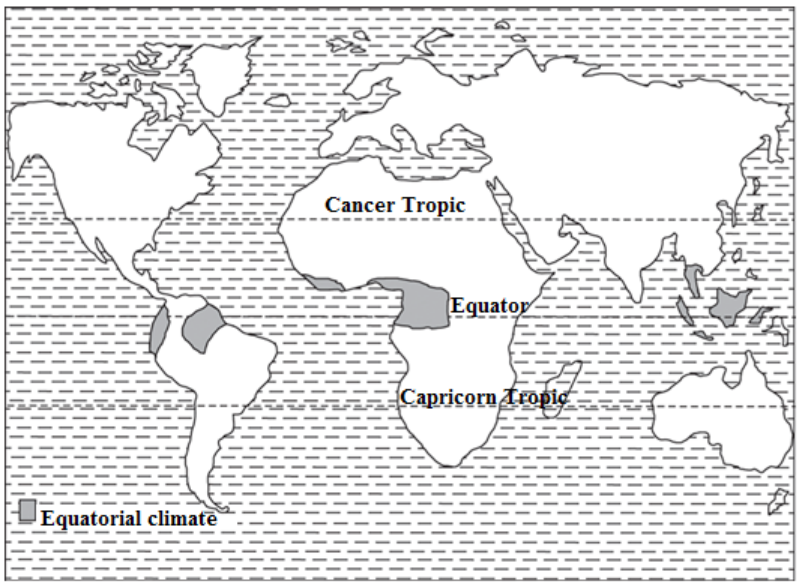


Figure 8.231: Equatorial climate

ii. Climatic characteristics of equatorial region

- This climatic region is located within 5° North to 10° South of the Equator.
- The average monthly temperatures are over 18°c. However, many places record average monthly temperatures of 24° to 27°c.
- The Equatorial regions lie in a belt where the winds are light. It is a low-pressure belt.
- The annual range of temperature is very small (the difference between the highest and the lowest temperatures) varies from 5°to 8°c.

- The equatorial regions get heavy precipitation throughout the year. Many areas receive 2000 mm of the rain per year. The annual average rainfall in the equatorial climate is nearly 2500 mm.
- There is a large amount of cloudiness.
- Conventional rainfall is received, and it is usually accompanied by thunderstorms.
- High temperatures and heavy rainfall encourage growth of natural vegetation. There are evergreen dense forests.

Below there is an example of Singapore weather station:

Singapore weather station

Months	J	F	M	A	M	J	J	A	S	O	N	D	Annual mean
T°C	26.4	26.9	27.5	27.5	27.8	27.5	27.5	27.2	27.2	26.9	26.9	26.9	27
P(mm)	399	221	157	139	112	95	100	187	167	206	120	235	2038 (total)

iii. Tropical marine climate

It is found on the East coasts of regions lying between 10° N and 25° N and 10° S and 25° S of the equator. These areas come under the influence of on-shore Trade Winds. Examples are East coast of Brazil, the Eastern coastlands of Madagascar, Mexico, Nicaragua, Guatemala, Venezuela, the lowlands of Central America, West Indies, the coast of Queensland (Australia) and the southern islands of the Philippines.

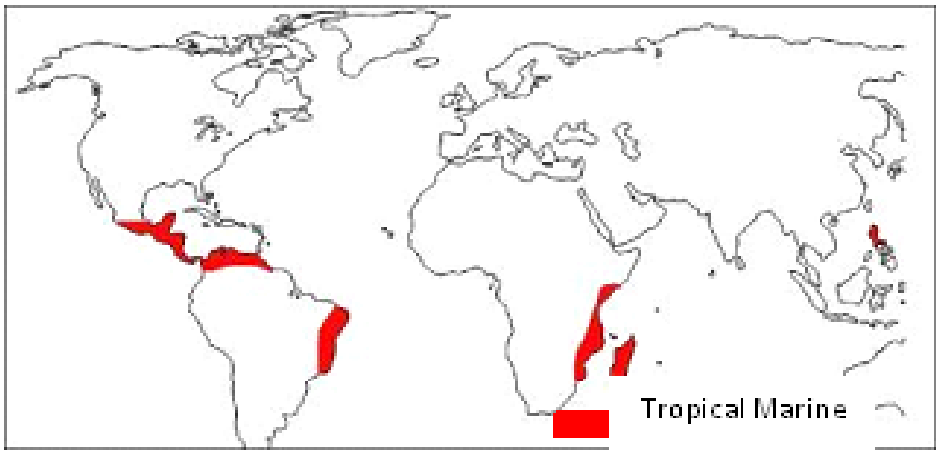


Figure 8.232: Tropical marine/maritime climate

Climatic characteristics of Tropical maritime/maritime climate

The annual temperature range is about 8°c.

Temperatures reach 29°c during the hot season while it is about 21°c during the cold season,

Annual rainfall varies from 1000 mm to 2000 mm.

Rainfall received is both convection and orographic brought by onshore Trade Winds.

Humidity is high throughout the year.

Sea breezes lessen the effects of the heat.

Tropical maritime climate is good for tree growth. The lowlands have tall and evergreen trees.

Cameroon weather station

Month	J	F	M	A	M	J	J	A	S	O	N	D
T°C	24	24.5	25	24	23.5	23	22	22.5	22.5	22.5	22.5	23
P(mm)	9	40	50	207	187	120	150	78	282	264	160	5

iv. Tropical continental climate

This climate occurs between 5° N and 15° N and 5° S and 15° S. It is in West, East and Central Africa, South America, parts of the Deccan plateau (India) and the areas to the north and east of the Australian Desert.

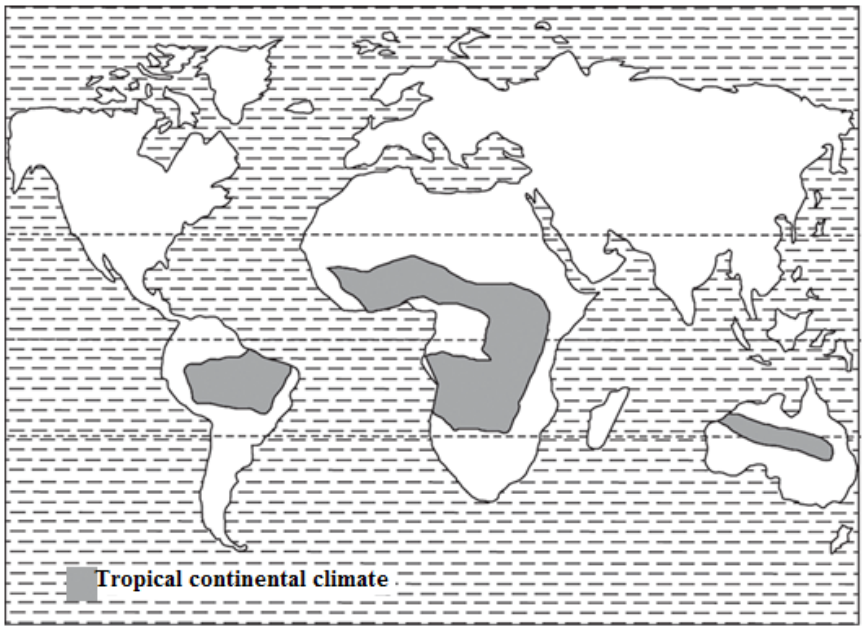


Figure 8.233: Tropical continental climate

Climatic characteristics of Tropical continental climate

- Heavy convectional rainfall is mainly in the summer.
- Annual rainfall is about 765 mm.
- In some regions, the offshore winds are strong and hot. An example is the Harmattan of West Africa.
- Humidity is high during the hot, wet season.
- Summers are hot (32° C) and winters are cool (21° C).
- The annual temperature range is about 11°C. The highest temperatures occur just before the rainy season begins. This is in April in the northern hemisphere and October in the southern hemisphere.

v. Savannah climate (Tropical wet-and-dry climate)

This is located between 5° and 20° latitudes on either side of the Equator. It is found in Latin America. These are the Llanos of the Orinoco Valley including Colombia and Venezuela, the Guyana Highlands and the Campos of Brazil.

In Africa, it is found in the South of the Congo basin, the Southern part of Democratic of Republic of Congo, Angola, Zambia, Mozambique, Tanzania, Uganda, Botswana, South-Western Madagascar, Central Nigeria, Southern Kenya, Togo, Ghana and Ivory Coast.

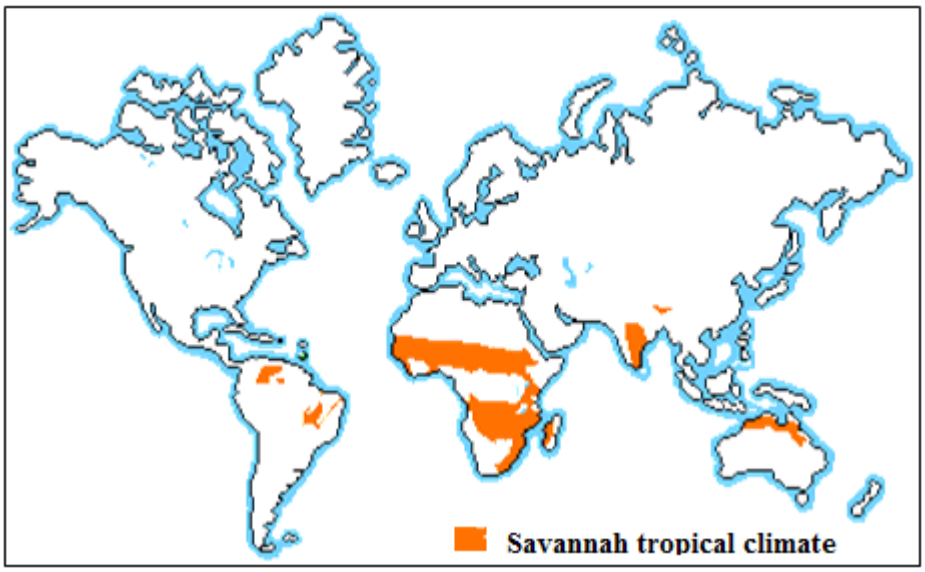


Figure 8.234: Savannah Tropical climate

Climatic characteristics of Savannah Tropical climate

- High temperature of around 20°c.
- The annual range of temperature is greater than in the equatorial regions. It is over 3° but not more than 8°c.
- Total annual average precipitation varies from 1000 mm to 1500 mm. Much of the rain falls during the summer.
- The vegetation is grasslands with scattered trees and bushes.

vi. Tropical desert climate

Most of these deserts lie between 15° to 35° N and S. The hot desert climate is found in the following deserts: Atacama (the coastal deserts of Peru and Chile in South America), the Namib and Kalahari deserts of coastal Angola and South West Africa, interior part of Botswana and South Africa, the great Australian desert, the Sahara and the Arabian deserts, the Iranian desert, the Thar desert of Pakistan and India, California (USA) and the deserts of Northern Mexico.

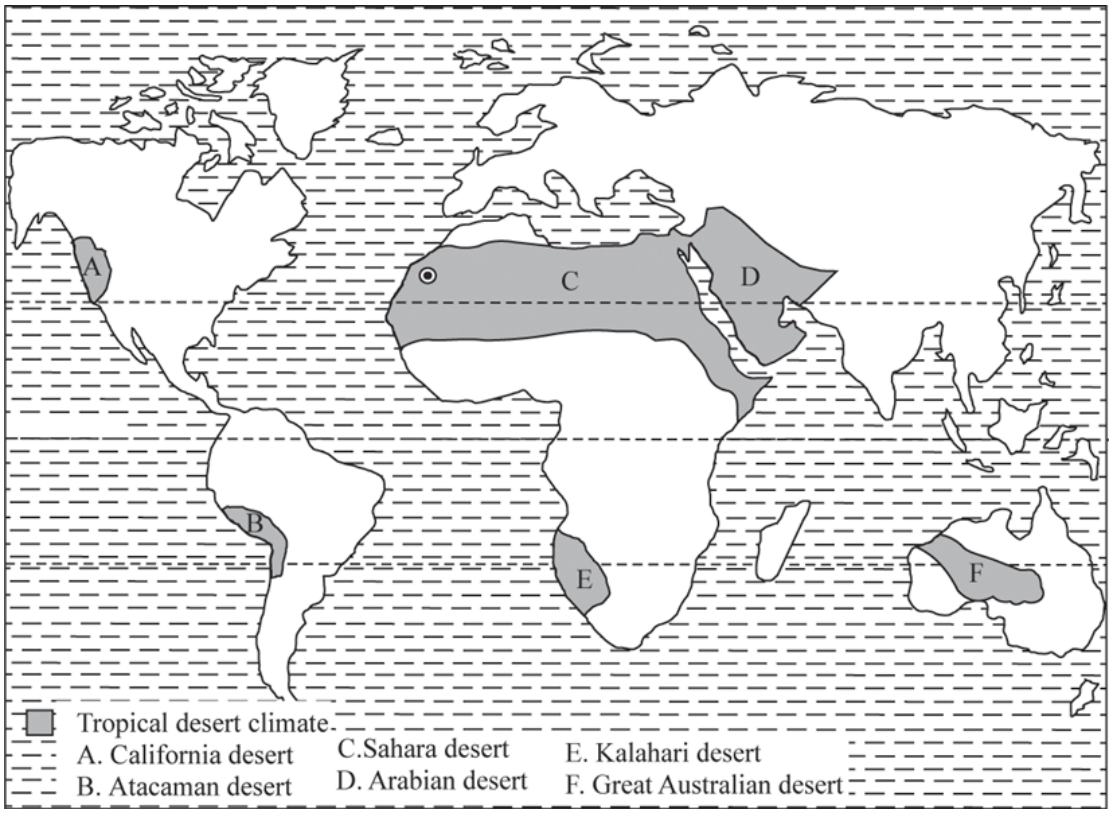


Figure8.235: Tropical desert climate

Climatic characteristics of Tropical desert climate

- Hot deserts have the highest temperatures recorded.
- They have cloudless skies and little or no water vapour.
- The daily ranges of temperature vary between 22° to 28° C. In rare cases, the diurnal range may be as high as 41.7° C.
- The annual average precipitation is less than 250 mm.
- Relative humidity is high.
- There is little plant cover.
- Below there is an example of Khartoum (Sudan) weather station:

Khartoum (Sudan) weather station

Month	J	F	M	A	M	J	J	A	S	O	N	D
T°C	22.5	23.5	27.5	30.7	33.1	33.3	30.8	29.4	30.9	31.4	27.5	23.7
Pmm	0	0	0	1	5	7	48	72	27	4	0	0

vii. Tropical Monsoon Climate

This is found in areas with seasonal land and sea winds. On-shore summer winds blowing from over tropical warm Oceans bring about heavy precipitation. Off-shore winds from over the land make the weather dry during winter.

Monsoon climate is found in the coastal areas of Eastern and Southern Asia. These places include India, Burma, Bangladesh, Indo-china, Southern China, and Philippines, Taiwan, Japan and Korea.

In tropical Africa, it is found along the South-West coast of West Africa. These areas include the coasts of Guinea, Sierra Leone, Liberia, and Ivory Coast.

Other areas are the Northeast coast of Latin America from the mouth of Orinoco River in Eastern Venezuela through Guyana, Surinam and French Guyana to the North-Eastern part of Brazil. The North coasts of Puerto Rico and the Dominican Republic in the Caribbean Islands which have a mild monsoon climate.

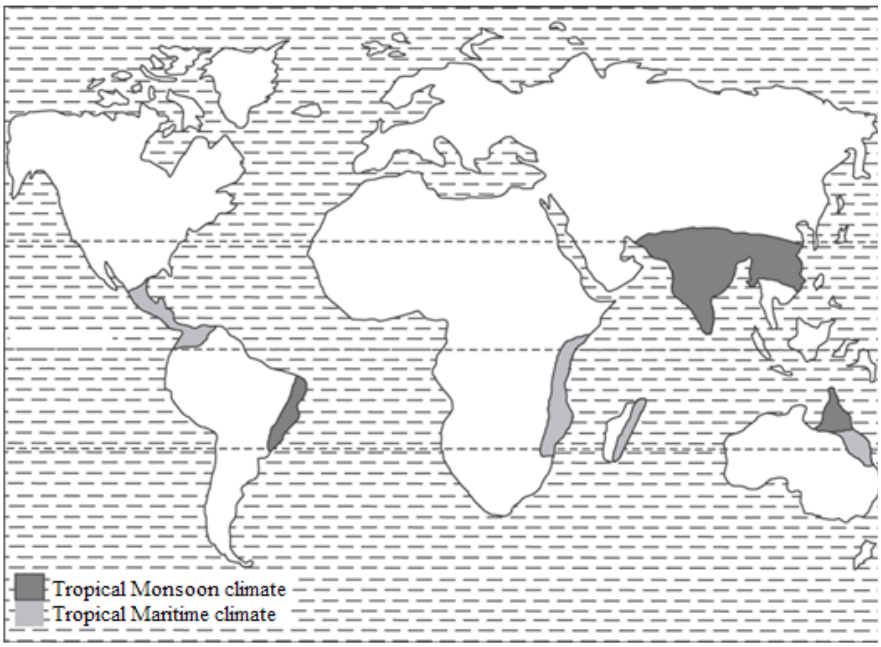


Figure 8.236: Tropical monsoon climate

Characteristics of Tropical monsoon climate

- High temperatures (32°c) in the hot season (summer) and low temperatures (15°c) in the cold season (winter).
- High annual range of temperatures of about 17°c.
- Summers receive high rainfall of up to 2500 mm.
- The winters are dry.
- There is a reversal of winds. In one season they blow from sea to land (onshore). These bring heavy rainfall. In the other season, they blow away from the sea (offshore), such come along with little rain.

Cherrapundji (India) weather station

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
T°C	12	13	17	19	19	20	20	20	20	19	16	13	17
R (mm)	20	41	179	605	1705	2875	2455	1827	1231	447	47	05	11437

8.4.2. Temperate zone

Mediterranean Climate

Mediterranean climate is found between 30°and 40°N and S of the equator. This is on the western sides of the continents. This climate is found in five regions of the world:

- North of the Mediterranean Sea from Portugal to Turkey and beyond in the Iranian Highlands, Morocco, Northern Algeria, and Tunisia, and North of Bengasi in Libya.
- The central and Southern California coast in the United States of America.
- Central Chile.
- The Cape Town area of South Africa, and
- Southern Western coasts of Australia.

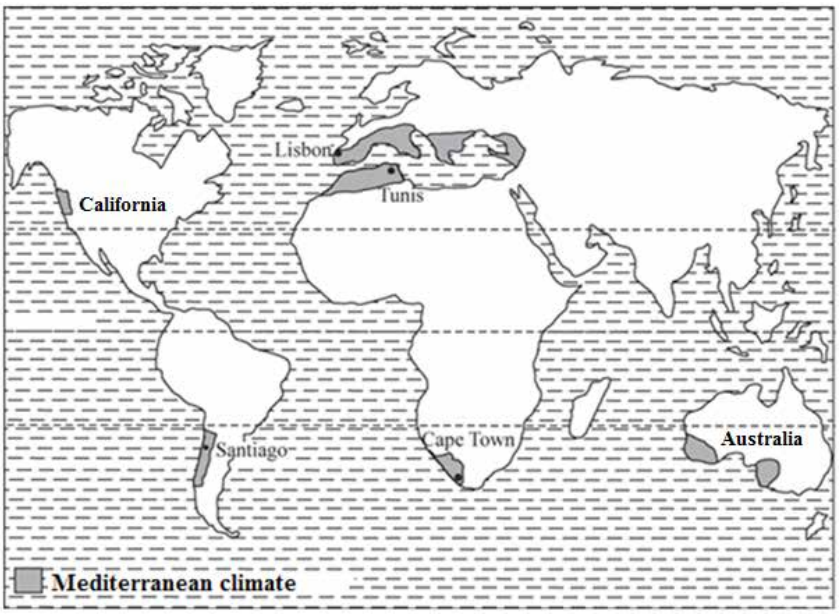


Figure 8. 237: Mediterranean climate

Characteristics of Mediterranean climate

- The average temperature of the coldest month is between 4.4°C and 10°c. That of the hottest month is between 21° C and 27°c.
- The mean annual temperature ranges are between 11°and 17°c.
- The average annual precipitation is between 350 and 750 mm.
- There is rain in winter while the summers are dry.
- Below there is an example of Algiers (Algeria) weather station:
- Algiers (Algeria) weather station

Month	J	F	M	A	M	J	J	A	S	O	N	D
T°C	11.9	13	14.2	16.1	18.8	21.9	25	25.3	23.8	20.3	16.9	13.1
R (mm)	107	90	89	59	33	15	2	7	29	80	117	137

Temperate Maritime Climate

This type of climate is found between 40° and 65° N and S of the equator. These are regions to the West of continents.

It is mainly found in Western Europe including Great Britain, North Western France, Germany, Denmark, Holland, Belgium and Norway.

In North America, it is found along the West coast up to 60° N of the equator. It borders the Sub-Arctic climate of Canada and Alaska. In Europe, it extends along the west coast of Norway to 68° N.

In the Southern Hemisphere, it is found to the Southwest coast of Chile, Southeast coast of Australia, the islands of Tasmania and New Zealand.

Below there is an example of Brest (France) weather station:

Brest (France) weather station

Month	J	F	M	A	M	J	J	A	S	O	N	D
T°C	6.7	7.2	8.3	10.9	13.3	16.2	17.9	18.1	16.3	12.8	9.3	7.2
R (mm)	84	75	57	54	49	49	51	53	54	78	91	96

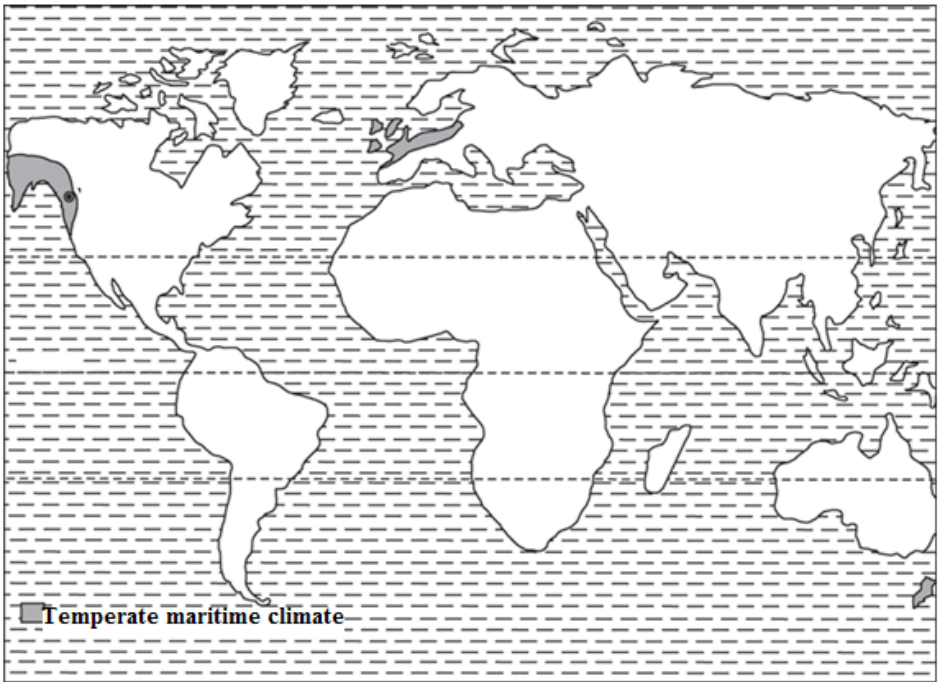


Figure 8.238: Temperate maritime climate

Characteristics of Temperate Maritime climate

- Temperatures are influenced by the warm Ocean currents.
- This climate has cool summers and mild winters.
- The annual range of temperature is about 7° C.
- Average temperatures in summer are between 15° C and 18° C. Winter temperatures range between 11° and 17° C.
- In Europe, the lowlands receive an average precipitation of 500 mm to 850 mm. On the windward side, it is between 2500 mm and 3750 mm.

Continental Temperate climate

This type of climate occupies a large part of the United States of America. In Europe, it is found in Romania and Bulgaria. It occupies the lower Danube Valley.

In Eastern Asia, it is found in North China bordering the yellow Sea, North and South Korea, and Northern Honshu in Japan.

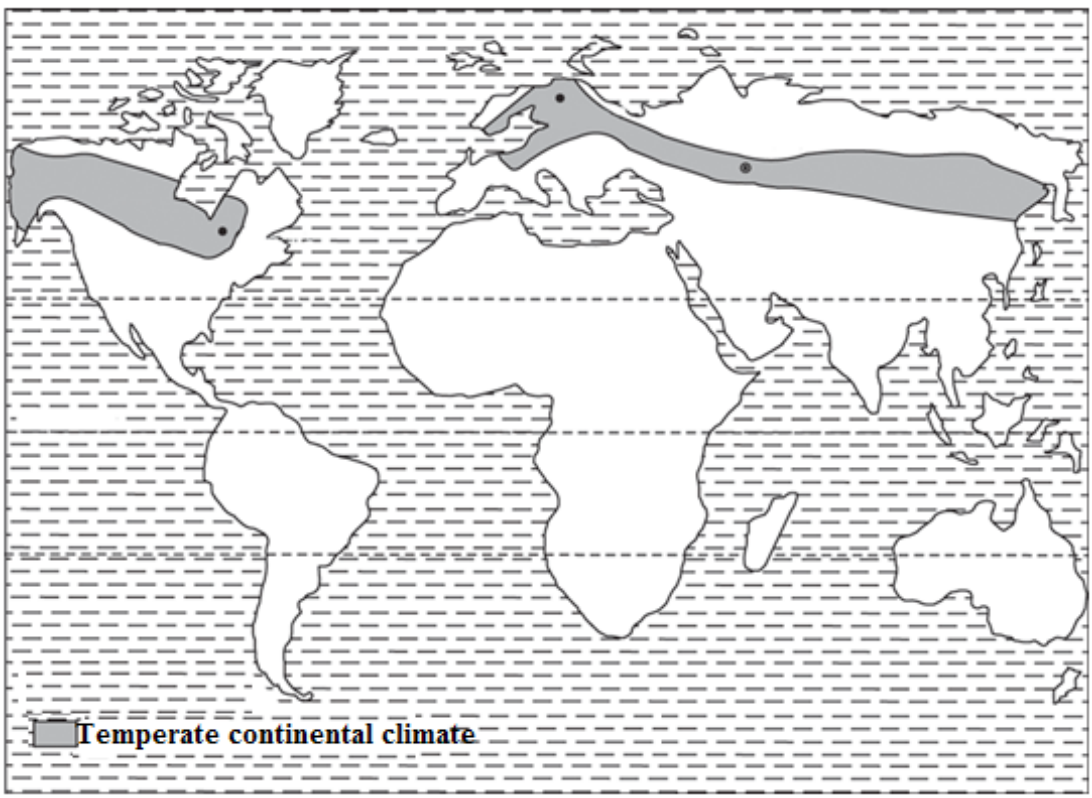


Figure 8.239: continental temperate zone

- Temperate continental climates are found on continents in the Northern Hemisphere between 40o-70o
- Climate in these areas is controlled by the fact that they are not located near Oceans where temperatures are moderate.
- Temperate continental climates are also called micro thermal climates, because they are located away from the Oceans. These climatic zones experience the extremes of temperatures.
- Summers are warm and can be very humid while winters are cold with snowstorms and blustery winds.
- The annual average temperatures are around 100 C.

8.4.3. Cold zone

Polar and Tundra climate

The Tundra climate is found in the northern hemisphere beyond 60° N of the equator. These are areas to the North of Asia and Canada. It also occurs on the coast lands of Greenland. Polar climate is found in Greenland, interior of Iceland and in the Antarctica.

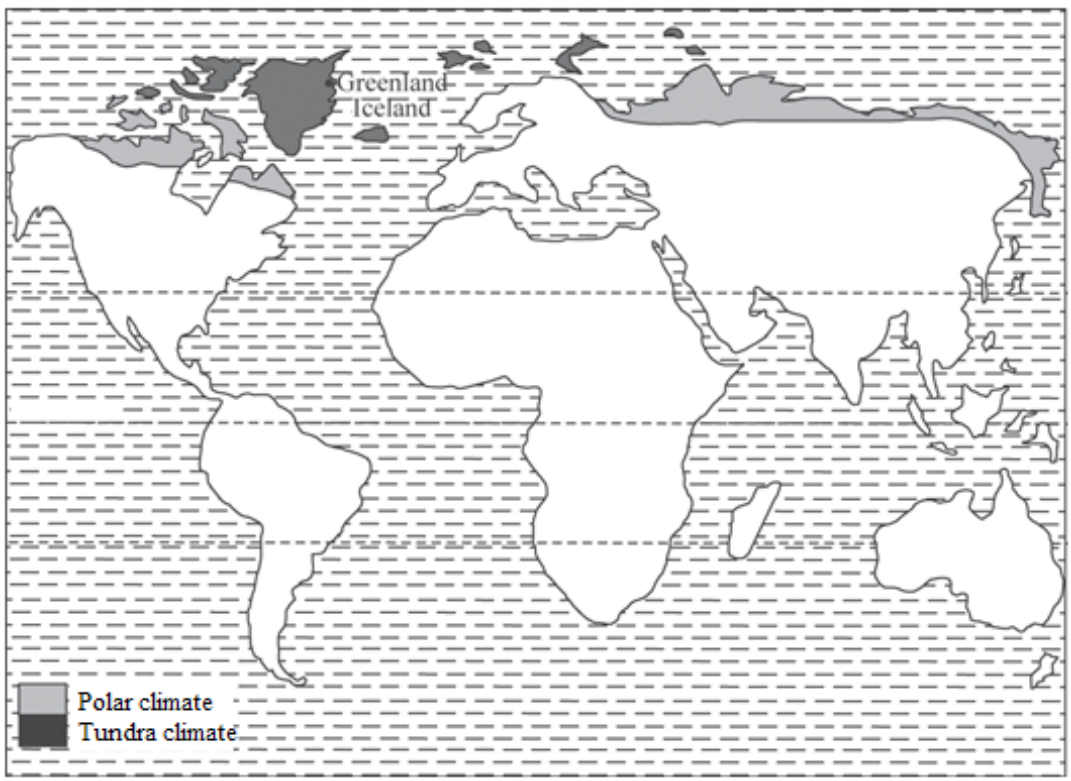


Figure 8.240: Polar and Tundra climate

Characteristics of Tundra climate

- The average annual rainfall is 250 mm.
- Precipitation is in the form of snow in winter and rainfall in summer.
- Humidity is low because of low temperatures.
- Winter temperatures are low. They range from - 29°c to 4°c. Summer temperatures average about 10°c.
- Vegetation consists of mosses, lichens and dwarf trees and shrubs. It is called tundra vegetation.

Characteristics of Polar climate

- Temperatures are always low. They are below 0°c, which leads to snow.
- Precipitation mainly occurs in summer. It averages between 100 mm and 250 mm.
- Winters are associated with one continuous night. Summers are one continuous day.
- Blizzards are common. These are snowstorms with high winds. Visibility is low.
- There is hardly any vegetation. This is because of snow and ice cover.

Below there is an example of Ours weather station:

Ours station

Month	J	F	M	A	M	J	J	A	S	O	N	D
T°C	-9,5	-11	-11	-7.5	-1,5	1.5	4.5	4.5	1,5	-1.5	-6	-7.5
R (mm)	28	36	30	18	20	20	18	23	41	36	25	30

Mountain climate

This type of climate is found in the mountain ranges of the world. These include Mt. Kenya, the Ethiopian Highlands and the Alpine ranges of Europe. Others are the North Western part of Rwanda, especially over volcanic region, the Andes of South America and the Rockies of North America.

Characteristics of Mountain climate

- High rainfall on the windward slopes. It is less on the leeward slopes.
- Orographic rainfall is received.
- Pressure and temperature decrease with altitude.
- But if the mountains are high enough, there is a height at which maximum precipitation occurs and above which it decreases.
- It is also characterized by strong local winds (mountain and valley breezes).

Application activity 8.4

a. Draw a world sketch map and on it mark and label the world climatic zones.

b. Describe the characteristics of each climatic zone shown on that world sketched map.

8.5. Influence of climate on human activities

Learning activity 8.5

"People in North Western part of Rwanda grow Irish potatoes, while people in Southern Rwanda grow cassava and those of Eastern Rwanda grow bananas. Again, in some regions of Rwanda tea is grown as a cash crop while other does not".

Hence explain how those crops grown are influenced by climatic conditions in each part.

Climate influences the distribution of population. This is because of temperature conditions, amount of precipitation and length of crop growing season.

The relationship between climate and human activities is summarized below:

- **Human activities in equatorial regions:** Heavy rainfall and high temperatures support growth of forests. The main human activities are lumbering and agriculture. Lumbering is the cutting down of trees and making them into timber. Crops such as coffee do well in this type of climate.
- **Human activities in savanna climate:** This type of climate is good for agriculture and dairy farming. There is enough grass for the animals. Growing of vegetables is done in this type of climate.
- **Human activities in desert climate:** The high temperatures and low rainfall are not supportive for agriculture. Animal keeping is also not well developed only camels, goats and sheep are kept in such type of climate. Furthermore, it is only around the oases that some farming is done. An oasis is a fertile spot in the desert where water is found. Growing of crops is done by irrigation. However, mining activities are done in some deserts for instance gold is extracted in West Australia; diamonds in the Kalahari and petroleum in Algeria, Libya, Saudi Arabia, Kuwait, Iran and Iraq.
- **Human activities in temperate climate:** This type of climate is suitable for agriculture and livestock keeping. Most developed countries are in this type of climate. These zones have high population.

– **Human activities in polar climate:** The main activities in this zone are the fishing and hunting. Few people are found here.

Application activity 8.5

"Most of entrepreneurs look for climatologists and meteorologists to advise them when locating their firms", Discuss the statement.

END UNIT ASSESSMENT

1. With aid of diagram describe the structure of atmosphere.
2. To what extent atmosphere plays a considerable role in regulating/ control negative effects of solar radiation?
3. Visit a weather station near your school to identify instruments used to measure and record weather conditions.
4. (a) Briefly describe the characteristics of Rwandan climate,

   (b) Explain the factors influencing the climate of Rwanda.
5. "Human activities depend upon climate and weather conditions of an area" with relevant examples in Africa, support this statement.

UNIT 9

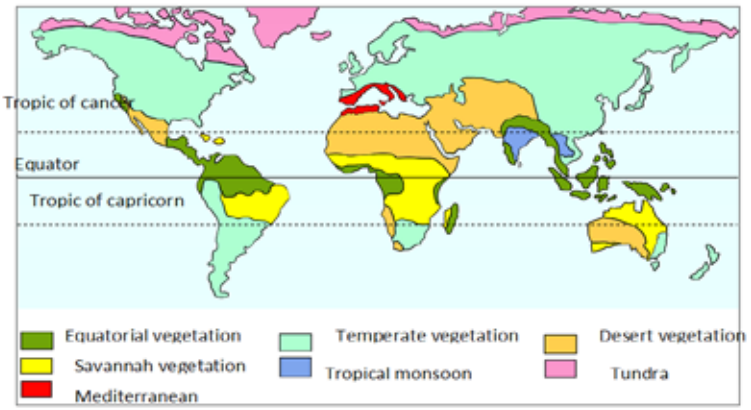
NATURAL VEGETATION OF THE WORLD

UNIT 9: NATURAL VEGETATION OF THE WORLD

Key unit competence

By the end of this unit, I should be able to appreciate the distribution of different types of vegetation in the World.

Introductory activity:



Vegetation is important to man in various ways and it acts as a habitat place for wild animals. There is need to conserve it due to its significance. The different countries have come up with environmental campaigns aimed at protecting the natural vegetation for the environment and sustainability.

1. Identify the different types of natural vegetation shown on the map provided above.
2. Describe the factors influencing the distribution of world vegetation.
3. Why is it important to conserve the natural vegetation and how can we preserve our natural vegetation?

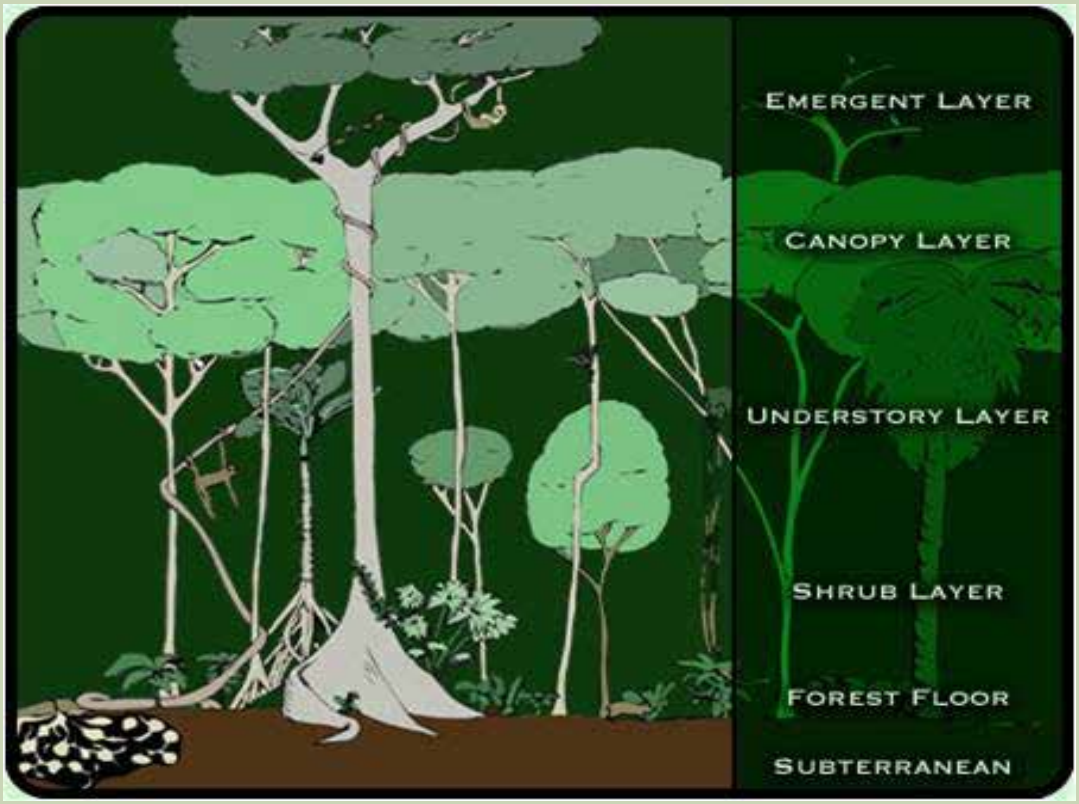
Vegetation refers to a community of plants which grow in an area and which gives it distinct character. Vegetation in biological terms is known as "flora", that is, all vegetation types growing on land and in water.

The world vegetation communities are into categories: forests and grasslands. They are distributed according to the vegetation zones and they include tropical, temperate, tundra, desert, mountain and aquatic/marsh or mangrove vegetation.

9.1. Tropical forests and their characteristics

Learning activity 9.1

Observe the photograph provided below and answer the questions that follow:



1. Describe the characteristics of the vegetation presented in the illustration above.
2. What type of vegetation shown in the illustration above basing on the characteristics described in (1) above?
3. Identify and describe the different types of tropical forests Tropical vegetation develops within the tropics. It can be sub -divided into three but related groups. These include equatorial rainforests, tropical monsoon forests and tropical mountain forests.

9.1.1. Equatorial forests

The equatorial rainforests grow within the tropics between 10 °N and 10 °S of the equator. Equatorial rainforests are sometimes called "rainforests". Equatorial rain forests cover only a small part of the earth's surface which is about 6%. They are situated in the Amazon basin in South and Central America, Congo basin in Central Africa, Malaysia, Burma, and West African coastal belt (Nigeria, Ghana, Ivory Coast, Liberia and Central Africa Republic).

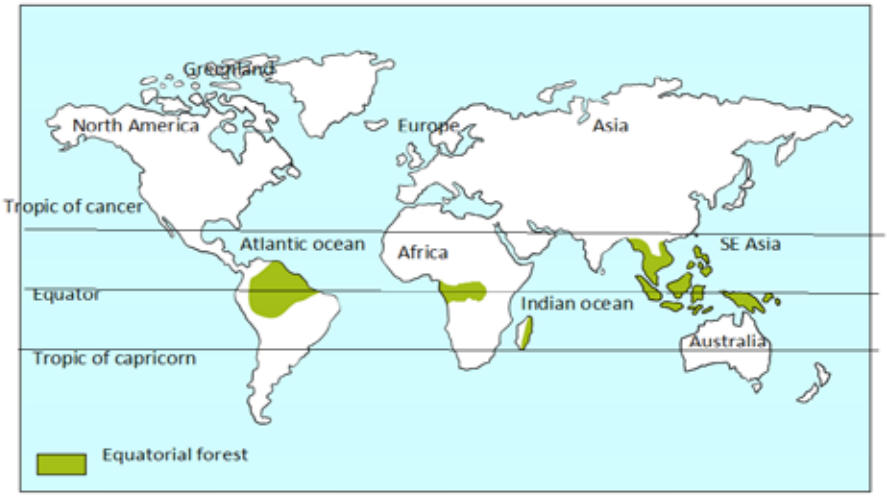


Figure 9.241: Location of equatorial rainforests

The conditions necessary for the growth of equatorial rainforests:

- Equatorial rainforests receive rainfall throughout the year about 2000 mm per year.
- The equatorial rainforests grow in areas with good fertile soils and well-drained soil.
- The equatorial rainforests require much sunshine to support their dense growth.
- The equatorial rainforests require about 23-240c temperature.

Equatorial rainforests are characterized by the following:

- They are evergreen, since the forests receive heavy rainfall throughout the year with no clear distinct seasons.
- They grow buttress roots in order to support their enormous sizes.
- The major tree species in equatorial are characterized by a long gestation period.

- Equatorial rainforests receive rainfall throughout the year with no distinctive seasons.
- The vegetation in equatorial regions is comprised of four vertical layers starting from the canopy of the tree to the ferns on the ground.
- Equatorial rainforests are dominated with valuable tree species such as mahogany, ebony, green heart and redwood.
- The forest floor receives only 2% of the sunlight. This has led to the existence of little undergrowth.
- The trees are very tall (35 m - 40 m) with a very dense and thick canopy. The result is that the canopy blocks most of the sunlight falling on them depriving the plants under them of sunlight.
- Most of the trees in Equatorial rainforests become tall in the search of light.
- There are broad-leaved evergreen forests of dense and prolific growth of flora as well as fauna.
- The major tree species do not grow in pure stands. Trees of pure stands are scattered all over the forest.
- Beneath the tree canopy exists a well-developed layering of understory vegetation, which is so dense and this limits light to reach the floor of the forested area.

The Equatorial rainforests are associated with various economic activities. These include lumbering as a major activity, provision of local materials which are used in craft industry, provision of fuel, research and study, herbal medicine, agriculture support, etc.

9.1.2. Tropical Monsoon forests

The Tropical Monsoon Forests are found beyond the equatorial region, between 10 0 and 250 North and South of the equator. This type of vegetation is found in areas such as; Burma, Thailand, the Indo-China region, parts of India, East Java, parts of Northern Australia, small parts along the South Western coastal areas of West Africa.

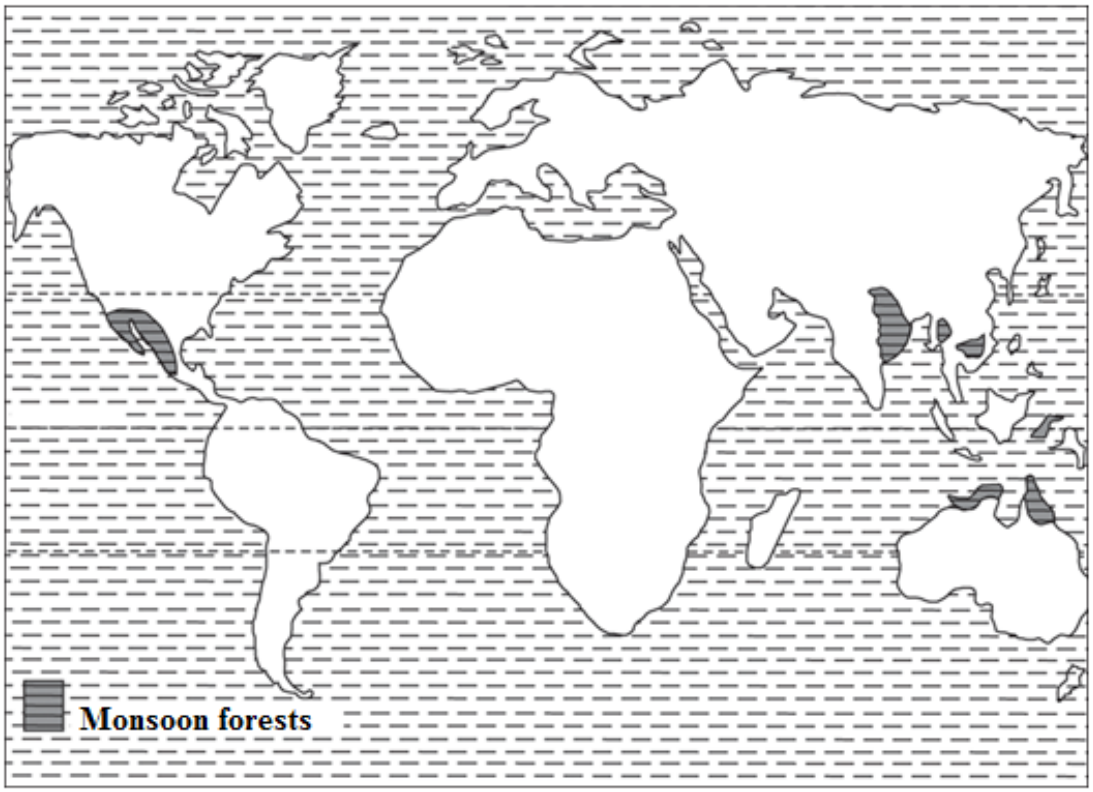


Figure 9.242: Location of tropical monsoon forests

The conditions necessary for the growth of tropical monsoon forests:

- The tropical monsoon forests receive heavy rainfall, which is around 2000 mm per year. This is received mostly in summer.
- In cooler seasons such as winter, very little rainfall is received. This is because these regions lie under the offshore trade winds.
- The tropical monsoon forest requires temperatures of about 27^0c. This temperature is moderately enough to support the growth of various plants.

Tropical monsoon forests are characterized by the following:

- The trees possess trunks that they use to store water during the dry seasons.
- The tropical monsoon forests can grow up to 30 metres in height.
- Trees possess long tap roots that penetrate into the ground to access groundwater. Inorder to sustain plants' growth, especially during the dry winter season when there is unreliable rainfall.
- Tropical monsoon forests shade off their leaves during the dry seasons in order to minimize water loss.
- Trees have broad leaves due to sufficient rainfall (2000 mm) received during the wet season.

- Tropical Monsoon forests experience temperatures that reach 280c especially in Summer.
- Tropical monsoon forests contain valuable hard wood tree species such as the teak and sandalwood.

Tropical monsoon forests are associated with various economic activities such as lumbering on the wider area, agriculture, craft industry, settlement pattern and provide herbal medicine.

9.1.3. Mountain tropical forests

The tropical mountain forests are mainly located at a high altitude in the mountains. These usually vary largely along the slopes of Himalayas Mountain ranges and East African Mountain peaks of Rwenzori, Mt. Kenya and other good examples include; Cameroon Mountains, and Ethiopia Highlands. The trees grow in plenty between the altitude 1,500 and 3,500 meters. This explains why such areas are dominated by mountain forests. They have evergreen trees like Teak, Bamboo, and other tree species such as Pine, Fir, Oak, Maple, Deodar, Laurel Spruce, Cedar, cedar pod carp and camphor. All these grow abundantly and dominate the natural vegetation in the area.

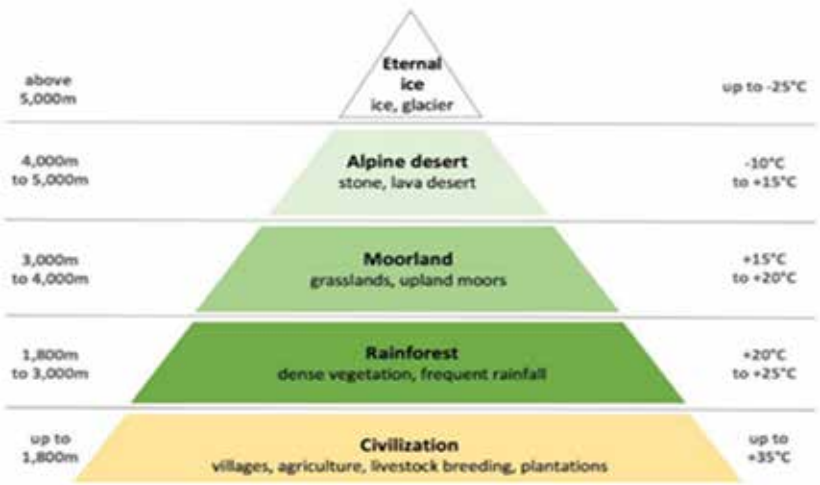


Figure 9.243: Vegetation zonation on moutain Kilimanjaro

https://www.jambo-kilimanjaro.com/practical-tips-and-tricks/vegetation-zones-of-kilimanjaro/

The conditions necessary for the growth of mountain forests:

- Mountain forests require much and reliable rainfall;
- Mountain forests require adequate temperature for the growth of tress;
- Mountain forests need deep fertile soil for the growth of forests;

Mountain forests have the following characteristics:

- Mountain forests grow broad leaves and they are evergreen;
- Mountain forests grow thick under growth;
- The forests contain giant evergreen trees that grow on the windward slopes of the mountain;
- The main tree species are characterized by long gestation period;

The mountain forests are associated with various economic activities such as lumbering on the wider area, provision of local materials, hunting of animals and provide herbal medicine.

Application activity 9.1

1. Briefly explain the geographical conditions that determine the location of equatorial forests.
2. It has been noted that the environment is composed of varieties of natural resources that support the socio-economic development of any country. Forests fall under such natural resources. Explain the influence of different categories of tropical forests on the development of Africa.

9.2 Temperate forests and their characteristics

Learning activity 9.2

Read the passage provided below and give feedback to the questions that follow:

Temperate forests occur in Eastern North America, North Eastern Asia, Western and central Europe. Temperate forests are those which grow outside the tropics. They are divided into three categories namely deciduous forests, Mediterranean forests and coniferous forests. Temperate forests are located between 300 and 700 North and 30 0 and 70o South of the equator.

1. Identify the types of forest mentioned in the passage above.
2. Compare and contrast the types of forest indicated in the passage above.

The temperate forests are categorized into 3 categories that include: deciduous forests, Mediterranean forests and coniferous forests.

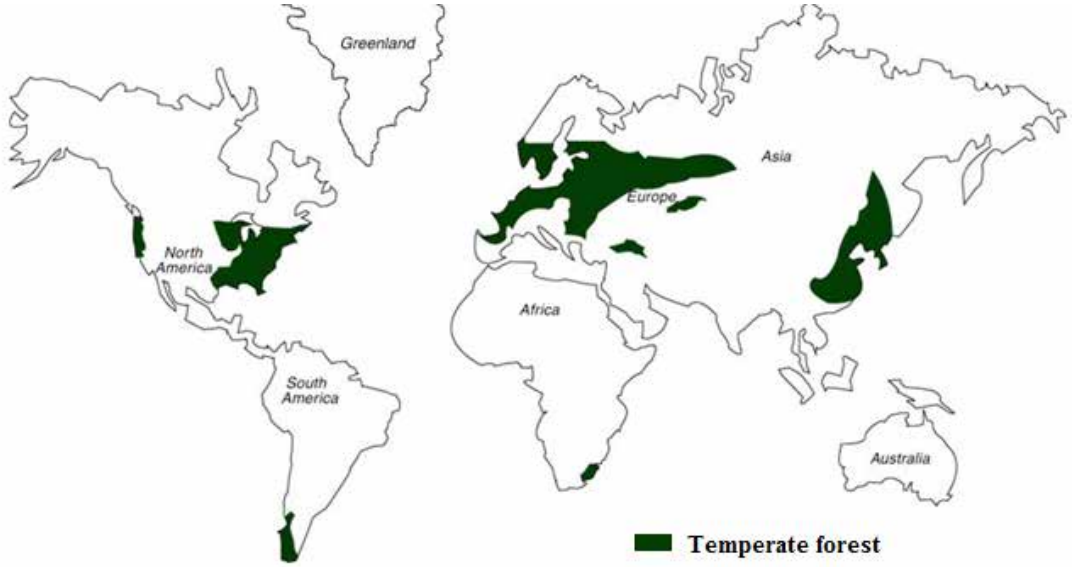


Figure 9.244 Temperate forests

The conditions necessary for the growth of temperate forests:

- Temperate forests need little supply of sunshine for the successful growth.
- Temperate forests require enough fertile soil and availability of water for growth.
- Temperate forests require amount about to 750 mm of rainfall in dry periods.

The characteristics of temperate forests

- With high levels of precipitation, humidity, and a variety of deciduous trees.
- Temperate trees are trees that lose their leaves in Winter.
- Trees shed their leaves in fall and bud new leaves in spring when warmer temperatures and longer hours of daylight return.
- Temperate forests have tall evergreen trees dominating the regions.
- They have Redwood trees which are the tallest in the world, about 360 feet high.
- The most prominent tree type in temperate forests is the Douglas fir, that is growing 280 feet tall.
- Temperate forest mature species of cedar and spruce trees typically exceed 200 feet in height.
- Temperate forests have epiphytes species such as mosses and ferns that live

on the branches and trunks of the trees, especially the broad-leafed maples.

- Temperate forests have many species of large ferns which occupy the shady forest floors.
- Temperate forests can get from 60 to 200 inches of precipitation annually.

The temperate forests are associated with various economic activities. These include tourism which is supported by the presence of many different species of birds such as broad-winged hawks, cardinals, snowy owls, and pileated wood peckers that attract very many people from different parts of the world. There is also hunting due to different types of animals such as white-tailed deer, raccoons, opossums, porcupines and red foxes.

9.2.1. Mediterranean forests

The Mediterranean forests are located mainly in South West America, Spain, Italy, France, Australia, Algeria, Morocco, Tunisia, and Central Chile. Mediterranean forests grow also well on the tip of South Africa near Cape Town.

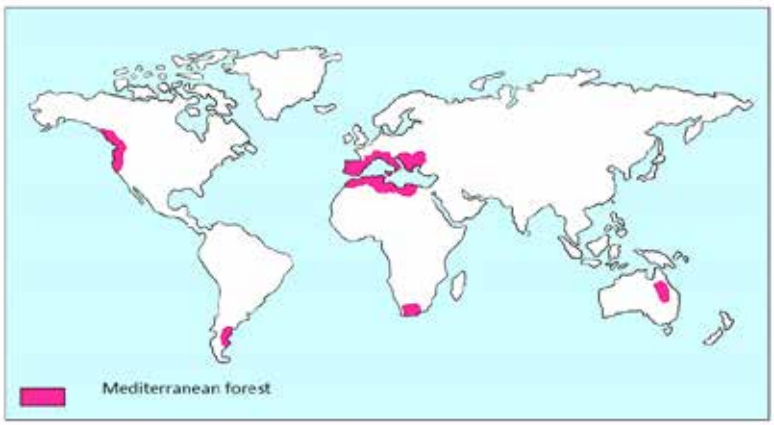


Figure 9.245: Mediterranean forests

The characteristics of Mediterranean forests are:

- Tree species in the Mediterranean are deciduous.
- The mediterranean vegetation is characterized by open and evergreen woodlands.
- The mediterranean vegetation has thicket with thin and waxy leaves.
- There is inadequate undergrowth.
- They are composed of broadleaf trees, such as the oak and mixed sclerophyll forests.

- Mediterranean vegetation has dense foliage composed of broad-leaved evergreen shrubs, bushes, and small trees usually of less than 2.5 m (about 8 feet).
- Tall trees grow in regions lying between 30° and 40° North and South latitudes.
- Trees even fully grown are often stunted.
- There are woody, evergreen shrubs or small trees that have developed various strategies of growth and usage of available water during the dry period.
- Mediterranean deciduous tree species have a long gestation period.
- Mediterranean plants have long taproots to reach underground water, called "Xerophytic Plants".
- Mediterranean trees adapt themselves to dry summers with the help of their thick barks and wax coated leaves. These reduce the rate of transpiration.

The Mediterranean forests are associated with various economic activities such as mining of oil, tourism, and very limited population settlement. There is also rearing of sheep and growing of crops such as wheat, oats and cultivation of chestnuts.

9.2.2. Coniferous forests / Taiga Forest

The coniferous forests are located across North America, Europe, and Asia. These forests are found within the extent of 50˚ to 60˚N. The coniferous forest is the largest terrestrial vegetation covering about 17% of Earth's land area. Countries such as Canada, Russia, and Scandinavia are almost entirely covered by these coniferous forests. The vegetation is identified by its climate, which occurs almost exclusively in the high latitudes of the Northern hemisphere.

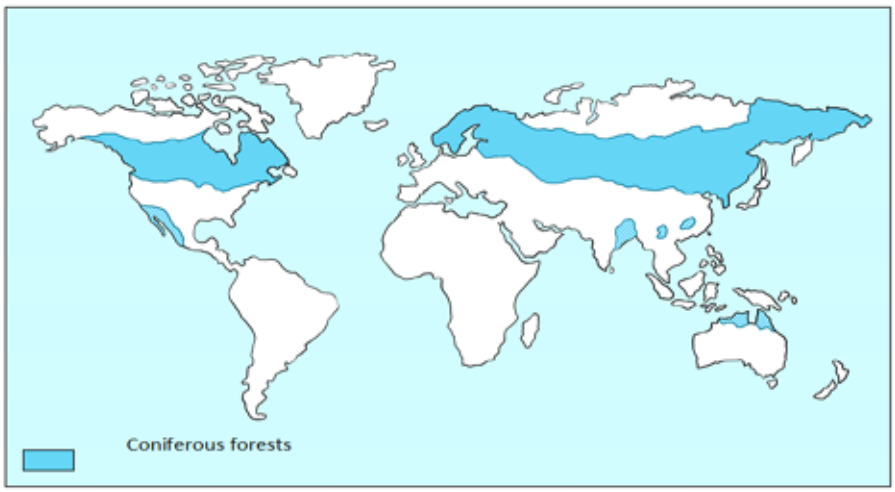


Figure 9.246: Coniferous forests

Coniferous forests are favoured by the following environmental conditions:

- The coniferous forests require inadequate supply of sunlight.
- The coniferous forests need medium fertile soil with availability of water.
- The coniferous forests grow well with an average temperature of below 430 F during the winter season.

The characteristics of coniferous forests are:

- The coniferous forests consist of tall and softwood evergreen trees.
- There are limited species of trees. The existing trees are evergreen and grow apart.
- The coniferous tree species grow tall, straight and contain few branches.
- The type of trees in these coniferous forests grow in pure stands;
- Trees are conical shaped with needle-like leaves. These include firs, pine and cedar which are important variety of trees in these forests;
- The tree species often grow to a height of over 30m (100ft) tall;
- Coniferous tree species grow shallow roots and can collect enough water from top soil;
- They have shallow roots used to absorb the nutrients and water from the top soil;
- The coniferous vegetation has adapted to harsh conditions associated with winter season.
- Leaves are small, narrow and often needle-like with the capacity of reducing transpiration.

The coniferous forests are associated with various economic activities which include lumbering, tourism, apiculture (bee keeping), hunting, herbal medicines, fruit gathering and Research and study.

9. 2.3. Deciduous forests

Deciduous forests grow well within the latitude of 40° N and 60°N and 30° S and 50oS of the equator.They can be found in the Eastern half of North America, and the middle of Europe. There are many deciduous forests in Asia. Some of the major areas having deciduous forests include Southwest Russia, Japan, and Eastern China. South America has two big areas of deciduous forests in Southern Chile and in the Middle Eastern coast of Paraguay. These are also located in New Zealand and South Eastern Australia also.

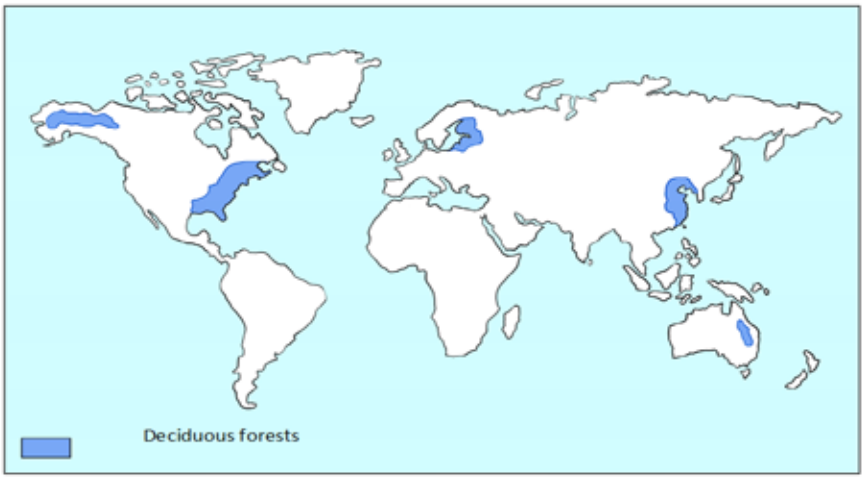


Figure 9.247 Deciduous forests

The conditions necessary for the growth of deciduous forests:

- Deciduous forests require moderately distributed rainfall.
- Deciduous forests need low sunshine supply.

Characteristics of deciduous forests:

- Trees shed their leaves in the dry season to conserve water.
- Deciduous forests are characterized by the existence of epiphytes which include mosses.
- Trees like sandalwood, teak, ebony, bamboo, etc. are the common trees found here.
- Deciduous forests have a short growing gestation.
- Deciduous forests grow in pure stands.
- Deciduous forests require low sunshine supply.
- They contain hard wood tree species such as maple, oak, beech and hazel.

The deciduous forests are associated with various economic activities which include lumbering, tourism activity, hunting, herbal medicines and fruit gathering.

Application activity 9.2

Describe briefly different types of temperate forests.

9.3. Grasslands in the tropical zone and their characteristics

Learning activity 9.3

Observe the photograph provided below and answer the questions that follow:

1. Referring to your observation, describe the characteristics of the grassland shown above.
2. Suggest two world areas where such presented vegetation is found.
3. Distinguish savannah humid from savannah dry grasslands.

Tropical grasslands are commonly known as savannah vegetation. Tropical grasslands grow well within altitude of 50 N and 15o N and 50 S and 15o S of the equator. Tropical grasslands grow well in Africa, South America specifically in Campos in Brazil". They can also be found in Guyana, Australia, Eastern Madagascar and India. Tropical grassland is divided into two groups: Savannah and steppe.

9.3.1. Savannah humid vegetation

Savannah humid forests grow well in regions experiencing the average total rainfall of 1000 mm per year. Mambo woodlands of Central Tanzania is one of the examples of savannah woodlands in East Africa. Other examples of savannah humid forests are found in Madagascar, Indian subcontinent, South East Asia and New Guinea.

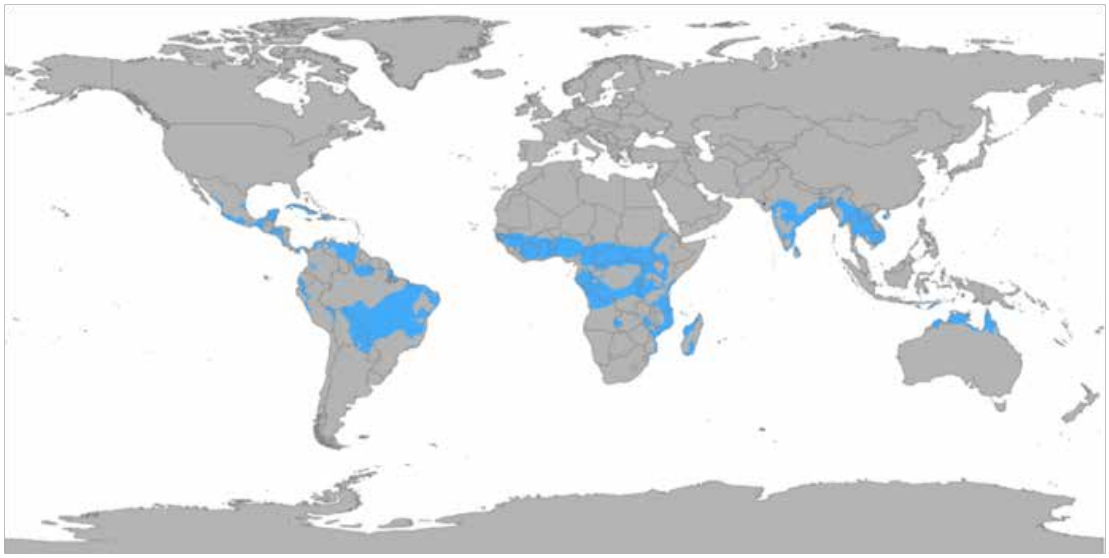


Figure 9.248: Location of Savannah humid vegetation.

The conditions necessary for the growth of the Savannah humid vegetation:

- The savannah humid can grow well in regions experiencing temperatures ranging between 250 c to 320 c.
- The savannah humid vegetation grow well in areas which experience rainfall about 750 mm to 1000 mm per annum.
- The savannah humid needs maximum sunshine and light necessary for the plants to make chlorophyll.

Its characteristics include the following:

- The tree species are deciduous, and shade leaves during the dry periods.
- The vegetation is mostly composed of shrub and short grass.
- The species of trees such as baobab and acacia are mostly common in the area.
- The grass can grow very tall (about 3 to 4 meters high). The common type of grass is known as "elephant Grass".

- Near riverbanks and water holes, deciduous trees can grow, e.g. Acacia, baobab, etc.
- The Savannah vegetation is characterized by undergrowth dominated by shrubs and short grasses.
- Most tree species in the savannah woodlands form small umbrella –like tops such as acacia.
- The tree species are deciduous and shade –off leaves during the dry season.
- The tree species such as the acacia and baobab are more dominant in savannah humid forests.
- Shrubs growing in this area have yellow or white flowers and can grow over six feet tall.
- The non-thorny trees such as baobab, candelabra, and the Jackal berry are found in savannah grasslands.

The Savannah humid vegetation is associated with various economic activities such as hunting, herbal medicine collection, fruit gathering, rearing of animals and subsistence farming, settlement, mining and gazetting of national park and game reserves.

9.3.2. Steppe/ Savannah dry vegetation

Savannah dry covers almost half the surface of central Africa and large areas of Australia, South America, and India. The climate is the most important factor in creating a savannah dry vegetation. Savannahs are always found in warm or hot climates where the annual rainfall is from about 508 to 1270 mm per year. These regions receive rainfall for about 6 to 8 months. This is followed by prolonged dry period that usually affects fire out-breaks.

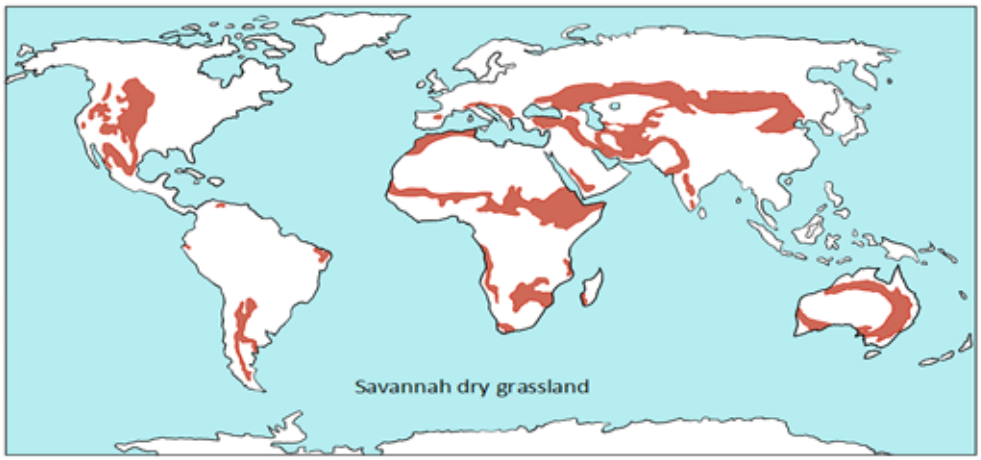


Figure 9.249 Location of steppe vegetation / Savannah dry vegetation

The conditions necessary for growth of Savannah dry/steppe vegetation:

- The soil which is dry and porous, with rapid infiltration of water.
- Dry climatic conditions that support the growth of different grasses due to the disparities in rainfall and soil conditions.
- Availability of the average annual rainfall of 762-1016 mm.
- The presence soils that are too thin. Trees require the existence of termite mounds where they grow.

The main characteristics of Savannah dry vegetation are:

- The trees and grass grow through direct competition for water, light and nutrients.
- The open canopy allows sufficient light to reach the ground to support an unbroken herbaceous layer consisting primarily of grasses.
- Annual herbaceous plants die completely at the end of the growing season or when they have flowered and fruited. These grow again from seed when the wet season sets in.
- The vegetation consists of tall grasses and scattered trees.
- The grasses are usually two meters high or more.
- The trees are mainly found near watercourses. The main types of tree species are acacia;
- Some trees lose their leaves in the dry season.
- Some plants have thick barks and thorny leaves to reduce water loss.

The Savannah dry /steppe vegetation is associated with various economic activities including hunting, fruit gathering, rearing of animals, settlement, agriculture and gazetting of the national park and game reserves.

Application activity 9.3

1. Describe savannah grasslands with reference to South Africa.

2. With reference to the Rwandan context, explain the importance of savannah grasslands in the economic development.

9.4 Grasslands in temperate zones

Learning activity 9.4

Study the picture provided below and answers the questions that follow:

1. Observe the picture provided and explain the conditions necessary for the growth of the vegetation shown above.
2. Suggest any two-world areas where the vegetation presented above is found.

Temperate grasslands are known by different names in various regions. "Prairies" in North America; "Pampas" in South America (Argentina), "Downs" in Australia "Velds" in South Africa and "Steppes" in Europe. These are found in the mid- latitudinal zones and in the interior part of the continents. The Temperate grasslands are found in Central Asia from Black Sea to Central Russia, North Central USA and Southern Canada, South-East Australia, Southern Africa and Argentina.

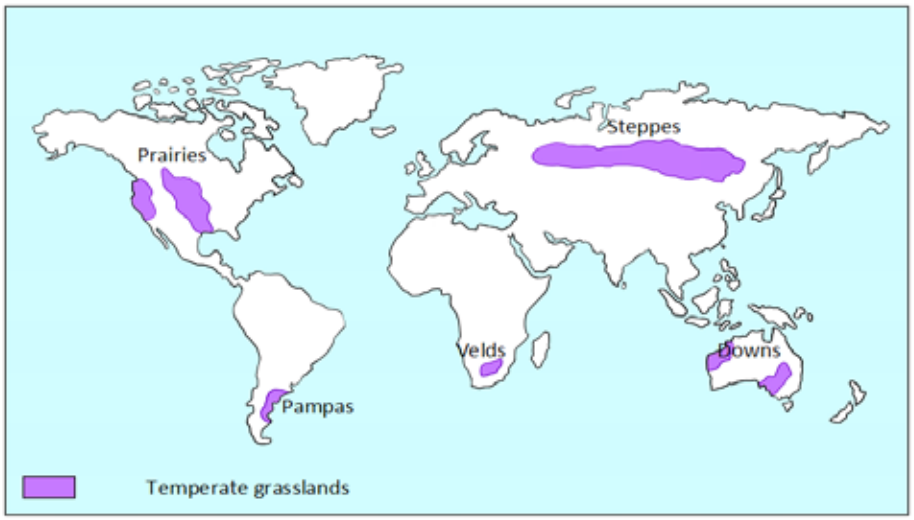


Figure 9.250: Location of grasslands in temperate zone

The conditions necessary for the growth of temperate grasslands:

- Temperate grasslands require minimum light for the plants to make their own food.
- The temperate grassland requires moderate fertile, fine drained and humid soil.
- Temperate grasslands need average sunshine in a dry and cool winter time.
- Temperate grasslands require moderate rainfall of about 500 mm - 750 mm for the best growth of grasslands.

The characteristics of temperate grasslands are:

- Grasslands found here are short and juicy, which is suitable for cattle feed.
- The region is known for the growth of maize and wheat in large amounts. This explains why the area is known as "the bread basket" of the world.
- The perennial temperate grasses mostly belong to the family of "Gramineae".
- The steppes form the largest segment of the temperate grassland biome. Steppes are divided into: Forest steppes, Meadow steppes and grass steppes.
- America Prairies are divided into three sub regions: tall grass prairie, mixed grass prairie and short grass prairie.

Brief description of Temperate grassland areas:

- Based on the rainfall, the Pampas in South America (Argentina) are divided into two types: humid pampas in the Eastern part and Sub-humid pampas in the Western part of Argentina.
- Velds in South Africa are sub-divided into three types: Themed veld (altitude varies between 1500-2000m), Sour veld and Alpine veld (2000-2500) of the Drakensberg mountain.
- Dows grown in Australia are divided into three types:- Temperate tall grasslands found in the Eastern coast of New South Wales to Victoria and Tasmania. - Temperate short grasslands found in the North of the Temperate tall grassland region. - Xerophytic grasslands developed in the interior lands of New South Wales and Queensland where semi-arid climate prevails.
- Canterbury grasslands are extended especially over the Eastern and the Central part of New Zealand.

The temperate grasslands are associated with various economic activities which include: hunting, fruit gathering, rearing of animals, settlement, agriculture and gazetting of the national park and game reserves.

Application activity 9.4

Assess the contribution of Temperate grasslands to the economy of the countries where they are found.

9.5. Desert Vegetation

Learning activity 9.5

Observe critically the photographs provided below and answer the questions that follow:

1. Identify the nature of the types of vegetation in these two figures above.
2. Compare and contrast the geographical conditions shown on both figures.

Desert vegetation grows in the Western margins of the continents between 15° – 30° North and South of Equator. The iggest deserts are: Sahara and Kalahari in Africa, Thar in India, Arabia desert covering the countries of Saudi Arabia, Iraq, Iran, Syria and Israel, Atacama Desert (Peru and Chile), Southern California in USA, Sonora in Mexico and Victoria in Australia. Desert Vegetation is divided into two types, namely hot desert and cold desert vegetation or Tundra.

9.5.1. Hot desert vegetation

Hot deserts are located between the latitudinal belts of 15°-30° North and South of the equator. These deserts can be found in North America, South Asia, South and Central America, Africa and Australia. Hot desert vegetation experiences hot climatic conditions throughout the year. The rainfall is unreliable. This is caused by

the dry winds that blow over the area, leading to arid conditions. Such conditions leave behind very poor vegetation in the desert region.

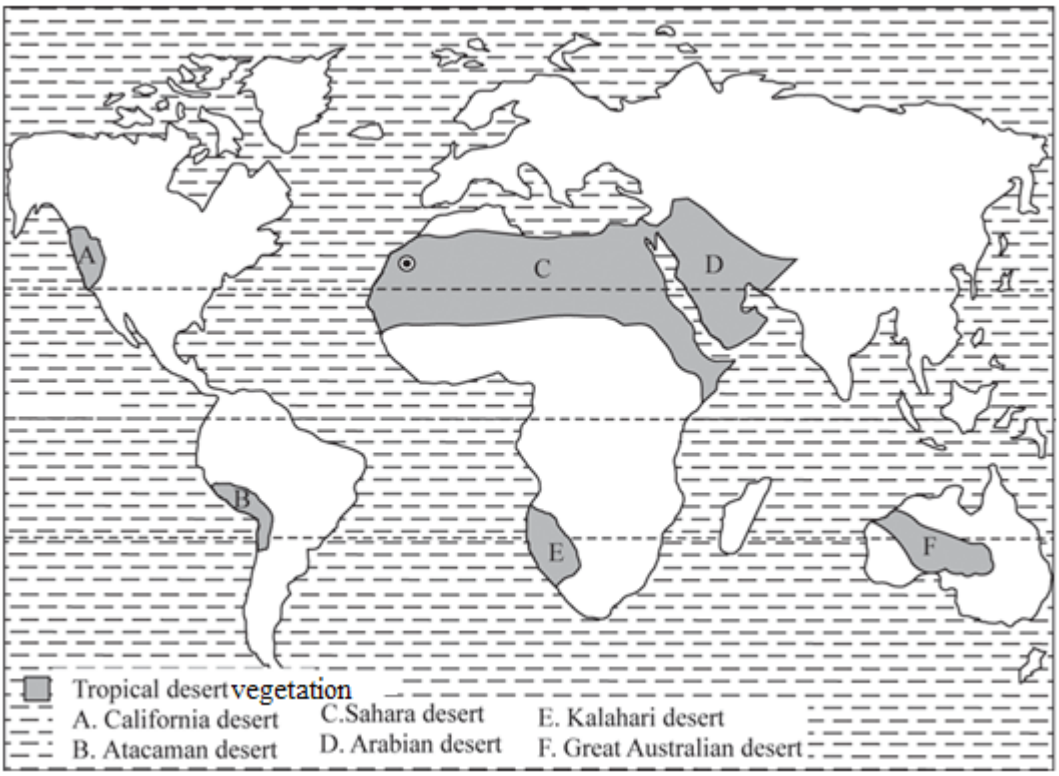


Figure 9.251: Hot desert vegetation

The conditions necessary for growth of hot desert vegetation:

- The presence of poor quality and infertile soils.
- Availability of about 250mm or less as total rainfall per year.
- The prevailing of high temperatures ranging between 290c and 310c to support the growth of plants associated with arid areas such s deserts.

Hot desert vegetation is characterized by the following:

- Plants in Hot deserts have small leaves, with sunken or restricted openings, pale and reflective leaves.
- There are a few plants with succulent stems, long roots and leaves.
- The desert trees shed off their leaves occasionally primarily to minimize on the water loss from the excessive temperature.
- Desert vegetation types especially the tree species grow long taproots to have access to water that is found deep in the underground water table.
- The main vegetation growing here is mainly thorny acacia, bushes, euphorbia and turfed coarse grasses.

– Some desert vegetation types grow no leaves in order to avoid excessive water loss through evapotranspiration.

9.5.2. Cold desert vegetation

The cold vegetation is located in high flat areas called plateaus. It is also common in mountainous areas in temperate regions of the world. Temperate regions lie between the Polar Regions and the tropics. Like other types of deserts, cold deserts get very little rain or snow and are mainly in the Northern part of Canada, North Russia, North Sweden and Finland islands in Arctic Ocean.

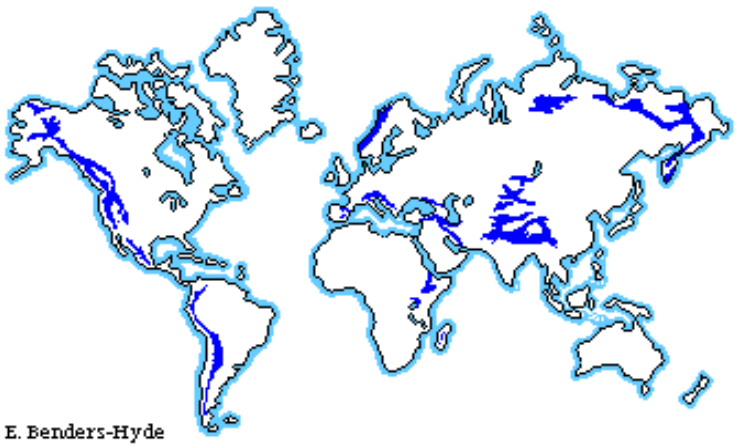


Figure 9.252: Location of cold desert vegetation

The conditions necessary for growth of cold desert vegetation:

– Cold desert vegetation needs low sunshine for its successful growth.
– It requires a combination of freezing temperatures, poor soil quality, lack of moisture and sunlight.
– This vegetation requires soils associated with relatively high soil salinity.
– The cold desert vegetation needs very little rain fall (of about 250 mm) during the summer season and snowfall during the winter.
– It requires areas characterized by frost conditions.

The major characteristics of cold desert vegetation include the following:

– Plants are widely scattered.
– The main plants are deciduous, mostly having spiny leaves.
– The cold desert vegetation grows in areas with large amount of snowfall in winter (and sometimes in summer).
– The cold desert vegetation experiences short and wet moderately warm summers.
– It experiences the mean average winter temperature that ranges from - 2 to 4º c.

– This vegetation receives a mean annual precipitation that ranges from 90 mm to 260 mm.
– The cold desert vegetation does well in areas with good drainage that facilitates the leaching of most of the salts.

The cold desert vegetation is associated with various economic activities that include tourism, mining and agriculture on small scale and establishment of the national park and game reserves.

Application activity 9.5

Referring to Sahara Desert, describe the impact of the desert vegetation and climatic conditions on the population settlement in any country around it.

9.6 Tundra vegetation

Learning activity 9.6

Observe the provided picture below and answer the following questions

1. Identify the type of vegetation shown on the photograph above.
2. Explain the characteristics of the vegetation identified in (1) above

The tundra vegetation is found in coldest regions of the world. The term tundra is derived from a Finnish word "tunturi" which means "treeless plain". It is among vegetation types that strive in the harshest conditions. This vegetation is found in the arctic region on top of mountains where climate is cold, windy and with limited rainfall. The tundra vegetation is found in regions that cover the areas of Alaska, parts of Russia, Northern Scandinavian countries and in some parts of Canada.

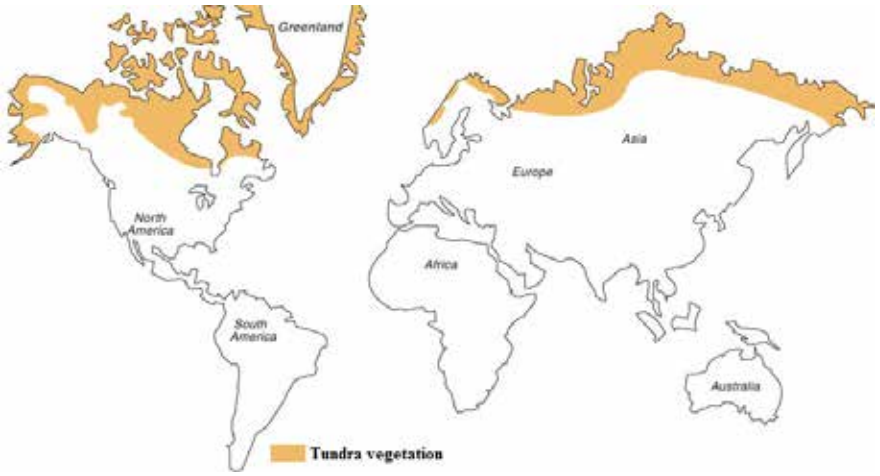


Figure 9.253: Location of tundra vegetation

The following are the conditions necessary for the growth of tundra vegetation:

- The Tundra vegetation requires winters that are cold, long and dark.
- It does well in regions that experience about 6 to 10 months with monthly temperatures below 32° F or 0° c.
- This vegetation needs limited precipitation and the existence of strong and dry winds.
- It requires snowfall conditions that support the survival of plants and animal life. It sometimes acts as a protection layer on the surface of the ground.

The characteristics of the tundra vegetation are as follows:

- There is a limited variety of trees.
- The vegetation arrangement is simple.
- The season of growth and reproduction is short.
- The drainage system is nearly limited.
- The nutrients and energy here is in form of dead and organic material.

The tundra vegetation is associated with various economic activities that include tourism which is associated with the following tourist attractions: Birds like ravens, falcons, snowy owls and snow geese and animals such as foxes, wolves and some smaller mammals like the lemmings and snowshoe rabbits. These areas also support hunting, oil exploitation and research and study.

Application activity 9.6

For either Russia or Canada, describe the necessary geographical conditions for the growth of the tundra vegetation in that country.

9.7. Mountain vegetation

Learning activity 9.7

Using your previous knowledge and geographical sources, answer the following questions:

3. Describe the mountain vegetation in the tropical zone.
4. Describe the characteristics of mountainous vegetation with reference to East Africa.

Mountain vegetation is categorized into two types; namely, tropical mountain vegetation and temperate mountain vegetation.

9.7.1. Tropical Mountain vegetation

the mountain vegetation has a variety of vegetation ranging from the tropical to the temperate types. On a typical Mountain slope, various vegetation types show clear demarcation zones. The savannah vegetation grows from the foothills, followed by the layer of tropical rainforests, bamboo forests, mountain heath and moorland.The rest is bare rock. This type of vegetation is traced in areas such as: Mt. Kenya, Mt. Aberdares, Mt. Kilimanjaro, Mt. Meru, Mt. Elgon, Mt. Cameroon, Mt. Ruwenzori, Mt. Virunga, Mt. Simien and Mt. Bale.

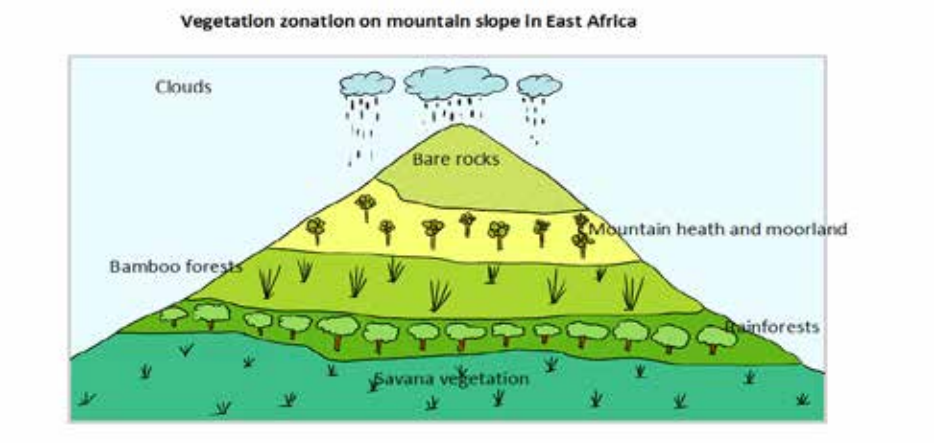


Figure 9.254: Zonation mountain vegetation

The conditions necessary for the growth of the mountain vegetation

- This type of vegetation requires the steep gradient.
- It needs well distributed rainfall characterised by humid conditions.
- It grows well in areas which generally are associated with strong seasonal differences.
- It requires temperature ranges of about 20° C at 900 m and 4°c in the summit region.
- It requires the annual precipitation of around 900 mm on the foothills, around 2000 mm at 1500 m and well above 3000 mm between 2000 and 2300 m on a windward side.
- It requires fertile soils that are well-developed with moderately acidic soil pH values, such as Andosol.

Characteristics of the mountain vegetation

- The vegetation on the mountain slope grows in clearly demarcated zones from the foothills to the summit.
- The mountain vegetation is dominated by tussock grasses and stands of giant rosette.
- The mountain heath and moorlands grow between the bamboo forests and the snow-line or bare rocks.
- The tree species, mainly of the lower canopy are the wild olive.
- Soils in the mountains are mostly young and fertile which favours the growth of trees.

- Above snow-line, plant life is always impossible. This is attributed to low temperature and the presence of eroded bare rocks that makes it hard for plant growth.
- In mountainous areas, the decrease in temperature with increasing altitude leads to the corresponding change in natural vegetation.
- The wet temperate forests are suitable between 1000 and 2000 mm.
- Temperate forests containing coniferous trees like pine, deodar, silver fir, spruce and cedar are found between 1500 and 3000 mm.

The mountain vegetation is associated with various economic activities. These include gazetting of the national park and game reserves, tourism etc.

9.7.2 Temperate mountain vegetation

The temperate mountain vegetation grows well in High Mountains of temperate regions. This grows best between 350 N and 600 N of the equator.

The temperate mountain vegetation is in the Alps, in Western Europe, in Norway, Sweden and Finland. Other traces of the temperate mountain vegetation can be found in California on the Rocky Mountain slopes, in British Columbia and Andes in South America.

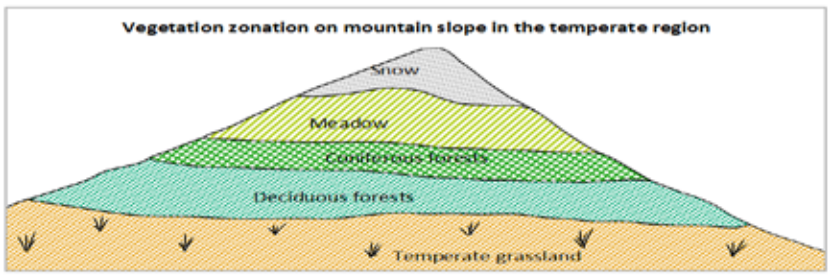


Figure 9.255: Zonation temperate mountain vegetation

Characteristics of the Temperate mountain vegetation

- Temperate mountain vegetation contains both deciduous and coniferous plant species such as poplar, birch, oak and elm.
- The vegetation arranges itself on the slope in clear demarcated zones.
- Some trees species grow a thick bark in order to store enough water to be used in the winter season.
- Tree species shed-off their leaves in winter when the temperature drops below 6° c.

– Tree species especially the coniferous forests adapt themselves to the climatic conditions by growing tiny needle-like leaves.
– Tree species become shorter and more dispersed towards the zones containing meadow.

Application activity 9.7

1. Explain the use of the mountainous vegetation with reference to North Rwanda.
2. Critically examine the role of the temperate vegetation to the economy of Switzerland

9.8. Aquatic, marsh and Swamp vegetation

Learning activity 9.8

Make a critical analysis of the photo below to answer the questions that follow:

1. Identify the type of vegetation shown on the photograph above.
2. From your own observation, describe the environmental conditions that influence the location and growth of the identified vegetation above.

(1) Mangrove vegetation

This is the type of vegetation that grows in marshy and swampy areas along the coast of East Africa. It is found in areas such as the coastal regions of Kenya and Tanzania, Deltas of the Ganga, Mahanadi, and Ganga Brahmaputra delta in India. The Mangrove vegetation is evergreen and grows along the coastal margins between 5o N and 5oS of the equator.

The conditions necessary for the growth of mangrove forests:

- They need average temperatures of the coldest month higher than 20°C. The seasonal temperature range should not exceed 5°C. They can tolerate temperatures of 5°C, but the development will be affected because they are not resistant to freezing.
- They need a large tidal range. This causes limited erosion and deposition of sediments.
- They need a fine-grained substrate. However, there could be some exceptions. This is the case in Papua New Guinea and Kenya, where the mangroves grow on corals.
- The shores must be free from strong wave action and tidal current.
- The mangrove vegetation requires swampy and marshy areas with deep soils which must be salty in nature.
- The mangrove vegetation requires a high temperature necessary for chlorophyll making.

Characteristics of mangrove forests:

- Mangrove vegetation have broad branches and leaves and they are evergreen.
- They are associated with saline soils with poor drainage.
- The dominating plants are trees.
- The mangrove vegetation grows butters roots.
- This type of vegetation has a long gestation period.
- They exist in areas with poor drainage and sufficient water supply. Such areas are waterlogged.
- They grow in areas that are hypoxic (oxygen deficient) waterlogged soil strata, with limited tidal pressures, strong winds and sea waves.
- Mangrove forest species survive under temperatures above 66° F (19° C). They do not tolerate temperatures below 18° F (10° C). However, temperatures below freezing should not occur for a long time.

(2) Aquatic plants:

The aquatic plants or vegetation is referred to as hydrophytes or macrophytes. These plants require special adaptation for living submerged in water, or at the water's surface. Aquatic plants can only grow in water or in soil that is saturated with water.

The following are the Characteristics of aquatic plants:

- They have reduced and shallow roots. The primary function of these roots is to anchor the plant to the ground.
- Plants that normally are submersed, typically form their flowers raised above the water surface.
- Some of the aquatic plants float on the surface of water with no attachment to the mud or bottom. These have inflated portions of leaves, stems, or special hairs that enable the plant to remain floating.
- Plants rooted in the mud have immersed leaves with photosynthetic stems. They also have relatively small leaves similar to those of typical leaves of terrestrial plants living nearby.
- They have real roots that link with underground roots. Such have numerous pores over their surfaces that allow gaseous exchange.
- The aquatic plants have structures that anchor as seaweeds to the substratum, such as the bottom layer or submerged bedrock.

Marsh vegetation:

A marsh is a wetland that is dominated by herbaceous rather than woody plant species. Marshes can often be found at the edges of lakes and streams. In such places they form a transition between the aquatic and terrestrial ecosystems. The marsh vegetation is dominated by grasses, rushes or reeds. Familiar examples of marsh vegetation include cattails, sedges, papyrus and sawgrass.

The following are the characteristics of a marsh:

- The mash vegetation grows in poorly drained water.
- The mash vegetation is a common characteristic of wetlands areas.
- The mash vegetation grows in both fresh and salty waters.
- The mash vegetation is found along the rivers and lakes.

Swamp Vegetation

The swamp vegetation occurs along large rivers where they are critically dependent upon natural water level fluctuations. When a swamp vegetation is dominated by forest, it is called a wetland. Some swamps have hammocks or dry-land protrusions, covered by aquatic vegetation or the vegetation that tolerates periodic inundation.

Characteristics of the swamp vegetation are:

- They are characterized by poorly drained soils and different plant life dominated by trees.
- The latter characteristic distinguishes a swamp from a marsh, in which plant life consists largely of grasses.
- They grow in waterlogged areas where there is sufficient supply of water which allows or stimulates the decay of organisms and prevents the accumulation of organic materials.
- They are often found in lowlands associated with rivers that supply the water to some lakes.
- The number of plant species in swamps is small. While the one found in areas associated with well-watered conditions and no waterlogged land,is sifignicantly great.

All swamp vegetation such as mangrove, mash, wetlands and aquatic forests, are associated with various economic activities. These include tourism, the hunting of large invertebrate sand waterfowl,the fishing of crayfish and mudfish. They are also used for research and study purposes. These support art and craft making.

Application activity 9.8

Clarify conditions that prove that the East African coast is dominated by mangrove vegetation.

9.9 The factors which influence natural vegetation

Learning activity 9.9

Make a field trip in your home area and observe types of vegetation. Use the results of your observation to explain the factors influencing their distribution.

There are various factors that influence the growth and distribution of natural vegetation. There is no single factor that plays a key role alone, but rather a combination of two or more factors. These factors include:

- Rainfall: the growth of vegetation depends on the amount of the rainfall. For example, Equatorial rainforests have evergreen and dense vegetation. On the other hand, places with low rainfall have scattered vegetation. This explains why there is little vegetation in deserts.

- Temperature: Forests found in cool areas have fewer tree species. Those in hot areas have more species. The cold mountain tops have heath and moorland.
- Relief and altitude: It has been noticed that with a rise in the altitude, the plants in the region show a stunted growth. Trees such as pine, silver fir, birch, and juniper fall in this category of vegetation. These contribute to variations in the vegetative zonation along the slope.
- Slopes: Areas on the opposite sides of mountains have different vegetation. Steep slopes have more runoff. Gentle slopes allow water to sink into the soil. Plants use this water.
- Soil types: This factor provides basis for different types of vegetation. The sandy soils in the desert support cactus and thorny bushes. Wet, marshy or delta soils support mangroves and other deltaic vegetation.
- Human activities: These include the settlement, mining, farming and livestock keeping. For example, vegetation is cleared to create space for building houses. Trees are cut for firewood and timber. New or artificial vegetation is planted.
- Drainage also determines the vegetation of a place. There are plants that grow best in areas of good drainage while others grow well in swampy conditions; for example the papyrus which only grows in swampy areas.

Application activity 9.9

Describe the influence of human activities on the vegetation distribution in Rwanda.

9.10. Importance of the natural vegetation

Learning activity 9.10

Make a field trip in your home area, observe the nature of the vegetation and explain its significance to man.

The following are the significance / importance of vegetation to man:

- Plants that form thevegetation are the main source of food for humans. Thisfoodisin theform of vegetables, fruits, grains, cereals, leaves, seeds and it consistsof carbohydrates, oils, proteins, vitamins and minerals.
- It provides construction materials; for example: trees are used for the construction of houses, bridges and poles.
- The vegetation helps regulate the flow of numerous biogeochemical cycles in the atmosphere, most critically those of water, carbon, and nitrogen. It also contributes in the local and global energy balances.

- The natural vegetation plays an important role in our ecosystem. Whereby, plants are known as the primary producers since they can manufacture their own food through the process of photosynthesis using sunlight.
- The natural vegetation provides man with a variety of products which include flowers, stems, roots, oil and many others. These are used to meet man's needs such as themaking of perfumes, cosmetics and aesthetic purposes.
- The natural vegetation provides food for some domestic and wild animals. Human beings also get food from some plants.
- The natural vegetation has contributed hugely to the world´s economy, particularly in the use of fossil fuels as an energy source. It provides thebiomass and some vegetation residuals are used to produce biogas.
- The natural vegetation provides timber for furniture. Items as beds, chairs and tables are made from timber. Timber is also used in construction activities.
- The natural vegetation plays a key role in soil formation. Their roots facilitate weathering.
- Dead vegetation becomes humus, which makes the soil fertile.
- The natural vegetation is also a natural resource thatprovides anumber of uses to man;i.e. the products like ropes, rubber, gum, papers, and wood used in themanufacturing of books, rope, tyres, and seatscome from the natural vegetation. Some plants have medicinal contents. Herbs are used in thetreatment of various diseases that threaten human lives as well as those of domestic animals.
- The natural vegetation is thesource of materials such as cotton,used in textiles and fabric materials to makefor humans.
- The natural vegetation such as forests and grasslands attract tourists. These pay (money) when they visit to see the animals and a variety of flora. The money is used to develop the social facilities like schools, hospitals etc.
- The natural vegetation helps clean or purify air through harvesting carbon dioxide from the atmosphere. Again, trees produce oxygen that human beings and animals use for theirsurvival.
- Places with forests receive more rainfall. This is through the process of transpiration.
- Areas with forests act as asource of rivers. These are called water catchment areas.
- Many people get jobs. They are employed as researchers, forest guards and forest officers.
- The natural vegetation makes the landscape beautiful.

– Tree and plant roots hold the soil together. Therefore, forests protect the ground (soils) against soil erosion, mass wasting and the general impact of heavy rainfall.

The natural vegetation has also the followingnegative influences on man:

– The natural vegetation associated with some pests such as tsetse flies and ticks which put the lives of people and animals at great risks, since they cause diseases.

– Some plants are thorny-leaved and they are harmful to human beings and animals.

– The natural vegetation is a homeplace for dangerous animals which may attack or harm human beings.

– Some plants are poisonous and may kill human beings and animals when eaten.

Application activity 9.10

Examine the value of the natural vegetation for thesustainable development of acountry.

End unit assessment

1. Discuss the distribution of the natural vegetation in the world.

2. Describe the relationship between vegetation and land use.

3. Draw a map of the world and on it, show the following vegetation types:
   – Savannah humid
   – Mediterranean vegetation
   – Desert vegetation
   – Mountain vegetation

4. How do the following factors influence the distribution of vegetation in Africa?
   – Variation in temperature.
   – Variation in relief

UNIT 10

POPULATION GROWTH IN THE WORLD

UNIT 10: POPULATION GROWTH IN THE WORLD

Key unit competence:

By the end of this unit, I should be able to discuss the problems of the population growth in the world and the ways of controlling it; explain the impacts of early sex, HIV/ Aids, health risks and STDS on the world's population.

Introductory activity

Population is one of the main complex issues in geography; its study is essential for proper national planning in relation to the provision of social services to the people. In general, today there is fear that the rate at which the population is increasing presents great challenges to the world resources.

1. Explain the term "population" and its related concepts.
2. Discuss the factors influencing the population distribution in any area.
3. Compare and contrast the population problems in developed and developing countries.
4. Describe the population policies that should be taken by the world countries to control such a rapid population growth.

10.1. Human diversities

Learning activity 10.1

The world population is composed of billions of people from different countries, speaking different languages, praying from different churches and having different cultures. This makes what geographers call "human diversity" in the World.

1. Referring to the statement above explain the following concepts:

   (i) Human diversity

   (ii) Race

   (iii) Languages

   (iv) Religion

   (v) Culture

Population

The term refers to the number of people living in an area at a given period. The study of population growth, density, distribution and movement is referred to as demography.

Human diversity

This is a term used to mean the existence of a wide kind of human beings with distinctive or distinguishing characteristics such as race, languageand political divisionwhich form different ethnic groups of people.This means that individuals are unique, and it is very important to recognize our individual differences. These can be along the dimension of race, religion, language and state.

10.1.1. Race

The term race refers to the similarities of genetic patterns among the aggregates of individuals of human populations. Race clearly expresses the varying genetic patterns expressed in the physical traits of human species. Races can be differentiated based on the following aspects:

- Hair types: People's hairs also differ. Some have black hair such as the Africans, others long and reddish hair suchas the Europeans and yet others have white, short or brown hair.
- Skin colour: People of the world have different skin colours. For instance, in Africa the majority of the people are black while others may be brown. In other continents, people are white and others are red like the red Indians.
- Climatic factors: Races are also differentiated basing on climatic location. For example, most people of the tropics are black and others though brown have black hairs.

Generally, two types of classification of races have been identified. These include the following:

a. Phenotypes: This is the classification criteria used while grouping or classifying human population into groups basing on their physical features.

b. Genotypes: This is also another classification technique used to classify population into groups basing on genetic origin of their physical traits.

10.1.2. Religion

Religion refers to a unified system of beliefs and practices that join all those who adhere to them into a single moral community. Indeed, religion is a unifying factor for the people with the same religious beliefs. For instance, some religions encourage people to join their religious affiliations or denominations.

Religion greatly sets grouping of population into varying classifications entirely based on their set of beliefs. There are various religions of the world and they include the following: Christianity, Islami, Hinduism, Buddhism, and many others. The following figure 10.260 shows the portions of the main religions in the world.

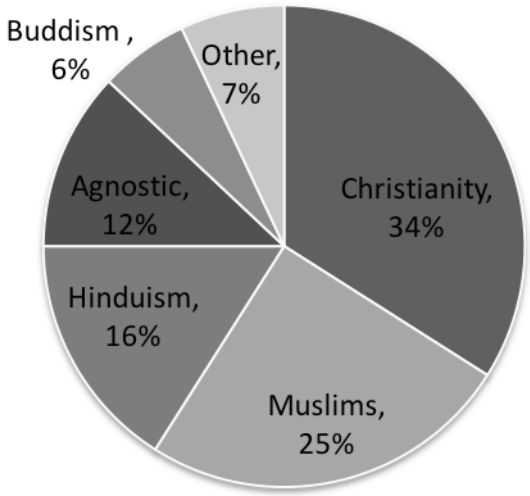


Figure 10.256: The number of adepts of main religions

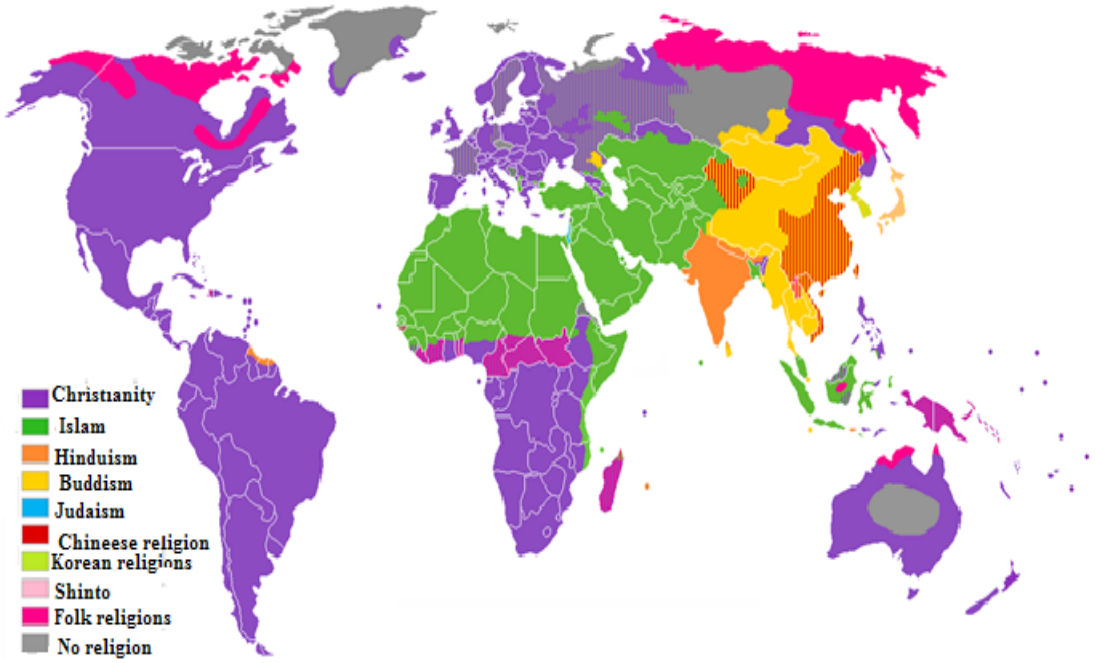


Figure 10.257: The world distribution of adepts of themain religions

10.1.3. Languages

This refers to any systematic method of communicating ideas, attitudes, or intent through the use of mutually understood signs, sounds, or gestures. The term language can also mean an organized system of spoken words by which people communicate with each other with mutual comprehension.

Various groups of people speak different languages. For instance, people in Rwanda speak Kinyarwanda, those of Burundi speak Kirundi, Kenyans speak Swahili, Ugandans speak Luganda and other languages etc. There are local languages spoken by a group of people within a country as well as national and international languages. Some people speak more than one language. The language acts as unifying factor that plays an important role inbringing people together. The languages can be classified according to the number of speakers as it is presented below:

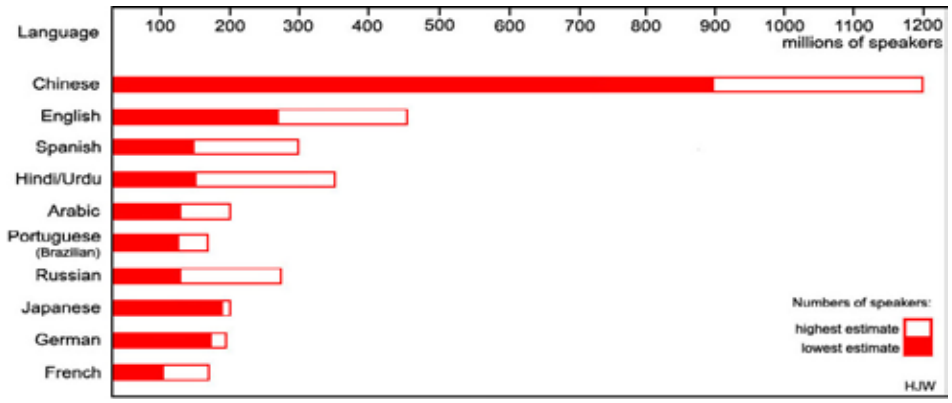


Figure 10.258: Ten top languages having more speakers (in 2012)

10.1.4. States

A state refers to a nation or territory considered as an organized political community under one government. In this case, a state is taken as a country. Nevertheless, in some cases a state is different from a country in political organizational structures based on federalism. A good example is the United States of America where a country is made up of union of 50 states. State expresses merely the actual organization of the legislative or judicial powers, i.e. people permanently occupying a fixed territory bound together by common habits and custom into one body.States have independent governments that administer them and control the people who are the registered citizens of them.

In 2017, the independent countries in the world were evaluated at 195, including South Sudan, which is the youngest country that got its autonomy recently. However, there are countries made of many states such asthe USA, India, and the United states of Arabs, the United Republic of Tanzania etc. The African continent is composed of 55 countries with South Sudan inclusive.

Application activity 10.1

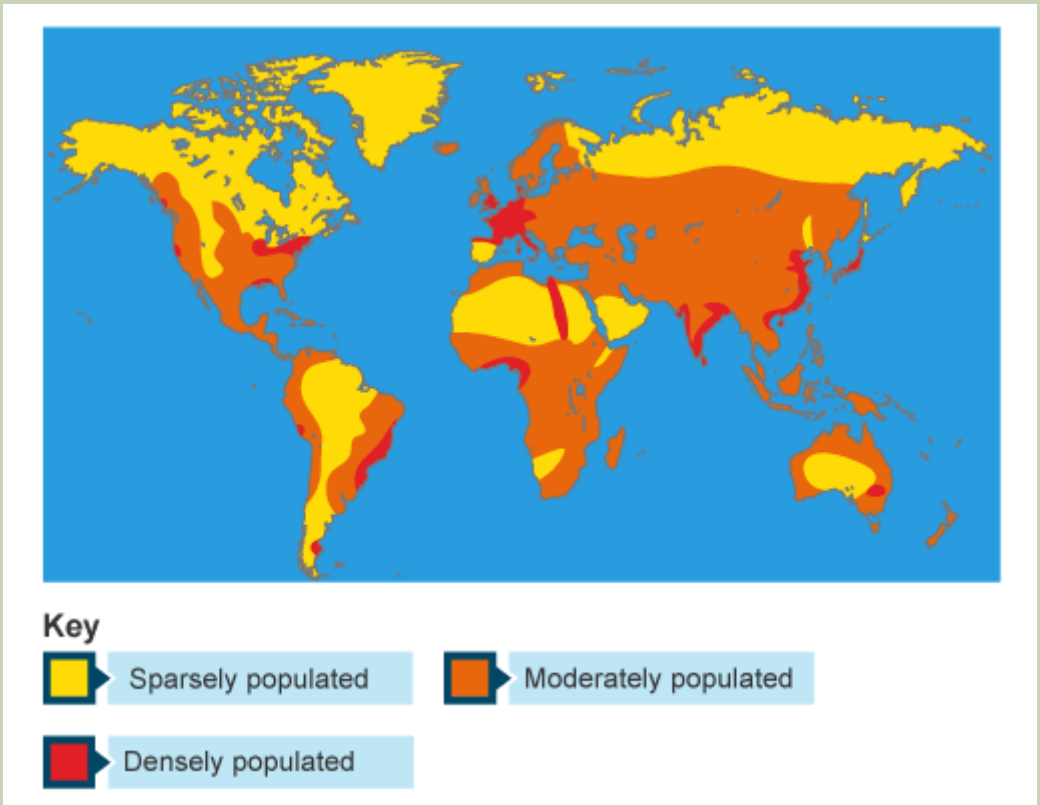
1. With typical examples from Africa, identify and describe the religions operating on the continent.
2. Examine the main aspects considered in differentiating the types of races.

10.2. World population distribution

10.2.1. Population density

Learning activity: 10.2

Critically observe the provided population map and answer the questions that follow:



With your own observation from the map above, identify the densely, sparely and moderately populated regions of the World.

The world population distribution describes how people are spread out across the globe. The population is not spread evenly. Some locations are sparsely populated while others are densely populated. Arid regions or areas associated with rugged reliefs have low population while others are completely unsettled. The world

locations with flatter land, good soils and mild climate (for example the Ethiopian highlands and the Nile valley in Egypt) are more densely populated.

Population distribution is the spread of the people across the world. It describes the pattern of where people live. There are places which are sparsely, moderately and denselypopulated.

Table 1: Top ten most populated countries in the world (2018)

	Countries	2000 population	2018 population	Growth % Pop 2000 - 2018
1	China	1,268,301,605	1,415,045,928	11.6 %
2	India	1,006,300,297	1,354,051,854	34.6 %
3	United States	282,162,411	326,766,748	15.8 %
4	Indonesia	214,090,575	266,794,980	24.6 %
5	Brazil	174,315,386	210,867,954	21.0 %
6	Pakistan	152,429,036	200,813,818	31.7 %
7	Nigeria	123,945,463	195,875,237	58.0 %
8	Bangladesh	128,734,672	166,368,149	29.2 %
9	Russia	147,053,966	143,964,709	- 2.1 %
10	Mexico	99,775,434	130,759,074	31.1 %
To ten Countries		3,597,108,845	4,411,308,451	22.6 %
Rest of the World		2,547,898,144	3,223,449,481	29.6 %
Total world population		6,145,006,989	7,634,757,932	25.5 %

Population density is a measurement of the number of the people in an area. It is an average number. Population density is calculated by dividing the number of people by area. Population density is usually shown as the number of the people per square kilometer. The World population distribution includes the following categories:

(i) The densely populated areas:

These are the regions with more than 100 people per square kilometer:

- East and south East Asia: This region includes countries like Singapore, China, India, Bangladesh, Japan, South Korea, the Philippines and Taiwan.
- Central and Western Europe: This includes countries like Germany, the United Kingdom, France, Italy, Belgium and the Netherlands.

- The Caribbean countries: These include Jamaica, Trinidad and Tobago, Cuba, West Indies and El -Salvador, Eastern USA and south eastern Canada.
- Nile valley and delta which is located in Egypt.

(ii) The moderately populated areas:

These are the regions which have between 25 and 100 persons per square km. They are usually dominated by agricultural occupations and typical examples include Australia, Brazil, USA, Argentina and Chile etc.

(iii) The sparsely populated areas:

The sparsely populated areas are the regions with few people per square kilometre. They include Sahara, Atacama, Kalahari and Australian deserts. There is also sparse population in the high mountain ranges; for example: the Himalayas, the Rockies, the Andes, the Alps and the dense forests of equatorial regions in the Amazon, Congo and the outlying islands of Indonesia.

10.2.2. Factors responsible for the distribution of population in the World

The population of the world in general is unevenly distributed. This is attributed to a number of factors. These factors include the following:

- Reliable and adequate Rainfall: There is a close relationship between the areas of high rainfall and the population distribution. Areas that receive high and reliable rainfall over 1500 mm attract high population densities because they are suitable for the agriculture.
- Soils: Areas blessed with fertile soils encourage the growth of a variety of crops; hence food and employment. This explains why such areas attract many people.
- Pests and diseases: Areas associated with pests such as tsetse flies and ticks discourage the settlement. Many people fear to live in areas known for their pests since they cause diseases like trypanasomiasis and East coast fever that discourage farming and settlement in some areas. Such places are therefore sparsely populated. Good examplesareBunyoro and Miombo woodland areas (in Uganda and Tanzania respectively).
- Altitude: This refers to the height of the land above the sea level. Altitude has an influence on the population distribution. Example from 2700 m above the sea level, temperatures are extremely cold, which discourages the settlement. There is also severe soil erosion at this altitude.
- Vegetation: The natural vegetation of an area is also an important influencing factor on the population distribution. Dense forests, bush land, deserts and swamps are unfavourable areas for the settlement; while grasslands are easy to settle, thus capable of attracting high population densities.

- Relief: The rugged areas or mountainous landscapes discourage the settlement. For instance, the rift valley and lowlands, especially along the rivers, are unfavourable for human settlement; while some gentle sloping areas are easy to work and build and hence attract more people.
- Slave trade that led to the depopulation of various areas of origin and led to increased population to the areas where slaves were taken.
- Migrations: The internal migration such as rural-urban migration leads to an increase in population in urban areas, and the rural-rural migration may influence the population distribution too. The influx of refugees from other countries results in increased population in the receiving countries. For example, the Northern part of Uganda has had its population increased as a result of the refugees from SouthSudan.
- Civil wars: This is one of the serious factors that have influenced the population distribution on the African continent and the world at large. Countries such as South Sudan, Somalia and the Democratic Republic of Congo have had their population reduced because of civil upheavals. In some countries tribal clashes push people away from their homelands to other places. For example in some parts of Kenya´s Rift Valley Region.
- Government policies: Some areas may have reduced population because of the government policies prevailing. Land is set aside for the establishment of national parks or the construction of dams, whereas some policies such as the establishment of irrigation schemes in dry lands or settlement schemes lead to the population increase.
- Industrialization: Industrial towns like Nairobi, Kigali, Kampala and Kinshasa have large industrial establishments producing chemicals, foodstuff, plastics and textiles which attract people for paid employment, hence a high population. However, their demarcated areas for theindustrial establishment may result in thedisplacement of people.
- Energy resources and minerals:Energy resources and minerals attract people to settle in a given area. Minerals like coal in their prime age have greatly influenced the pattern of population distribution in countries like Great Britain, France, and Germany. This is because of the employment opportunities that are created and other social benefits or advantages.
- Historical factors:Areas that were occupied by kingdoms, especially thosenear the King's palaces, attracted a high population due to security. For example, the central part of Uganda where the population is high, the large population is attributed to the presence of the king's palace that marked a centre of attraction to many people.

- Economic factors. The economic viability of an area lies in its carrying capacity and its ability to provide employment opportunities. This in turn affects not only the size of the population but also its spacing. A specific economic system tends to arrange people in a specific distributional pattern.
- Transport and communication:The establishment of roads, railways and communication lines attract dense population due to theaccessibility of the area.
- Political factors:Political factors have a great influence on thepopulation distribution and density in different areas. For example, countries that are politically stable attract a high population, whereas political instability in some countries can cause thepopulation displacement and migrations.
- Demographic factors:The changes in the distribution and density of thepopulation in the world take place through variations in the rate of natural increase (fertility and mortality rates). Developing countries that have a high birth rate will always have a high population growth leading to a high population density.
- Natural hazards and disasters:Areas known to be prone to earthquakes, landslides, volcanic eruptions, floods, glacial advances, storms, epidemics, fire, and severe droughts discourage thesettlementand will therefore have sparse population than theregions that are free from such challenges.

Application activity 10.2

1. With the aid of a drawn sketch population map of the world, identify the densely and sparsely populated areas.
2. Explain factors controlling population distribution in Rwanda.

10.3. Population concepts and related effects

10.3.1. Optimum population

Learning activity 10.3

Worldwide, areas with favourable climatic conditions, abundant natural and water sources, fertile soils, social amenities, security and political stability tend to pull people to settle there and, therefore, being over crowded areas. On the other hand, areas with unfavourable climatic conditions, infertile soils, poor drainageand limited social facilities tend to limit population settlement, hence being less populated areas.

1. Why is under population undesirable in a country?
2. Referring to the above passage, explain the following population concepts:
   - Optimum Population
   - Under population
   - Overpopulation

The term optimum population refers to a situation where the resources available can satisfactorily support the existing population in a state of equal balance and sustainability. This takes place where the population and the resources are equal. Optimum population is considered as one that lies within the limits, large enough to realize the potentialities of human creativity to achieve a life of high quality for all the inhabitants, without affecting the existing ecosystems.

In other words, the optimum population can be regarded as that state of equilibrium between the population and the resources, which satisfies the well-defined needs of all the members of a community and which varies both in time and space.

The following are the major characteristics of the optimum population:

- The optimum level is that size of the population which yields the highest quality of life. A life described by adequate food supplies, energy, water and other social facilities that are enough to satisfy the needs of people.
- The presence of the highest per capita output characterised by the marginal productivity of the labour exceeding the average productivity and where the rates of growth to the total production are the highest.
- The availability of enough employment opportunities. That is, where every person fit to work is able to find a job.
- Having a very low dependency ration that is not over-burdening the working class or straining the national budget.

The basic criteria for assessing the optimum population include: per capita production, average standard of living, degree of employment, longevity of life, dependency ratio, social harmony, family stability, attainment of knowledge, growth of purely intellectual functions, per capita food consumption, proportion of expenditure on food, rationality of land use, balanced demographic structure and rational development of resources.

10.3.2. Under population

Under population is a situation whereby the size of the population is small in relation to the available resources of the country. It is a situation where the size of the population is below the available resources, hence they under-utilize the available resources.

(i) Positive effects of under population

The following are positive effects of under population:

- No Congestion: A country with less population experiences little or no congestion.
- Employment opportunities as a result of the small size of the population. There will be enough job opportunities for the people.
- Increase in social and infrastructural facilities: an under populated country experiences higher production per capita (in terms of social and infrastructural facilities available to the people in the country).
- Availability of idle resources: The fact that a country is less populated means that the resources available in that country are higher than the number of people. Hence, many idle resources would abound everywhere.
- Low pressure on social amenities: Owing to the low population, there is also low pressure on the social amenities in the area.

(ii) Negative effects of under population

The following are negative effects of under population:

- Underutilization of resources: Resources are highly underutilized in a country with low population. This means that the resources will not be economically utilized.
- Shortage of enough people to defend the country: At times of war and emergency, a country might find it difficult to mobilize enough people to defend itself.
- Shortage of labour force: This is one of the effects of under population. The shortage of labour force results in failure to exploit the available natural resources, capital stock and technology.

- Lack of specialization: Under population makes specialization impossible. As the supply of labour is limited, specialization and rationalization schemes cannot be undertaken.
- Low per capita income: The underutilization of resources in the under populated countries leads to a low per capita income.

10.3.3. Overpopulation

This refers to a situation where the number of existing human population exceeds the carrying capacity of the country or an area.The economic development of a country depends largely on the quantity and quality of the population. Therefore, when there is over population, resources become scarce and other negative effects set in. Such a situation reduces the quality of life and the government spends much addressing the social challenges instead of developing the economy. The following are the effects of overpopulation:

- Food shortage: Overpopulation results in food shortage. This is one of the serious effects associated with overpopulation. It becomes too costly to purchase the food stuffs because of high demand.
- Unemployment: The excessive population leads to massive unemployment. This results from the lack of proper economic development, since much is spent on solving the social challenges such as birth control and the purchase of medicine among others.
- Fall in the efficiency of labour: When the population increases after a particular stage, the number of labour also increases. As a result, each labour gets fewer amounts of capital and this leads tothe fall in the efficiency of labour.
- Increase in dependents: Overpopulation implies the increase in population beyond a particular level. Birth rate increases due to overpopulation. The size of the working population becomes less when compared to the size of the children and old-aged persons. As the dependence ratio increases,it undermines the future investments since the working class spend every income they get to sustain people that depend on them. Therefore, little is saved.
- Pressure on the land increases: The excessive population brings pressure on land. As a result, the marginal productivity of the additional labourers is zero. Eventually, the average productivity of labour and land remains less.
- Decline in standards of living: Over population leads to the shortage of the necessary or essentials of life. There occurs the shortage of foodstuffs, scarcity of houses, spread diseases, uncontrolled migrations and high cost of living. All result in a decline in the standards of living of the people.

- Inflation: The overpopulation results in the growth of inflationary conditions in the country. As the output and productivity in different sectors fall, and as the demand for various goods and services increases, prices of goods and service rise up.
- Limited transport: This is increased pressure on transport and communication facilities or services. It leads to the wastage of time and in some cases business becomes stagnantly developed. The funds that would be used to establish new roads, railway lines and other related services are used to cater for urgent challenges such as the control of diseases, crime cases etc.
- Limited educational facilities: Over population results in the lack of financial resources to invest in education due to the ever-growing population.
- Over exploitation of natural resources. There is over utilization of the resources of all kinds. This results in the depletion of some resources and forests are cleared too. The swamp and wet lands are reclaimed. All these put together result in environmental degradation.
- Housing facilities: The overcrowding results in the development of slummy areas and their associated evils such as immorality and drug use.
- Diseases: The overpopulation leads to the congestion and easy spread of disease such as dysentery, cough, cholera and others.

Application activity 10.3

1. Basing on the examples of Rwanda; discuss the effects of over population to the economic development of a country.
2. With clear examples, identify thenegative effects of under population.

10.4. Population problems of developed and developing countries

Learning activity 10.4

Read and analyse the passage below:

The developed countries are characterized by high levels of industrialization and urbanization, high per capita income, dependence of a major part of the workforce on secondary and tertiary activities, and an efficient and productive agricultural sector. Unlike developing countries which are characterized by low level of technology, low level of skilled labour, poor infrastructures, low level of industrialization, low income per capital etc.

Referring to the above passage:

(a) Explain the characteristics of developed countries.

(b) Explain the challenges faced by population in developing countries.

10.4.1. Population problems of developed countries and their solutions

The developed countries experience various challenges in relation to their population as indicated below:

- High proportion of old age population: As the birth rate is low, the proportion of younger people in the population is relatively small. The low death rate and high life-expectancy mean that there is an ever-increasing proportion of older people in the population. Many retire from active work in their sixties and then become dependent on the working population. The provision of pensions and other facilities, e.g. extra health services, for elderly people pose financial problems.
- Shortage of labour: The improved standards of education has resulted in children remaining longer at school and joining the workforce later. This implies that there will be slow expansion of the workforce. In addition, the low population growth leads to the shortage of labour force. As a result, many countries of Europe face the shortage of labour. High wage rates disrupt the overall economic pattern.
- Congestion in towns: The increased expansion of urbanization has caused high pressure on the civic amenities, transport, housing etc. The effects of this (pollution and social tensions) lead to heart diseases, breathing problems, lung and skin problems etc.
- Development of slum areas: The unregulated growth of urbancentres leads to the growth of slums, which creates many social and environmental problems. The highly productive agricultural land is encroached by urban houses, roads and industries.

- Rural depopulation: Towns provide amenities such as shops, entertainment and better social serviceswhich cannot be matched in the country districts; and the employment is usually easier to find in urban areas. This has influenced the rural youth to migrate to urban centres, yet these would be the ones to develop the rural economy. There is stagnant rural economy.
- Congestion in towns: There increased expansion of urbanization which has caused high pressure on the civic amenities, transport, housing etc. the effects of this such as pollution and social tensions lead to heart diseases, breathing problems, lung and skin problems etc.
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- Rural depopulation: Towns provide amenities such as shops, entertainment and better social services, which cannot be matched in country districts, and employment is usually easier to find in urban areas. This has influenced the rural youth to migrate to urban centers, yet these would be the ones to develop the rural economy. There is stagnant rural economy.

The following are some of thesolutions to the problems of thepopulation in developed countries:

- Most developed countries are now encouraging and promoting vertical expansion through setting up skyscrapers.
- Federal and state governments continue to invest many capital and skilled resources in thedevelopment of social infrastructures and housing facilities.
- Most developed countries like USA continue to strengthen theirimmigration operations worldwide as a means of controlling illegal immigrants entering the country.

10.4.2. Population problems in the developing countries and their solutions

The developing countries experience various challenges in relation to population as indicated below:

- Low levels of technological development: This is directly linked to low productivity levels in the countries of Sub-Saharan Africa, South East Asia and Latin America. Low productivity refers to the slow economic growth, which is the root cause of rapid population growth in these countries.
- Low standard of living: This is the strange case of many countries having abundant natural resources but lie untapped economically. In such countries poverty remains an active descriptor of their economies.

- Rapid population growth: This is because of improved health facilities and reduced mortality rates. This younger section puts tremendous pressure on a comparatively small working population.
- Lack of diversification of economy: The lack of development of secondary and tertiary sectors leaves limited employment opportunities for the skilled and educated people. These most commonly move to more developed towns or to foreign countries in search for better job opportunities.
- Under-nourishment and lack of hygiene: Due to low standards of living, the incidence of diseases is high, leading to high rates of mortality especially among the children and pregnant mothers.
- Inefficient agricultural sector: The developing countries are characterized by the subsistence agriculture with traditional and backward methods of production leading low productivity.
- Weak industrial base: The lack of capital, out-dated technology and inadequate skilled work force have resulted in a weak industrial base in most of the developing countries. This has prevented any substantial improvement in the living standards of the populations of these countries.
- Tradition-bound societies: The inward looking attitudes restrict the flow of awareness as regards birth control, family planning etc. Standing systems inhibit the social mobility in different societies.
- Unfavourable physical conditions: Many of the under populated countries have hostile climatic or topographical conditions. Such conditions obstruct the development and it is both difficult and expensive to overcome these problems.

The following are some of the solutions to the problems of the population in the developing countries:

- Rehabilitation: An alternative to this scheme is to provide the residents of shantytowns with the materials to improve their existing shelters. Residents are also encouraged to set up community schemes to improve education and medical service. For instance, Bolivia and Pakistan.
- Sewage rehabilitation: Several cities have been repairing water and sewerage pipes and this improves the safety and quality of water in the city and reduces mortality rates.
- Encouraging the population migration from urban areas to rural areas of the same country. This is done through the beautification of rural areas.
- Setting up social - economic infrastructures such as education, health and transport networks.

- Through the modernization of agricultural sectors as a means of increasing their productivity and output. That is the use of the best seeds and fertilizers to boost agricultural output and check on the issue of food shortage.
- Family planning and education has helped in reducing the rapid population growth.
- Government policy that aims at establishing house facilities, especially in town areas, to improve on the housing facilities.

Application activity 10.4

3. Compare and contrast the population problems associated with developed and developing countries.
4. Referring to Rwanda, propose possible remedies to curb the problems identified in (1) above.

10.5. Population growth

Learning activity 10.5

Read the passage and provide answers to the questions that follow:

Population growth can be explained as the average annual percent change in the population, resulting from a surplus (or deficit) of births over deaths and the balance of migrants entering and leaving a country. The rate may be positive or negative. The growth rate is a factor in determining how great a burden would be imposed on a country by the changing needs of its people for infrastructures (e.g., schools, hospitals, housing, roads), resources (e.g., food, water, electricity), and jobs.

Identify the factors that affect the rate of the population growth and explain why this is an important aspect in population studies of a given area.

Population growth rate: Population growth rate refers to the change in population over a unit time period, often expressed as a percentage of the number of individuals in the population at the beginning of that period. This can be calculated using the following formula:

$$\text{Population growth rate} = \frac{(Births\text{-}Deaths)+(immigration\text{-}emmigration)}{Total\ Population} X100$$

A positive growth rate indicates that the population is increasing while a negative growth rate indicates that the population is decreasing.

10.5.1. Factors influencing birth rate

Birth rate is the total number of live births per 1000 in a population in a year or period of time.

Birth rate $= \frac{Number\ of\ live\ births}{Total\ population} X1000$

Birth rate is influenced by different factors that include:

- Social and religious beliefs: for example, Islam allows polygamy and Catholics do not support abortion.
- Economic prosperity: (although in theory when the economy is doing well families can afford to have more children; in practice, the higher the economic prosperity the lower the birth rate).
- Poverty levels: Children can be seen as an economic resource in developing countries as they can earn money through dowry.
- High mortality rate: A family may have more children if a country's mortality is high. Families produce more since some are expected to die.
- Limited health facilities which limit easy accessibility to the use of family planning techniques.

10.5.2. Factors influencing death rate

Death rate is defined as the ratio of deaths to the population of a particular area or during a particular period of time, usually calculated as the number of deaths per 1000 people in a given year.

Death rate $= \frac{Number\ of\ deaths}{Total\ population} X1000$

Death rate is influenced by different factors as follows:

- Limited medical facilities and health care increases death rate.
- Low nutrition levels and poor feeding lead to malnutrition which results in high death rate.
- Poor Living standards due to high poverty levels reduces the life span and results in high death rate.
- Lack of clean drinking water that leads to easy contamination of contagious diseases.
- Low level of hygiene caused by poor sanitation conditions, thus enhancing death rate.

- Social factors such as conflicts and levels of violent crime. This leads to death of many people unselectively.
- Wars in different countries have led to high rate of death. For instance, Somalia, Southern Sudan, Nigeria, Syria and Afghanistan.

10.5.3. Factors influencing the rapid population growth

Below are some of the factors that could influence the rapid population growth rate:

- Improved health care which has reduced mortality rates by diagnosing health problems in a timely manner. This includes also the use of vaccines which has helped to prevent illnesses that used to kill many people in the past. As a result, this has helped in saving the lives of many people.
- Introduction of better farming techniques. This has boosted the production of food. In addition, efforts toward food security have been successfully implemented in many countries. Areas that were associated with deaths caused by drought and famine can now get enough food supply, thus saving lives.
- Increase in the fight against poverty has also contributed to population increase. In the past, only a few families had enough money to support themselves while many faced various problems including health issues due to poverty. Many homesteads are able to meet medical charges, which has saved many lives.
- Immigration has also contributed in the population growth in developed countries and urban centres. Many people immigrate to other countries in search for better living standards. This has led to an increase of population in many developed countries.
- Poor family planning in many families is one of the major causes of the high population growth. Many families tend to have many children, and yet they cannot support them.
- Children are regarded as a religious duty: Many people have the religious belief that having children is regarded as a holy and religious duty of the married couple.
- Malnutrition which caused many people to die every day. Parents are not sure that all of the children can survive. Therefore, they want to give birth to as many children as possible.
- Polygamy is also one of the causes of the population increase. A man gets married to multiple women, and these women give birth to more babies. This is associated with the cultural and traditional beliefs in developing countries.
- Cultural factors also may cause high birth rates. Many people do not want to apply the measures of family planning. They think it is unholy to use family planning measures to prevent conception. They believe that the birth of a

child is a gift from God. Therefore, they do not want to stop births.

- The social and religious values and customs are mainly based on the traditional attitudes of people. Parents do not get respect in the society if they have no children, especially a son. It is the conservative belief that the son is necessary to inherit the parental property, continue the family line and perform the funeral rites.
- Artificial population increase. This arises from incoming migration of refugees. In Africa, Latin America and Asia, the natural phenomena such as war, flooding, famine and landslides, force many people to move to other places. Therefore, these massively displace people causing a rapid increase in the population of the receiving country.
- Level of education: Families that are educated prefer to have fewer children. In addition, people take long at school and come out at about 25 years; this lowers the reproductive and fertility rate than a person who dropped out of school and married at 16 years.

10.5.4. Effects associated with rapid population growth

The following are some of the effects of the rapid population growth:

- Available facilities become insufficient for the growing population. It leads to the falling of living standards.
- It is difficult to provide suitable employment opportunities for all. The result is large-scale unemployment which also causes the living standards to decline
- Natural resources are over-utilized and their quality degrades. Eventually, they are depleted.
- The environment is polluted and environmental problems occur.
- Crimes such as robbery, theft, murder and abduction increase and this leads to the killing of people. In the struggle to search for better life, some people may resort to stealing and breaking commercial banks.
- It will be more difficult to meet the basic needs such as food, shelter, clothing, education and health services.
- If the population increases rapidly, there is unemployment problem in the country.
- Due to the rapid population growth, there is deforestation for agriculture and settlement since more land will be needed.
- Land shortage which results into land fragmentation, conflicts, food shortage and famine.
- Heavy strain on government expenditure in the provision of social services and others such as the importation of drugs and food to sustain the population.

– High population growth rate results in great dependency burden. This leads to the low saving of capital, low capital accumulation and low investments; which results in the slow economic development of a country.

10.5.5. Ways of controlling population growth

The following are some ways of controlling population growth:

– Family planning: Family planning is to ensure that a woman gets a child when she actually wants one. It reduces accidental pregnancies and ensures a controlled family size.

– Raising the level of education: Education particularly that of women is very important in population control. Education changes the cultural beliefs and attitudes of people.

– Increasing employment opportunities for women: As more women join career jobs, they tend to be occupied by work. This limits the chances of having more children.

– Increasing income: Increased income results in greater demand for durable goods such as electronic goods, houses and furniture (instead of children). This increases the expenditure for families, which may influence them to consider the importance of having manageable family sizes.

– Increased security in old age: In some communities where children are regarded as security in old age, the introduction of pension schemes, insurance schemes and income for old people, can substitute as security for the old age. This can be more effective if more efforts are made to ensure that more people join the National Social Security Fund.

– Enacting child labour laws: Where children are regarded as suppliers of labour, strict laws should be enforced to restrict the minimum age for child employment. For instance, laws should be enacted to make it illegal for anybody to employ a child below the age of 16.

– Balanced economic growth: This should be through the decentralization of industries and other economic activities. It ensures better regional income distribution and it removes pressure from a few urban centres. When people get employed in such industries, they have limited time to spend at home,which could assist in the creation of manageable family sizes.

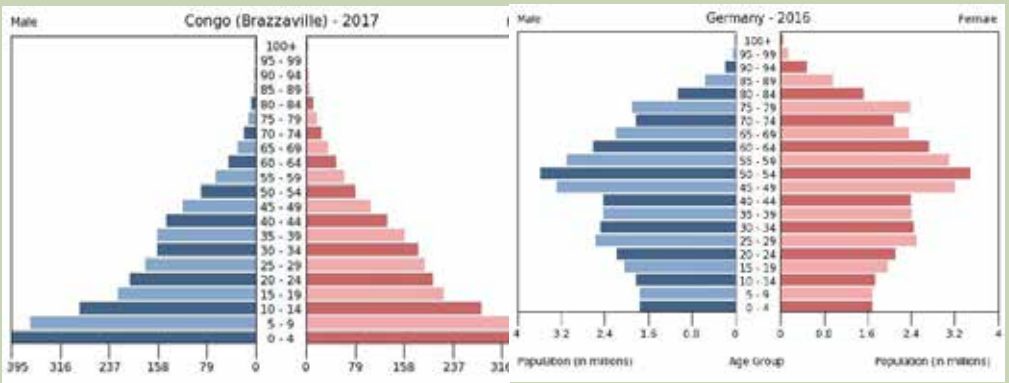
Application activity 10.5

1. With reference to specific examples, discuss the impacts of the population growth on the environment.
2. Explain the appropriate population control measures that can be used in Rwanda.

10 .6 Population structure and the composition

Learning activity 10.6

Observe the population pyramids of Congo (Brazzaville) 2017 and Germany in 2016



Referring to sex and age group graphs shown, describe the nature of the above population pyramids.

Compare and contrast the population pyramids of country A and country B.

Population structure refers to the composition of the population of a region. It relates to the age and sex of the population. It shows the population structure of a given region.

Population Pyramid: A population pyramid shows the age and sex structure of a country. In addition, it is a type of graph that is divided into males and females and then age groups in correspondence to their totals.

(i) Sex composition

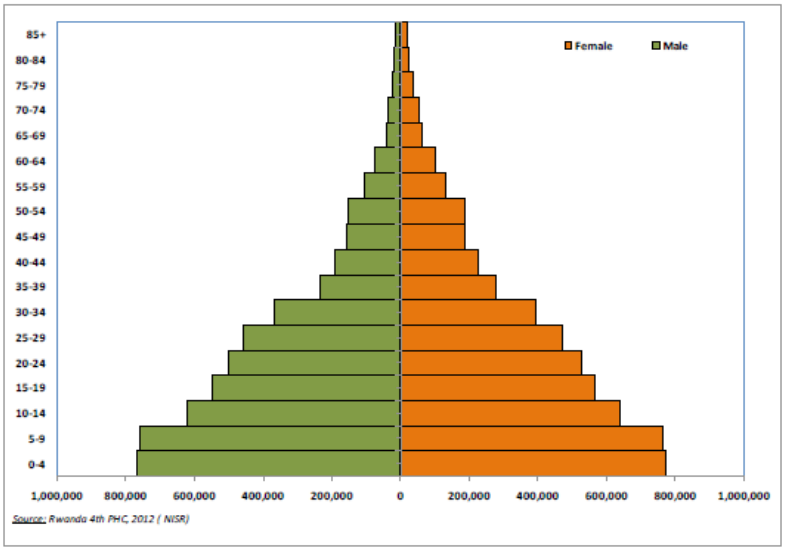
Communities differ in sex composition,i.e. the composition of male and female. Sex ratio is an index linked with the socio-economic conditions of an area. It is an important tool for regional analysis. It has a profound effect on the demographic structure of a region. It is a function of three basic factors: sex ratio at birth, sex ratio at death and sex-selectivity among migrants.

- Definition of sex Ratio:Sex Ratio is the ratio of males to females in a population. It is calculated using the formulae $\frac{Pm}{Pf} X100$
- Measurement of sex composition of a population:The numerical measurement of sex composition of a population is often expressed in terms of sex. The number of male population is expressed and calculated as $\frac{Pm}{Pt} X100$, while the female population is expressed and calculated as $\frac{Pf}{Pt} X100$

(ii) Population age composition

The proportions of children and older persons have much to do with the balance of national expenditures on schools, childcare, immunization and reproductive health, as against the expenditure on old-age, social security systems and health care for chronic and degeneration diseases.

- Measurement of age structure:The age structure of a population can be analysed in a number of ways. The most commonly used method is the one in which the percentage of the population distribution in various age groups is worked out.
- Age groups:Generally, the population is categorized into three broad age groups; the young, the adults, and the old. Thus, the three broad age groups that emerge are 0 to 14 (young), 15 to 59 (adults) and 60 and above (old).
- Age pyramids:One of the most commonly used methods of analysing age composition is the age pyramid, which is commonly known as age and sex pyramids. The age pyramids are constructed for portraying the age structure of a population along their vertical axis. In such pyramids, age groups at a regular interval 'say 5 years', starting from 0 to 4 and ending according to the age structure of the population under review.
- The horizontal axis of such pyramids represents the total population or the populations of males or females that are expressed in percentages. The horizontal axis represents males and females separately. The pyramid is divided vertically into two halves, the right side representing the females and the left side catering for males.



Source:*Rwanda 4th PH-C,2012(NISR)*

Figure 10.259 The sex-age pyramids of Rwandan population (2012)

(iii) Active and inactive population

A distinction has often been made between the total population and the work force. While the total population refers to the entire population inhabiting the area, the work force consists of only those persons who could participate in economically gainful activities in the event of need.

Different countries classify the work force further into two-subcategories: The economically active population and the economically non-active population. The **economically active population** is that part of manpower which is actually engaged in the production of goods and services. It consists of both males and females.

The economically non-active population is that part of work force which is engaged in activities like household duties in their own homes or at the place of their relatives, retired personnel, inmates of institutions, students and those living on royalties, rents, dividends, pensions, etc.

(iv) Standard of living

Standard of living is a grade or level of subsistence and comfort in everyday life enjoyed by a community, class, or individual. Thus, it is the degree of wealth and material comfort available to a person or community. Therefore, the developed countries have the higher standard of living compared to the developing countries.

(v) Education

Education managers in developing countries are fighting for the young people to gain access to quality education and they further advocate for the acquisition of skills that provide the foundation for lifelong learning. More efforts are invested in programs that aim at ensuring that every child receives quality primary and secondary education. Many countries work hard to reduce the barriers or constraints that had existed for centuries between the education for boys and girls. The reduction of such gap targets has enabled the girl-child education.

A quality basic education gives children and youth the knowledge and skills they need to face their daily life challenges; whereby, empowering them to take advantage of the economic and lifelong learning opportunities. It is also a key driver for reducing poverty, fostering the economic growth, achieving gender equality and social development in developing countries.

Application activity 10.6

1. Explain why life expectancy is short in developing countries.
2. Compare and describe population pyramid of East Africa countries.

10.7 Population Policies in the World

Learning activity 10.7

Worldwide, each country comes up with its own policies that help in controlling the rapid population explosion. One of those policies implemented in developing countries (such as China)is regulating the number of children per family.

a. Suggest any other policies that could be put in place to control the rapid population growth in Africa.
b. Explain the effects of "one child per family" policy in a country where it is applied.

A population policy is defined as procedures taken by a country to adjust the way its population is changing, either by promoting large families or immigration to increase its size, or by encouraging the limitation of births to decrease the number of people living in the country.

To be effective, the population policies should address all the sources of the continuing population growth to a moderated rate, purposely to sustain the development of each country whether a developed or developing one.

10.7.1. Population policies in developed countries

- Provision of incentives and favourable conditions for big families. Several social and economic measures have substantial effects on a desired family size.
- To encourage families to increase birth rates in order to get enough active population.
- Provision of pensions and other facilities, e.g. extra- health services, for elderly people.
- Increase the number of population to improve the utilization of facilities and resources available in the country.
- Delayed marriage and child-bearing period as a way of addressing the needs of young women.
- Continuing improving thegirl child education and educational attainment for all, specifically among girls. The availability of mass education changes the value placed on large families and encourages parents to invest in fewer but "higher-quality" children.

10.7.2. Population policies in developing countries

The developing countries face numerous challenges related to big families due to the persistence of high fertility and mortality, no access to contraceptive tools, poverty, early marriage and lack of education on the impact of population growth. Below is a detailed explanation of the population policies witnessed in developing countries:

- Improvement in population health through access to child health care services, contraceptive measures and sterilization.
- Eradication of mass epidemic diseases through improving the living standards of the population.
- Family planning as a dominant component of the population policies and integrating in schools' curriculum the avoidance of early marriage.
- Investing in women and providing them with economic prospects and social identities apart from motherhood. Improvement in the socio-economic and legal status of girls and women in general are likely to increase their bargaining power in the decision making. This gives them a stronger voice in family reproductive and productive decisions.
- Assisting mothers to become economically productive by enabling them to have enough time in their professional work.

10.7.3. Effects of population policies on population growth

The effects of population policies on the population growth will result in the following:

- The decline of both birth and death rates will lead to the occurrence of an ageing and (economically) non-active population. This has undesired economic implications.
- Some of the population policies create ground for the resources to be in the hands of the few, who are rich.
- There will be an increase in literacy and educational levels and high levels of specialization.
- There will be stagnation in the population growth and therefore, there will be less young people in the society to supply the required labour.

Application activity 10.7

Referring to population problems in Rwanda, describe the population policies that have been adopted by the government to deal with such problems.

10.8. Impact of early sex, health risks, HIV/Aids, STDs in the world

Learning activity 10.8

Read the passage below and use it to answer the questions that follow:

World AIDS day takes place on the 1st December each year. It's an opportunity for people worldwide to be united in the fight against HIV, to show support for people living with HIV, and to remember those who have died from AIDS-related illnesses. Founded in 1988, World AIDS day was the first ever-global health day.

Having sexual intercourse at a very early age, especially during adolescence can affect your health. It can have a negative impact on your physical as well as psychological health. Sexual intercourse at an early age can have a long-lasting effect on your body.

1. What do you learn from the above passage?
2. dentify the diseases mentioned in the above passage and discuss their impacts on the society.
3. Describe the ways in which the mentioned disease is spread?
4. Referring to the passage above, explain the term "early sex".
5. Explain the effects of having sexual intercourse at an early age.

10.8.1. Causes of Early Sex

1. Peer pressure

Many young people feel great pressure from other teenagers to become sexually active. They do not want to be different or be rejected by their friends.

2. Pressure from a partner

For many young people it is difficult to say "NO" especially to someone they care about and this leads to early engagement in sexual activity.

3. Sexual attraction

Hormones in the teenagers tend to be more active. This increases their urge and desire for sexual intercourse.

4. Social and mass media pressure

There is too much and a wide range of media and social communication ways that have become the perfect means of exchanging pornographic data. The youth begin to learn and witness sexual messages in movies, TV shows, magazine and in some countries billboards. All these put together arouse the sexual desire especially in young people.

5. Parental example of permissiveness

There are some parents who have a problem with the abuse of alcohol or drugs, and sex. They fail to control their sexual desires even when the children are present. This ends up planting bad seeds in the minds of the teenagers at an early age. To them, having sex becomes a normal practice regardless of age.

6. Improper execution of sex education programs or practices

Sex education programs are sometimes extended to the teenagers in a wrong manner with no professionalism at all. Sometimes when the teenagers are taught on how condoms are used; if the facilitator does not handle it well, he or she leaves the majority curious and wishing to practically exploit the new experience. On the other hand, in many homes and societies, sex education is a sensitive aspect. It could leave the children or teenagers to discover things on their own.

7. Alcohol and Drugs

There is increasing misuse of drugs and alcohol by the teens and adults. The use of alcohol and drugs increases the drive for pleasure and increases the willingness to take risks by decreasingthe inhibitions and impairing good judgment. This has always resulted in making improper decisions.

Impact of early sex and possible prevention measures

The negative early sex affects the livelihood of the teens in the world as follows:

- Unwanted pregnancy at early age resulting in school dropouts and poor school performance.
- Increase of infected people (by HIV/AIDS and other transmissible diseases).
- Increase of mortality rate which results in a smaller skilled population and labour force.
- Poor cognitive development, social isolation and mental problems like anxiety and depression.
- Increase of the population growth resulting in poor feeding, malnutrition and the existence of street children.

Possible solutions to prevent early sex and related consequences:

- Sexual education should be incorporated in school curriculum to avoid early age sex.
- Peer group awareness between the governmental and non-governmental agencies, which should organise training on how to prevent unwanted and early pregnancies.
- Promoting cultural clubs and discussions about sexual abstinence.

- Sensitize about sex abstinence by educating about the negative effects of sex intercourse
- Use of condoms in times of lack of abstinence.
- Abstain from sexual activities or be in a long-term mutually monogamous relationship with an uninfected partner.

10.8.2. The impact of HIV/Aids and STDs on social economy development of country and possible prevention measures

HIV/AIDS is made of two abbreviations (HIV and AIDS). They stand for: HIV-Human Immune deficiency Virus and AIDS is Acquired Immune Deficiency Syndrome. HIV spreads primarily by having unprotected sex (including anal and oral sex), contaminated blood transfusion and hypodermic needles and from mother to child during pregnancy, delivery, or breastfeeding; whereas STDs are sexually transmitted diseases. The methods of prevention include safe sex, needle discharge programs (disposing used needles/syringes), treatment of those who are infected, and male circumcision.

The impact HIV/Aids and STDs on social economy development of country

The following are the main impacts of HIV/Aids and STDs on social economic development:

- On the level of the household, AIDS causes the family members to spend all their income on healthcare. The people who would be working and supporting the family members become bed-laden, yet the medical expenses accumulate and the end result is terrible poverty. Children fail to go to school since much of the money is used for healthcare and the funerals.
- Reducing the resources available for public expenditures such as education and health services. That is, there is increased pressure on the state's fund since such diseases must be eradicated or contained to moderate or controllable levels. Such affects the economic development of the country.
- The tax base is reduced since there are increased expenditures by the homesteads. Much money is spent on treating the sick and looking after AIDS and STDs orphans.
- The increased mortality in the regions affected by HIV/Aids results in the occurrence of a smaller skilled population and labour force.
- If the economic conditions are not good, a person with HIV/AIDS or STDs may decide to become a sex trade worker to earn more money. As a result, more people become infected with HIV/AIDS or other STDs.

- Poverty increases as a result of HIV/AIDS. This has undesired impact on the productivity and it is worsened by the loss of the lives of the economically productive members of the society. In general, HIV/AIDS adversely affectsthe production and the productivity in all the sectors of the economy, most notably agriculture, manufacturing and service industry.
- Considering the impact of HIV/AIDS on women and their roleespecially in food production, food security and export, it could create the risks of having malnutrition and undernourishment.
- HIV/AIDS morbidity and mortality have affected negatively the efficiency and effectiveness of the labour force in various work places. It is a result of increased absenteeism, increased staff turnover, loss of skills and experienced staff, and the declining of staff morale. Thus, it lowers the productivity of the labour.

Possible HIV/AIDS and STDs prevention measures

- Get tested and treated. It is very important that your partner is also tested and treated.
- Use a new condom for every act of sexual intercourse throughout the entire sex act (from start to end).
- Wrap the condom in a tissue and throw it in the trash where others won't handle it.
- Have less risky sex. HIV is mainly spread by having sex without a condom.
- Limit your number of sexual partners. The more partners one has, the more he is likely to have a partner with HIV or whose HIV is not well controlled or a partner with sexually transmitted diseases.
- Do not engage in unprotected sex unless you know your partner is not infected with HIV or STD.
- Do not have sex with people who use intravenous (IV) drugs.

Application activity 10.8

(1) Discuss the impact of HIV/AIDS and STDs on the economic development of a country

(2) Assume that you are appointed as a specialist in charge of epidemic diseases and prevention in the Ministry of Health.

Propose the possible prevention measures that should be taken by the Ministry of Health to control HIV/AIDS and STDs in the country.

10.9. Migration

Migration is the movement of people from one place to another with the intentions

Learning activity 10.9

When her husband left her alone with four children, Amina decided to leave her home country of Nigeria to seek a better life for her family. Unfortunately, Amina and her children felt victims to one of the smuggling networks that operate between the Horn of Africa and the Arabian Gulf. They were held captive for three months by a gang which tried to get money from Amina's family. Eventually, after a dramatic rescue, Amina and her children were referred to IOM Yemen's Migrant Assistance and Protection team. They are now receiving food, water and shelter. Thanks to IOM's assistance.

1. Identify the type of migration explained in the above passage.
2. With reference to the passage above, explain the causes of migration.

Migration is the movement of people from one place to another with the intentions of settling permanently or temporarily in a new location.

10.9.1. Types of migration

There are various types of migration. It is very important to note that migration has often been classified into various categories or types. Below is a detailed description of the main types of migration:

Internal migration: This is the movement of people within the country. It is further subdivided into rural-urban, urban-rural, rural-rural, urban-urban migrations.

International migration: This is the movement of people from one country to another. For example, if a person leaves Rwanda and settles in the USA, this type of migration will be called international migration or external migration. In this case, the Rwandan society will refer to him or her as an emigrant while in the USA he or she will be classified as an immigrant. Immigration is the coming of people from one country to another or leaving one place such as a village to another.

On the other hand, emigration occurs when people leave their mother countries or a place of residence to another. In the example used above, the act of leaving Rwanda and settling in USA, within the country of origin the situation will be known as emigration. It is very important to note that, an emigrant is the out-going person that has migrated to another place or country.

Permanent migration: This is the type of migration that involves the movement of people from one place to another without theintention of coming back to the source area.

Temporary migration: This type of migration involves the movement of people or person from one place to another but with the hope of returning back to the source area.

Voluntary migration: This is when people move from one place to another out of their own will without being forced. It is their choice to move.

Involuntary migration: This is when people are forced to move from the areas of origin. The good example is the refugees who are forced to leave their homeland because of the war.

10.9.2. Causes of migration

The following are some main causes/factors of migration:

- Technology factors:The people may move to places where there is advanced and more sophisticated technology. This is one of the common causes of migration in developing countries, where the influx of people go to the developed world.
- Economic reason: The lust (desire) for virgin lands for cultivation, the depressed economic resources from the motherlands, force people to migrate. This is because people want to settle in the area where the conditions reflecting the economic prosperity offer greater employment potential or opportunities.
- Underemployment and unemployment: These force people mostly the youth to leave their homes to the places and countries where the employment opportunities are abundant.
- Overpopulation: An excess of the population in an area in relation to the resources and technology available is known as overpopulation, and it can force people to migrate to another area in their search for virgin places.
- Social and religious causes: The human desire to stay, work and enjoy life with the people of his or her ethnic, social and religious groups, is also an important cause of migration.
- Political policies: There are policies established by the government such as the construction of a given infrastructural facility in a given area,which may result in forcing people to leave and resettle somewhere else for the erection of this large-scale public system. Example: the establishment of the New Airport in Bugesera, in Rwanda´s Eastern Province, where homesteads were paid and resettled in other places.

- Peer influence: Some people may move from one place to another as a result of influence friends or relatives. This is the main cause of migrations amongst the youth.
- General rise in the aspiration: People move from one place to another in search for employment opportunities. This is usually concerned with the working class or professionals who are always in search for better opportunities, jobs with high salaries and working conditions.
- Wars: This factor has caused many people to move from one place to another in search for peace and security. People are migrating to Europe from Libya, Syria and Southern Sudan among others. War has been an important cause of human migration. For instance, the two world wars I&II. World War I (1914-1919) displaced six million people and World War 2 (1939-1945) displaced 16 million people.
- Love for adventure: There are people who are naturally interested in adventuring new places. Having holidays or recreation in distant and new places; for instance Europeans coming to Africa (Rwanda and East Africa).

10.9.3. The effects of migration in the world

There are both positive and negative to areas of origin (source are) and destination (Receiving area) of migrants. They include the following:

Positive effects to areas of destination

- Simplifies easy exchange of ideas among people of different countries such as religious beliefs, technology, culturalvalues etc. which are essential for the development of the country.
- Provision of cheap labour force to the receiving areas. For example, immigrants in the UK and Japan provide Low-priced labour, thus adding to the growth of industry, agriculture and service sectors.
- Migrants provide security, for instance UK immigrants serve in security firms. They look after banks, shopping centres, suburban areas and in National security services; therefore, defending the country's interests.
- Immigrants are a source of revenue to central governments through the payment of Visa fees, entry fees and work permits in the receiving countries. Such revenues are used to develop the economies of the receiving countries.
- Immigrants provide ready market for produced goods such as electronics, textiles and food stuffs.

Negative effects to areas of destination/recipient area

- Migration has led to the spread of diseases from the origin place to the receiving areas. Such has often led to the loss of lives and poor standards of living by the people who are infected with diseases.
- High crime rate, for instance robbery and terrorism in Nigeria, Somalia and Southern Sudan, which has compromised the standards of living, security and sometimes resulting in the loss of lives.
- Development of Slummy areas with undesirable results; for instance in Kigali, Bujumbura, Kampala and Nairobi. Such a case boosts poor sanitation conditions which result in ill-effects.
- The large influx of immigrants in a given area or country results in the congestion on roads, delayed provision of services, and jam-packed markets. For example:This is what is happening in Kampala, Nairobi and Kigali cities.
- High unemployment cases are being created. The immigrants flock into the country and begin to offer cheap labour. Usually, these are highly skilled and professional than the local natives. It therefore lowers the standards of the natives who eventually may find it hard to make a living.

Positive effects on the areas of origin

- Reduced conflicts, for instance political emigrants from Iraq, Southern Sudan, Syria, Nigeria and Burundi etc. It creates some peace in the source areas which results inpolitical stability.
- Decreases pressure on land and other resources, for example in China and India people are encouraged to migrate to other countries and export human resources,which leaves behind less pressure on the resources. This is economically important since they always send money back home.
- Vanishing of criminal rate, for instance thieves, thus boosting the people's standards of living. That is to say, criminals migrate to other areas or countries leaving peace and security in the places of origin.

Negative effects on the areas of origin

- Insufficient market for goods, which affects various economic sectors engaged in the production of goods and services. The mostly affected ones are the industrial and agricultural sectors. It thus leads to the under development of rural areas.
- There are limited investments established in the source areas. For instance, lack of standard hospitals, advanced research centres and modern markets.
- Low agricultural productivity in the rural areas due to the active youth that run

away for urban centres, in search for employment opportunities, leavingbehind old people whose efforts cannot yield a lot. Such a low output may cause the shortage of food.

10.9.4. The measures to be taken to control migration

The following are some of measures to be taken to control migration:

- Governments should encourage urban-rural migration in order to develop the rural areas.
- Resettlement schemes should be established in the rural areas to cater for the homeless and landless people. Where resources allow, affordable housing systemsshould be put in place in the suburbs of urban centres.
- Improvement of the security to control high crime rate especially in the rural areas and slummy places. Such a situation will enhance investments.
- Creation of markets for the locally produced goods in the rural areas as a way of improving the income of people. This can create or provide employment to local people.
- Setting up rural electrification to develop the industries. Thus, improving the standards of living in the rural areas by getting people access to television, milling maize industries, and appropriate lighting systems during the night.
- Improvement and provision of clean water and sanitation facilities in the rural areas. This can be done through the development of piped water, so that water based diseases like cholera outbreaks are minimized.
- Improvement of communication and transport services in the source areas to boost the transportation of goods to the market centres.
- Setting up micro-finance projects in the source areas so that the provision of loans to farmers, businesses, and homesteads can improve the trading capacity and small-scale industries. When this is done,it can boost the standards of living of the population.

Application activity 10.9

1. With reference to examples, discuss the reasons for and the results of internal/ international migration.
2. Migration has occurred in Rwanda in the past; briefly discuss the causes and consequences of this migration to Rwandans.

10.10. Case Studies

10.10.1 The population of Nigeria, Gabon and Bangladesh

Learning activity 10.10.1

1. Draw sketch map of Nigeria, Gabon, and Bangladesh; and on each, mark and label the areas that are densely and sparely populated.
2. Explain the factors responsible for the population growth in Nigeria, Gabon and, Bangladesh.

Population of Nigeria

Nigeria is located in Western Africa. It neighbors are the Gulf of Guinea, Benin on the West and Cameroon on the East. The country's landmass extends from the Gulf of Guinea in the South to the Sahel in the North. Nigeria's population is now estimated at 195,809,553 over a total area of 923,768 km^2 (in 2018), with the population density of 212.0 persons per square kilometre.

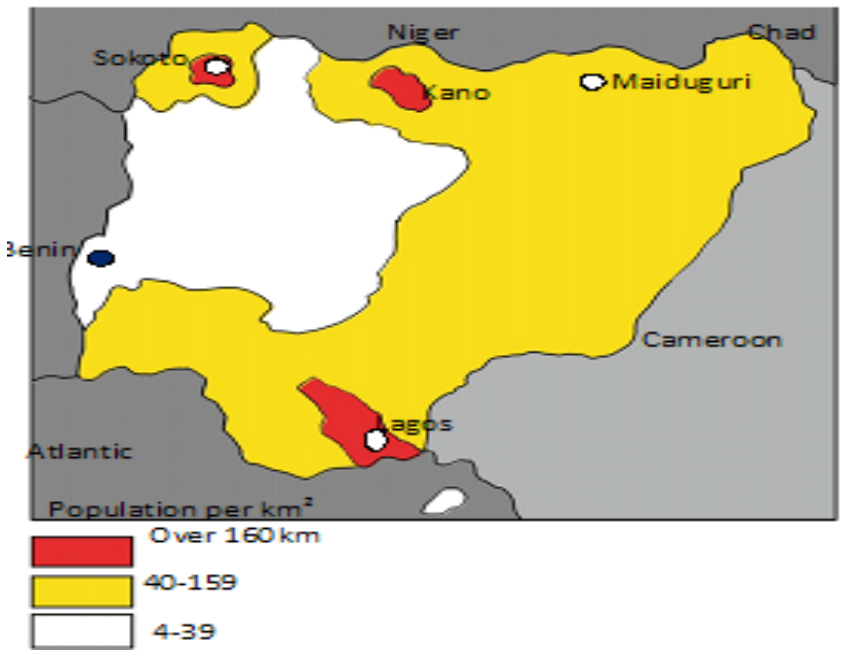


Figure 10.260: Population map of Nigeria

(i) Nigeria's population distribution

The Nigerian population is not evenly distributed. In some areas, dense population is found. Such areas include the Coast region, South East, South West, Abuja and Lagos; the moderately populated regions are Kano, Kaduna, Rivers state, Katsina, Oyo state, Kano and Sokoto; while the sparsely (low) populated regions include the

middle belt, semi-arid region of North and the central parts of the country.

(ii) Factors influencing population distribution (density) in Nigeria

- The presence of favourable climate: This is experienced by the regions along the coast, in the South-West and South-East of the country. This explains why such areas are densely populated. On the other hand, areas with unreliable rainfall discourage the settlement; they are thus sparsely populated.
- Fertile and well-drained soils in the South-East and South-West parts support the growing of crops. This has encouragedhigh population densities.
- Favourable relief. The relief in the South-East and South-Western is largely hilly and therefore favourable to the rapid population settlement.
- The Southern parts of Nigeria are gifted with mineral resources especially oil or petroleum deposits. Minerals exploitation has attracted a dense population settlement due to employment opportunities in the area.
- Inadequate water resources particularly in Northern Nigeria has led to sparse population while areas with enough water resources have encouraged a dense population.
- The powerful tribal groupingsuch as the Yoruba, Ibos and Hausa Moslems have glorified and preserved their traditional and cultural attitudes. The traditional attitudes preserved have forced these people not to move away from their traditional and ancestral areas; thereby causing a dense population.
- Slave trade and internal slave raids by powerful tribes like Ibo and the Yoruba led to a low population in the middle belt.
- Government policy has encouraged a wider spread of settlement by developing transport, mineral resource exploitation, power supplies and urbanization leading to a high population in some places.
- The process of large-scale urbanization, especially in the South-Western (Lagos, Ibadan), has also contributed to the high rate of population growth in Nigeria.

(iii) Nigeria's population problems

- Unemployment challenges in Nigeria due to the densely populated South-East and South-Western agricultural regions. Many people in the rural areas of Nigeria still live under the poverty line.
- High rate of rural-urban migration from the densely populated regions to the country's large urban centres such as Logos, Ibadan, Kano, Sokoto. This has resulted in numerous urban population evils.
- Growth of slummy areas and the general absence of housing facilities.
- Congestion and lack of space for the expansion of large Nigerian cities.

- Moral decay in the form of prostitution, high crime rate and robberies.
- Challenges of the population explosion on land specifically in the South-East and South-West. This issue has resulted in a number of ecological problems such as severe soil erosion and deforestation. Severe soil erosion has led to land degradationand the decline in crop yield. Hence, famine in the country is a common experience.
- There are generally inadequate social services such as hospitals, schools, clean water, and energy resources in most of the rural areas. Where such facilities exist, they are highly overstrained, thereby causing great shortage.
- Nigeria still experiences a challenge of a high dependency ratio and low life expectancy.

(iv) Solutions to the problems facing population growth in Nigeria

- Family planning techniques and education are the main tools to check the problem of high population growth rates.
- The Government should continue to develop other sectors such as industry, mining, trade and commerce in such a way that employment opportunities are created.
- The Nigerian Government should continue investing in the establishment of social infrastructures. This shall help in making the upcountry self-reliant in the industrial and agricultural sectors.
- The government of Nigeria should encourage and promote vertical expansion through setting up skyscrapers in Abuja and Lagos. Therefore, horizontal expansion of large cities should be discouraged.
- The local government should constantly develop the under populated regions. Thus being engaged in the establishment of irrigation farming and mineral exploration as well as encouraging migration into such states which are sparsely populated.

Population of Bangladesh

Bangladesh is one of the world's most densely populated countries. The total population is 166,325,373 (2018). The total area of Bangladesh is 144,000 km2 and the population density is 1,155.0 per km2. The most populated areas are found along river Bengal.

(i) Factors influencing population distribution in Bangladesh

- Lowland plains: the flat river valleys, deltas, and volcanic areas with fertile soil tend to have high population densities. Mountainous areas with steep slopes and poor quality soil tend to have low population densities.

- Climate:Areaswhich are very dry, very cold or very wet, tend to have sparse populations whereas, areas which have a moderate climate with evenly distributed rainfall or with monsoon type of climate have denser population.
- Soil: Areas with fertile soils encourage successful agriculture. This tends to attract high population densities. However, areas with poor quality soils discourage agriculture which, in turn,causes the latter to be sparsely populated.
- Water supply: Water is essential for the human survival and development. For this reason, the areas which have sufficient water tend to have dense population compared to those having irregular water supply.
- Natural resources: Areas which are endowed with natural resources such as oil and coaloften have higher population densities than the ones which don't have.
- Pests and diseases: These may affect the population density as people try to avoid the areas where pests and life threatening diseases prevail.
- Industrialisation: Areas in which the manufacturing has developed tend to be densely populated. This is because of the availability of employment opportunities associated with such areas.
- Availability of transport and communication networks: Areas with well-developed transport infrastructures and links through road, rail, shipping, canals and air tend to be densely populated. On the hand, areas with poorly developed forms of transport discourage the settlement, and thus become sparsely populated.

(ii) Population problems in Bangladesh

- Traffic jam: This is one of the most challenging problems in Bangladesh. It comes as a result of many people living in the cities and urban centres of Bangladesh. This is at worst levels during the rushing hours.
- Environmental degradation: Numerous people are landless and forced to depend on cultivating flood-prone lands. With the use of poor farming practices, the soils have been degraded, soil erosion reaching its undesired levels and forests cleared in favour of farming. All these are attributed to the population explosion in Bangladesh.
- Health problems:Manypeople in Bangladesh suffer from various diseases. For example, several children in this country are blind because of poor nutrition.
- Limited social amenities: The large number of population has resulted in increased pressure on the social facilities. Bangladesh faces a challenge of social amenities like enough hospitals. In relation to this, the patient to doctor ratio is very high. For instance, one qualified doctor for every 25,000 people on average.

- Housing problems: The rapid increase in population in Bangladesh has resulted in a serious shortage of residential houses. This has led to the growth and development of slums with poor housing conditions mostly in the outskirts of urban areas.
- Poverty: Bangladesh is a poor country with a rapid growing population. This implies that an increasing population in a country puts pressure on the national funds and limited resources. The case in Bangladesh has resulted in persistent poverty among the country´s citizens.
- Overcrowding especially in urban areas like Dhaka, has caused serious problems like noise, pollution, traffic jam, easy spread of contagious diseases and increased crime rates in these areas.
- Scarcity of food:Every year Bangladesh imports huge quantity of food from foreign countries to cater for the increasing food demand. This has increased government expenditures.

(iii) Ways of controlling population in Bangladesh

- Discouraging early marriage: This can be done through encouraging formal education. Education may prove to be more successful in preventing child marriages. This is so because people spend more time in educational institutions. In addition to this, educated people are well informed about the dangers of high population.
- Use of family planning methods: The use of contraceptives and other family planning methods can control the birth rates which eventually reduces the population growth rate in Bangladesh.
- Mass education: People can be sensitized about the threats of having big families. Hence encouraging them to have manageable families.
- Introduction of sex education in schools. This is meant to provide awareness to the youth about the dangers of early marriages and uncontrolled population growth.
- Providing incentives to families that have small and manageable families. For example, over taxing the families with large members. This can be an efficient measure in combating the challenge of rapid population growth in the country.
- Paying some money to the people with few children or free and discounted education for the people with a single child.

The population of Gabon

The population of Gabon is estimated to be 2,069,885 people (2018). Its total area is estimated to be 257, 670 km2. This makes its population density to be 8 people per km2.

(i) Factors influencing population distribution in Gabon

- Drainage: Low-lying areas that are prone to periodic flooding and water logging have sparse population. Such areas are unsuitable for agriculture and other economic activities, therefore, push away people who would otherwise settle there. On the other hand, well drained areas like gentle sloping zones encourage high population densities because they are suitable for the settlement and agriculture.
- Vegetation:Forested areas have wild animals, disease vectors and discourage the human settlement and other economic activities. However, areas which are not densely forested encourage the population distribution because there are less incidences of pests and diseases attacks.
- Climate: The cool and wet areas are densely populated because they are suitable for farming. Hot dry areas have sparse population because they are unsuitable for farming.
- Relief: Mountainous and hilly areas have low temperatures and rugged terrain which discourage the settlement or development of infrastructures. Plains and gently sloping areas are usually densely populated because they are suitable for the settlement and other economic activities. Flat depressions, flood plains and low-lying places are sparsely populated because of poor drainage which causes flooding in the wet season.
- Soil fertility: Fertile soils are suitable for agriculture thus attracting large population. On the other hand, areas that have infertile soils do not enhance economic activities like farming, hence a sparse population prevails.
- Pests and diseases:Areas that are infested with pests and disease-carrying vectors discourage the settlement since the conditions are unhealthy for both livestock and human beings, leading to sparse population. However, areas which are disease free, are favourable for the human settlement and agricultural activities, hence high population densities.
- Historical factors: Gabon,like other countries in West Africa, faced slave trade which led to some people to be taken away by the slave masters and colonial rulers of the time. Some Gabonese had to run away from their cradle land in search for peace and safety. These resettled far away from homeland and never came back. Such a situation resulted ina low population density in the source areas and increased population growth in the receiving regions.

- Tribal conflictsand wars have led some places to be sparsely populated. This is sobecause many people move to other places where they are assured of peace and safety, especially in the neighbouring countries.
- Economic factors like the exploitation of natural resources (Forestry and mining) attract a large population of job seekers for paid employment. In areas where such a situation exists, the population becomes higher than the regions that have no such activities.
- Infrastructures and industries in Libreville pulled many people from the rural areas to settle in industrial and urban areas.
- Political factors and government policies have led to the resettlement of people from the gazetted conservation areas like national parks and forest reserves. Therefore, such areas have a sparse population.

(ii) Problems associated with the rapid population growth in Gabon

The population of Gabon faces various problems as follows:

- Poverty has become a characteristic associated with the rapid population growth of Gabon. This has led to under development of economic activities in the rural areas. Farmers in this case cannot afford to purchase better farming tools.
- Rural -urban migration: Many young people (the Youth) are running away from the rural areas to Libreville in search for jobs and leaving old people (whose productivity is low) in the rural areas.
- Poor government policies that are not supporting the development of rural areas through establishing social services such as schools, industries, health centres and other infrastructures.
- Pollution of the land is a problem in Gabon's growing urban centers due to the industrial and domestic garbage.
- There is likely to be a problem of dependency on theimportation of manufactured goods, foreign aid and social services.
- Rampant deforestation: Most Gabonese use charcoal and fire wood, which leads to thecutting of trees in large numbers.
- Poaching: There is illegal procurement of protected wildlife such as fish, game, logging or plant collecting.

(iii) Possible solutions to the problem of high population growth in Gabon

- Family planning techniques and education are the main tools that the Government can use to check on the problem of high population growth rates.
- The Government should continue to develop other sectors such as industry, trade and commerce as a way of increasing employment opportunities to the increasing local population.
- The Government should allocate huge or reasonable amount of funds to the development and establishment of social infrastructures. Such an act would assist the masses through having accessibility to a better life style.
- The government of Gabon is encouraging and promoting the vertical expansion through setting up skyscrapers in Libreville, discouraging horizontal expansion of other large cities.
- The Local government constantly develops her under populated regions in the form of establishing irrigation farming, mineral exploration and migrations into such states that are meagrelypopulated.

Application activity 10.10.1

3. Analyze the factors leading to thepopulation explosion and suggest possible ways of reducing population problems in Nigeria or Gabon.
4. Describe the impact of rapid population growth in Bangladesh.

10.10.2.The population of Germany, USA and China

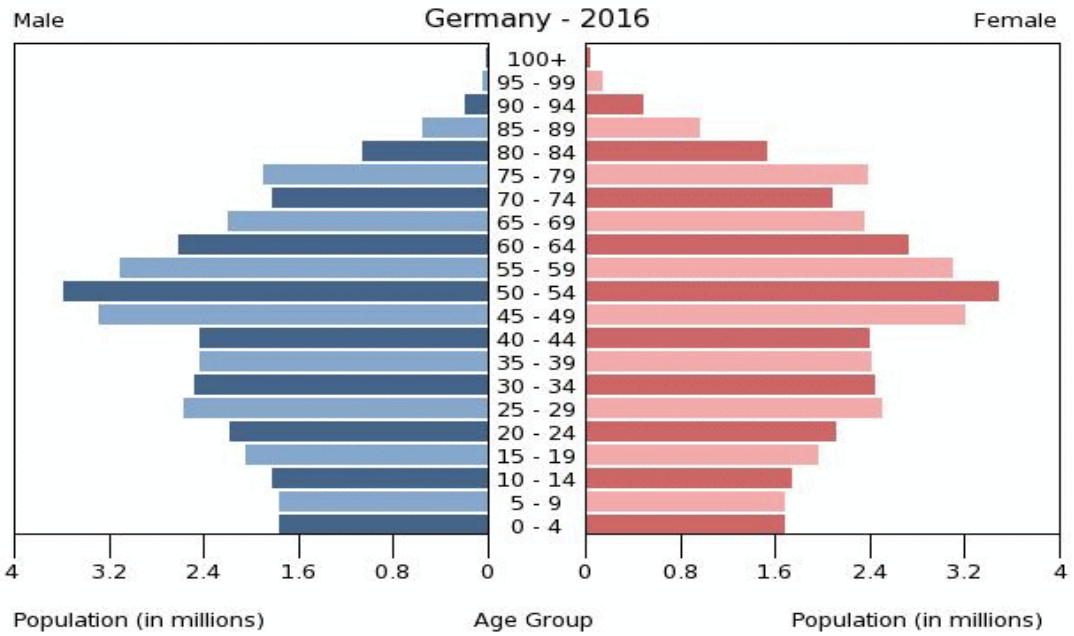
Learning activity 10.10.2

Despite a drop in the country's growth rate, Germany's population is now estimated at 82.29 million (in 2018). The country has a population density that stands at 227.9 persons per square Km as per March 2018. This makes Germany the 17th most populous country in the world. It is also the largest country in the European Union. The total area of Germany is 357,021 km2.

5. Referring to the above text, identify the ranking position of Germany at world level in relation to the Population density.
6. Using Geographical resources, draw a sketch map of the USA and on it mark and label the densely, moderately and sparsely populated regions.
7. Using Geographical resources, explain the factors responsible for the population growth in Germany, China and USA.

Population of Germany

Germany is located in Western-Central Europe. The country is bordered by Poland, Denmark, the Czech Republic, Austria, France, Switzerland, Luxembourg, Belgium, and the Netherlands. Germany is the most populous country in the European Union with an estimated population of 82.29 million people in 2018. It ranks 17th populated country in the world.



The population structure represented by the above pyramid is divided into three main age groups. These arethe population under 15, between 15 and 64 and aged population-over 65-year-old. Germany's population pyramid displays a contracting structure. This type of pyramid is more common or associated with highly developed countries, known for having low birth and death rates. Usually,the countries with such kind of population age groups have long life expectancy due to improved standards of living they enjoy. Such people have access to high level education and assured of better and affordable health care.

(i) Factors influencing population distribution in Germany

The factors that influence the population distribution in Germany are briefly short listed hereunder:

- The availability of enough and sufficient arable land that has supported large numbers of people to settle where they wish to be.
- The country has vast forested areas which have supported the growth and development of Lumbering and other associated industries such as ship building, pulp and paper. The areas where these economic activities exist have become the centres of attraction for large numbers of people.
- The availability of transport and communication facilities. Areas that are assured of having such facilities attract many people to settle there. While, on the other hand, where they do not exist, such areas become sparsely populated.
- Historical factors. After World war II, many countries sent their technicians to rebuild the country of Germany. These increased the population of the country. At the same time, those who had taken refuge elsewhere started coming back.
- The country has a well-developed sector of urbanization. There are many cities and towns in the country. These have attracted many young and old people from the rural areas to urban centres.
- Drainage has also played a great role in influencing the distribution of the population in Germany. Areas with better drainage have been settled by many while poorly drained areas have discouraged the settlement.
- Relief and landforms: Lowland plains, flat river valleys, deltas, and volcanic areas with fertile soil have played a role in attracting many people from all over the country of Germany to settle there.Mountainous areas with steep slopes and poor-quality soil tend to have low population densities.

(ii) Population problems in Germany

- There is increased congestion as a result of several cars, buses, etc. on the road.
- There is an increase in prices of the commodities which has resulted ina high

cost of living. The housing services are costly.

- Increase in air, noise and water pollution; for instance open sewage points, fires, etc.
- A high rate of environmental degradation in the form of pollution or poor disposal of wastes.
- Development of Slum areas particularly in large cities like Ruhr and Berlin.

(iii) Germany can address population problems in the following ways:

- Improve the work-life-balance for women and men (including flexible work schedules and high quality day care).
- Implement an immigration policy that meets the requirement of the German labour market.
- Adapt its structures and institutions to a declining and ageing population.

The population of the USA

The Population of theUnited States of America is estimates 326,903,782 people. The population density in the United States is 36 persons per Km2 and the total land area is 9,147,420 Km2.

The USA's population is unevenly distributed. Some areas are densely populated where the average densities is over 100 persons per km2. For instance, New York, the Great lakes region, much of the Eastern part, Los Angeles and San Francisco. The moderately populated areas are Chicago and Birmingham where the average density is between 10 -100 persons per km2 and the central. Much of the Western parts of USA are sparsely populated where the average density is less than 10 persons per km2.

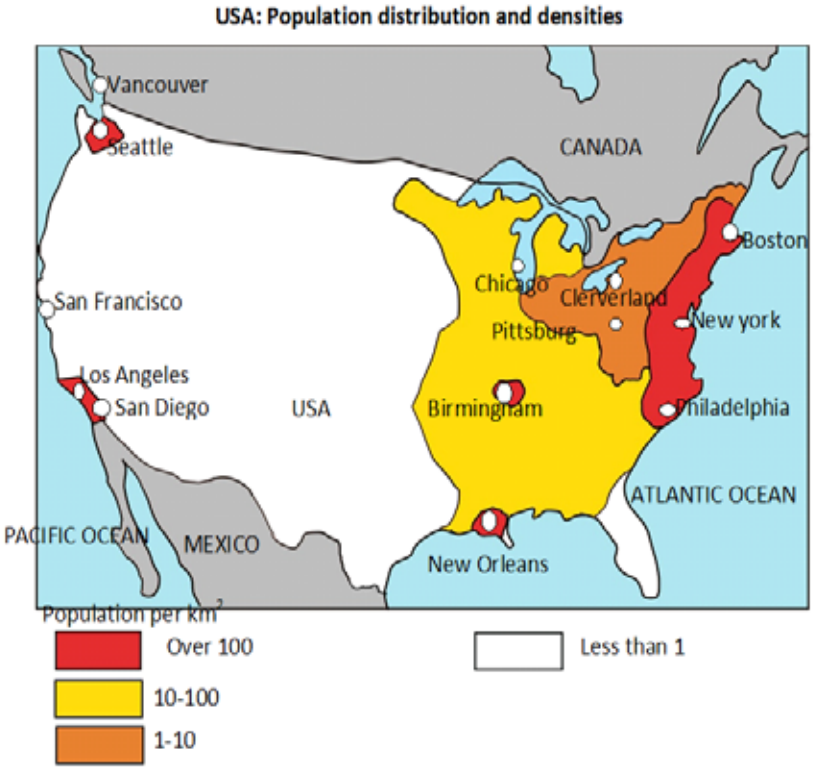


Figure 10.261: Population map of USA

(i) Factors influencing the population distribution in USA

- The climate has a greater influence in the population distribution in the USA. Areas which receive reliable and well-distributed rainfall have attracted large numbers of people. On the other hand, areas are sparsely populated since farming is discouraged.
- The relief of the Eastern parts of the USA is mostly mountainous considering the AppalachianMountains, such discourages the settlement. However, areas with gentle slopes attract large population.
- The impact of ancient European immigrants who settled in the Eastern side of the USA, mainly in the states of New York, and West Virginia.
- Large-scale urbanization in numerous parts of the USA has been responsible for the present high-level differences in the population distribution and densities. For instance, large cities like New York and Chicago and some parts of the western coast of the USA (that is Los Angeles) have dense population.
- The USA society has, for a long time, continued to receive international immigrants from both the developed and developing worlds. This has led to the spread of population in different parts of the country.

- Countries like the USA with stable governments tend to have a high population density. Due to this political stability, the country has used its resources to develop industries and social infrastructures, and all these support high population densities.
- The improved and availability of modern or advance technology. In areas known to be having improved technology, many people settle there than in places with poorly developed technological advancement.
- The existence of a modernized economy characterized by developed mining, industrial, fishing and agricultural sectors, has attracted many immigrants. These have contributed to the growth of the population in some places.

(ii) Population problems in the USA

- Congestion in Cities: The high rate of urbanization growth has attracted many people leading to traffic jams in urban areas.
- Increased pressure on the social amenities such as hospitals, water, electricity, schools among others.
- Development of slums: The increase of population in urban areas of the USA has led to a high unemployment rate which has resulted in the existence of homeless people and development of slummy areas.
- The USA is threatened by moral decay as a result of high rate of immigrants from other parts of the world. These are mainly from the developing countries of Africa and Caribbean.
- Environmental degradation:this is attributed to the highpopulation density that has come along with the development of industries which release gases that pollute water bodies, air and land.

(iii) Solutions to the USA's population problems

- The Federal Government continues to develop other sectors such as industrialization, mining and trade and commerce as a way of increasing employment opportunities to the local population.
- USA constantly supports her immigration offices worldwide as a way of controlling illegal immigrants entering the country.
- The USA government is encouraging and promoting vertical expansion through setting up skyscrapers in New York City and discouraging the horizontal expansion of other large cities.

The population of China

China is located in Eastern Asia along the Western shore of the Pacific Ocean. The population of China is 1,415,045,928. The total land area is 9,388,211 Km2 and the population density of China is 151people per Km2. It is the most populated country in the world.

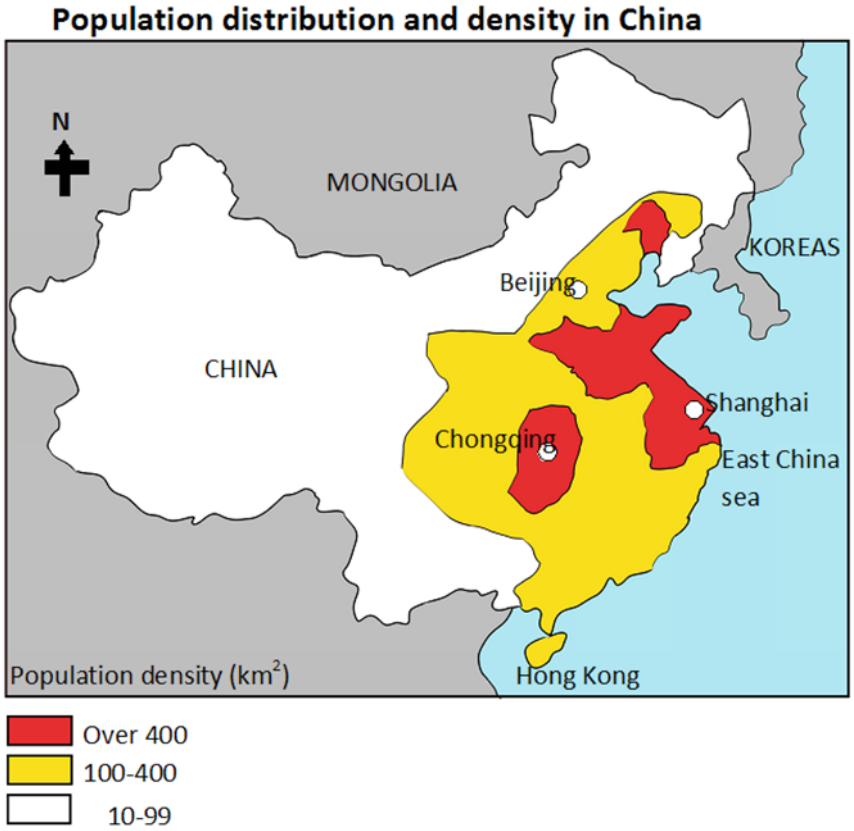


Figure 10.262 Population map of China

(i) Factors influencing the population distribution in China

- The presence of fertile and well-developed plains and river valleys of the Eastern region. This has attracted many people to settle in such areas. For instance, there is North Chain plain, Chang Jiang plain and Xi Jiang plain. These river valleys present suitable and ideal settlement conditions.
- The Western parts of China present a hostile relief that discourages the population settlement. This area is composed of steep mountainous relief, which discourages the population settlement. For instance, in mountainous regions like Xingjian (Sinkiang), Gansu (Kansu), Qinghai (Tsinghai) and Tibet, the population density is as low as less than one person per km2.
- The availability of fertile soils that are also well drained. These have influenced the population distribution in China. Areas with fertile soils are densely populated while those with infertile and poor soils are sparsely populated. The good example includes the Great plains of Eastern China.
- The climate of Eastern China is monsoon in nature, which favours environmental conditions for the existence of a dense population distribution. The rainfall received is very heavy and suitable for the growing of various crops. The

climate of the Western part, which is dry due to unreliable rainfall, makes cultivation very difficult, and therefore, discourages the settlement. Such areas will therefore have a low or sparse population.

- The availability of clean water. The presence of river systems like Chang Jiang, Xi Jiang and Sichuan provide water for irrigation purposes. This explains why there are highly populated regions in China.
- The high level of urbanization has influenced many people to settle in cities and towns. The rural areas tend to have sparse population.
- The favourable government policies. For example, the Chinese government policy established rapid economic development of the Eastern region. This eventually attracted large numbers of people to settle there.
- The presence of good infrastructures has attracted many people to the areas where they occur. In the Eastern part of china, there are well developed educational institutions and hospitals. There is uneven distribution of social services in Western China compared to the Eastern side, hence leading to a sparse population in this area
- Political ideologies. The Chinese Communist Government tried to decrease the population growth. This has resulted insome places having fewer people than others.

(ii) Chinese population problems

The country of China is highly populated. This high population has resulted into serious challenges that are now affecting the socio-economic development of the country. These problems include:

- There is a high rate of unemployment in the rural areas of China leading to poor living standards.
- There is an increased government's expenditure in relation to the establishment of social service infrastructure that are needed to address the challenges faced by the population.
- China experiences one of the highest rates of the rural-urban migration in the entire world.
- High birth rates in many districts of China continue to present great social challenges to the Chinese government expenditure.
- There is a challenge of regional economic inequalities between the urban centres and rural areas of china.

(iii) Solutions to the Chinese population problems

- The Chinese Communist Government set a policy of regulating the number of children per family as a way of controlling the high population birth rate.
- Providing free education, housing, pension and family benefits to those with one child.
- A penalty of 15% of the family income is imposed on families with more than one child.
- In China, the marriage age for men was extended to 22 years and women at 20 years.
- The couples who are willing to marry are requested to apply for a permission.
- The Chinese communist government continues to reinforce the policy of "family planning". For instance, the use of contraception, sterilization and abortion in the rural communes.
- The Chinese communist government continues to invest in various sectors of the economy as a way of creating more employment opportunities for the increasing population.

Application activity 10.10.2

1. Are Chinese population policies relevant to Rwanda? Support your answer.
2. Compare the population problems of USA with those of Rwanda.
3. Describe the measures that Germany has undertaken to reduce rapid population increase.

End unit Assessment

1. Describe and suggest the reasons for the rapid increase in the world's population in the recent times.
2. Explain why the problems may result in areas of overpopulation and under population.
3. Describe the relationship between the population growth and the resources in your country.
4. Explain how physical factors can cause variations in the population density in different parts of the world.
5. Assess the impact of the population growth onthe economy of your country.
6. With a specific reference to any country you have studied, discuss the problems associated with the rapid increase of population in the Cities.

UNIT 11

URBANISATION IN THE WORLD

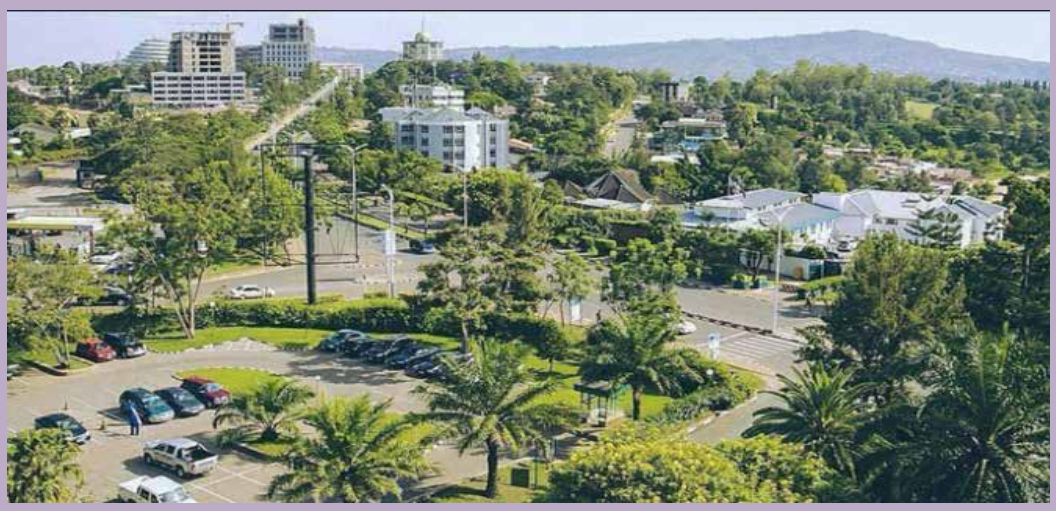
UNIT 11: URBANISATION IN THE WORLD

Key unit competency:

By the end of this unit, I should be able to discuss the impact of settlement and urbanization on the sustainable development of different countries.

Introductory activity:

Most cities including your home town or city, have in common a land use pattern that stretches from the centre to the rural-urban fringes and to the rural area.



1. Compare the areas presented what are common on the three pictures?

2. Which of the following photographs best explains a village? Support your answer with evidence.

3. Identify the main activities found in urban areas.

4. What are the environmental impacts of both rural and urban settlements?

The concept of urbanization is well defined from the concept of settlement.

A settlement refers to a place where people live. It can be large or small, permanent or temporary. A settlement also means the process of settling in a given a place. Settlement is associated with the concepts of shelter, infrastructure and community services like health, culture and education. There are two types of settlements: rural settlement and urban settlement.

The term **'urban',** is opposed to rural which can refer to isolated building, hamlet, village, small market town while urban is related to towns or cities. **Urban settlement** is large nucleated settlement in which most of the employed inhabitants are engaged in non-agricultural activities. Urban areas may be defined by national governments according to different criteria; for example, size of the population, population density, occupation of the people, and type of local government. However, the United Nation defines an urban place as a permanent settlement with not less than 20,000 inhabitants.

Urbanisation is a process of increasing number of people that live in urban areas in a country or the process of growing of cities and towns, therefore, the societies becoming more urban. For example, according to 2012 national census, 16.5 % of Rwandans live in urban areas. Urbanisation refers also to the physical expansion of urban areas, or the increase in number of urban areas or towns.

11.1. Rural settlement

Learning activity 11.1

With reference to your own observation and the knowledge acquired from past studies

1. What do you understand by the term rural settlement?
2. Describe the different types of rural settlement.
3. What are the factors that would influence someone to create a settlement somewhere?

Rural settlement is a sparsely populated community that exists in each area. The population density in rural areas is very low compared to the urban areas. In such areas houses are scattered. The largest land use is agriculture. This means that most people are engaged in agricultural activities and other related activities such as livestock farming, fishing, mining, hunting etc. Sometimes, there are larger

agricultural agglomerations. However, this cannot be considered as urban centres because of the primary activity common in that region.

11.1.1. Types of rural settlement

The following are the various types of rural settlements:

(i) Nucleated settlements pattern: It is also known as clustered or grouped settlements. Houses are concentrated in one place without proper arrangement. Nucleated or clustered settlements often form at crossroads or route centres. These types of settlements are known as "Imidugudu" in Rwanda. Socially, the people are closely knit.

Figure 11.263: Nucleated settlement

(ii) **Linear settlement pattern:** This is where houses are well planned and concentrated along the communication lines like roads, railway stations or along the coast. The fields extend behind the buildings in long, narrow strips. These are mainly influenced by economic factors. Linear settlement patterns are also known as ribbon settlement.

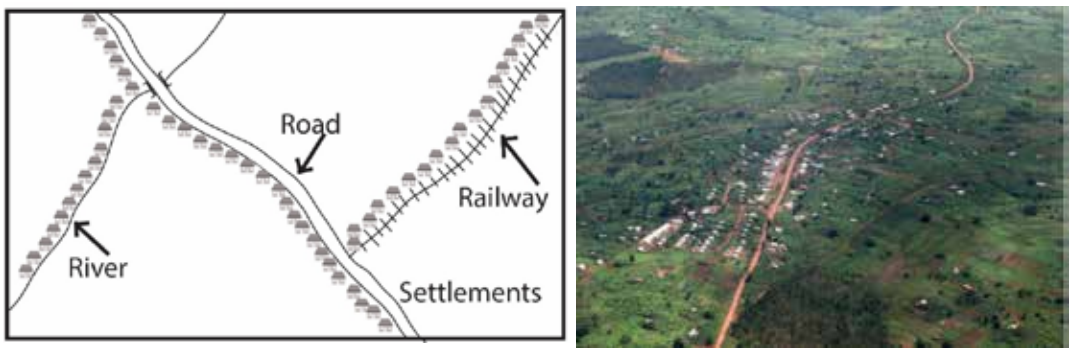


Figure 11.264: Linear settlement

(iii) Dispersed /scattered settlement pattern: This is where houses are scattered all over the area. The settlements are located at distance apart from each other. This type of settlement dominates in areas where agricultural and livestock activities are dominant.

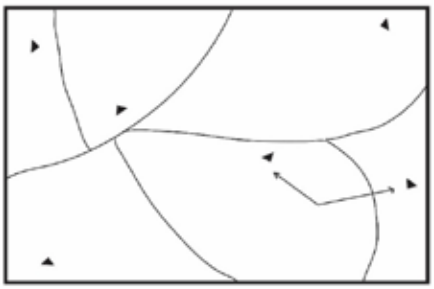


Figure 11.265: Scattered settlements

(iv) Isolated settlement pattern: This is a type of settlement which is characterized by people who are hunters, shifting cultivators and food gatherers or other specific activity. That is, people who are socially isolated by other people.

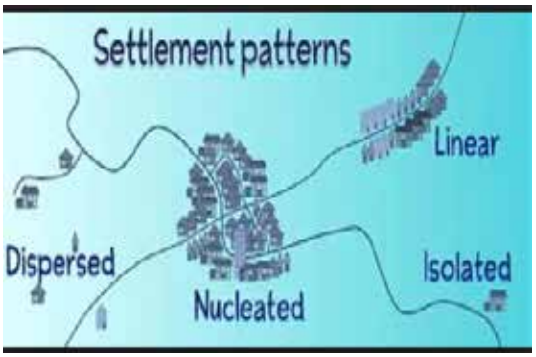


Figure 11.266: Isolated settlement compared to other types of settlements

(v) Ring settlement pattern: In this type of settlement, houses make a circle. There is an open ground at the centre.

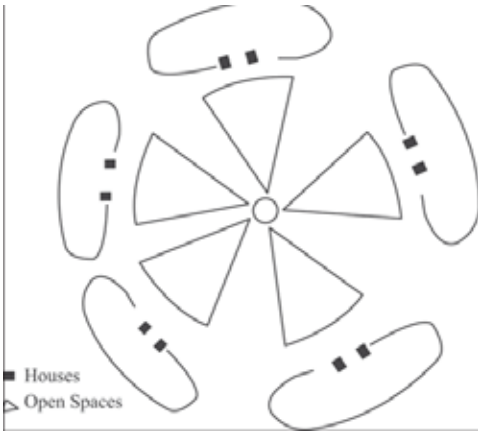


Figure 11.267: Ring settlements

Planned settlement pattern: These are settlements which are deliberately designed to assume a certain shape or pattern. They may develop according to the government's plan. The emergence of the various patterns of settlement is influenced by the following factors.

Figure 11. 268: Planned settlements

11.1.2. Factors influencing rural settlement

A place where a settlement starts is called a site of a settlement. Any settlement site is chosen because it has a lot of good reasons for locating a settlement there. The following are the main factors influencing rural settlement:

- **Water supply:** Water is an important human need. It helps in deciding where a settlement might be located. Thus, most settlements are located near water sources such as rivers and lakes.

- **Soil fertility:** Farmers often choose to settle at points where the land is suitable for crop growing as agriculture and livestock are the key activities in rural areas.
- **Security:** More people settle in areas where there is peace. They can live without fear of anything.
- **Building materials** like timber and stone attract people to settle where they are easily available.
- **Absence of natural hazards:** few people live in places likely to be hit by natural hazards.
- **Climate:** People are much more attracted to settle in temperate climatic areas. Few people live in very hot or very cold areas.
- **Means of transport and services:** The presence of roads, schools and hospitals attract many people for settling around them.
- **Presence of minerals:** People like to settle where mining activities are taking places as jobs are available in those areas. In those areas, the markets, schools and hospitals are built to serve them.
- **Government policy:** The government decides where people should and should not settle. This is done as part of planning.
- **Cultural and social factors:** For example, a father dividing his land among his children. The children settle in the same area.
- **Relief:** Few people live on the steep slopes of mountains. On the other hand, Flat land is easier to build on and it is good for growing crops. This explains why many people live in plateaus and the plains.

11.1.3. Effects of rural settlements

The concentration of people in rural areas has both negative and positive effects:

Positive effects

- The development of rural settlement, especially grouped and planned settlement facilitates the establishment of social facilities. Facilities such as schools, shops, hospitals, electricity, water points and other basic infrastructure are usually established and made available to the entire settlement.
- Rural settlement leads to the development of trading activities with surrounding settlements and urban centres.
- Rural settlement produces food stuffs to the urban areas.
- Rural settlements provide or supply the urban centers with affordable labour force.

Negative effects

- Rural settlements, especially dispersed settlements experience shortage/lack of basic infrastructures such as water, electricity, roads, etc.
- They are exposed to pollution resulting from uncollected garbage and contaminated water.
- Rural settlement experience shortage of social services such as hospitals, schools and markets. People make a long distance to access such services.
- In rural settlement people fight for land. Therefore, constant land disputes are witnessed.
- There is high spread of diseases like dysentery, cholera, and malaria due to poor hygiene and compaction of individuals.
- There is environmental degradation due to high demand for building materials, firewood, charcoal which further results into soil erosion, reduction in rainfall and landslides.
- The family plots are fragmented. This makes them to be too small for commercial mechanized farming.

11.1.4. Solutions to the problems affecting rural settlement

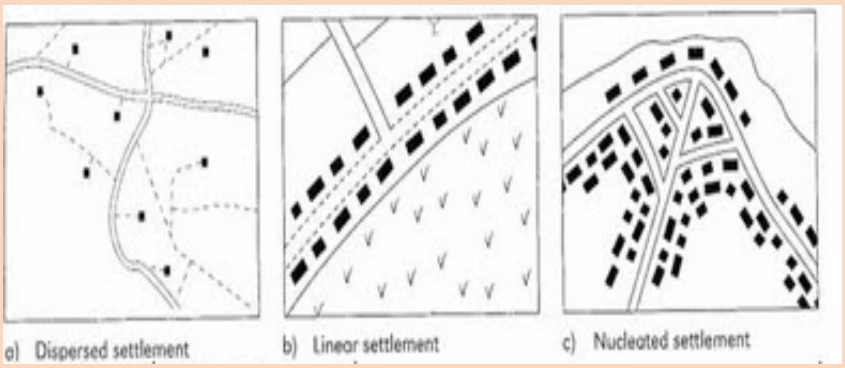
- To avail the basic infrastructures such as water, electricity, roads, etc. in the areas to be settled.
- Construction of social facilities and services such as hospitals, schools, market.
- Regular registration of land to reduce the conflicts related to the land ownership and use.
- Preparation of master plan and land use guide for all country to avoid unplanned settlement.
- Making environment management policies to avoid environmental degradation.
- Establish good governance to avoid any kind of division, insecurity in population, etc.
- Sensitizing the rural settlers on the most effective way of managing the environment.

Application activity 11.1

1. Make an excursion in rural areas not far from your school and find answers for the following questions:

a) Examine the predominant activities.

b) Basing on what you have learnt in this lesson, associate the below diagrams with their corresponding names/ types.

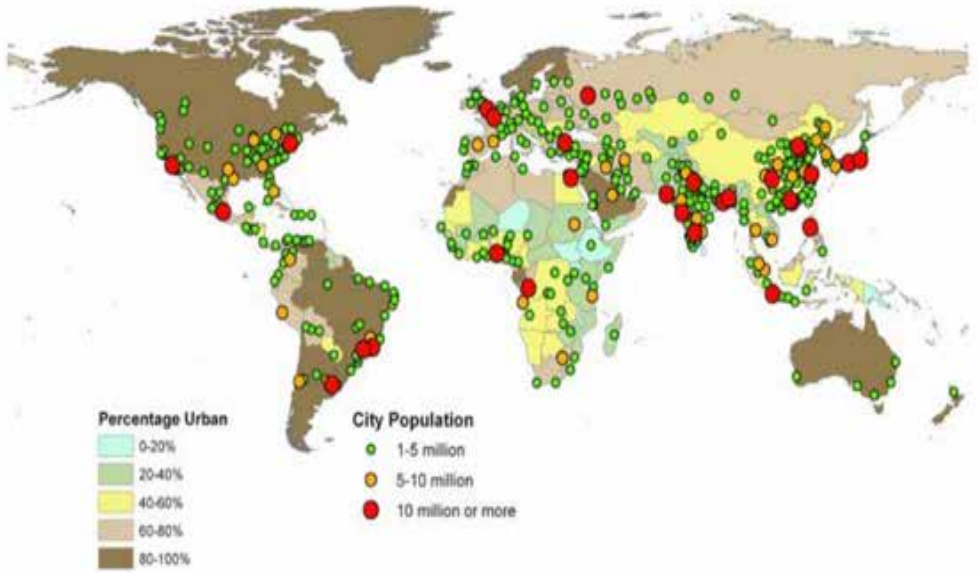


11.2. Urbanization in the world

Learning activity 11.2

Figure 1.3: Global patterns of urbanization, 2015

Source: Based on United Nations, 2014b



1. Analyse the map shown above and name the most urbanized regions in the world.
2. Discuss the major factors influencing urban development in the world.
3. From your understanding, what are the socio-economic benefits of the big cities compared to small cities?

11.2.1. Definition of basic terms

Different terms are used to express urban centres according to their size or characteristics. The following are the commonly used terms.

- **Trading center:** A trading center is a given settlement whose major occupation is associated with trading activities. It may be an area within a city or located away from the main city.
- **Town:** It is the smallest unit of urban settlement. Here, urban functions are well marked although the possibility of some rural activities existing is not ruled out.

- **Town board:** It is the legislative body that governs a town/city.
- **Municipality:** A municipality is a political subdivision of a state for a specific population concentration in a defined area. The municipality is bigger than a town in terms of covered area and the size of population settled in that area.
- **City:** The term city is derived from the Latin word 'civitas' which means community/city/town or state. It is a full-fledged urban agglomeration showing predominance of urban occupations and complex internal structure. Any town with a population of 100,000 inhabitants/dwellers or above is termed as city.
- **Agglomeration:** It is an extended city or town area comprising the built-up area of a central place (usually a municipality) and some suburbs linked by continuous urban area.
- **Megalopolis:** It denotes a large urban region formed by the out-growth of many metropolises. A megalopolis (sometimes called a megapolis; also, megaregion, or super city) is typically defined as a chain of roughly adjacent metropolitan areas, which may be somewhat separated or may merge into a continuous urban region. Megalopolis also expresses the full mature stage of urban growth.
- **Conurbation:** It is a large continuous built-up area formed by the joining together of several urban settlements or town. It is an urban region consisting of a large metropolis and several small towns huddled together.
- **Suburb:** It is a mixed-use or residential area, existing either as part of a city or urban area or as a separate residential community within commuting distance of a city. Some suburbs have a degree of political autonomy, and most have lower population density than inner city neighbourhoods.
- **Green city:** It refers to a broader metropolitan area. For example, "Chicago" represents the greater metropolitan area surrounding the city of Chicago. It aims at informing and stimulating the interest with authorities, organizations and companies which are professionally involved in planning and developing the urban area, ensuring green belts (Areas covered with selected flora) will be applied appropriately.
- **Slum:** It is defined as a highly populated urban residential area consisting mostly of closely packed, dilapidated housing units in a situation of deteriorated or incomplete infrastructure, inhabited primarily by impoverished persons or low income earners.

Figure 11. 269: City of Mumbai and its slum

11.2.2. Location of major world urban centres and ports

The major world urban centres and ports are considered as megalopolises which are large urban regions formed by the out-growth of urban center.

- The most known urban regions are developed along the North-Eastern sea board of USA. This includes: Boston, Massachusetts, New York City, Philadelphia, Baltimore ending in Washington, D.C. and Northern Virginia
- The urban regions in Eastern Asia which include the urban centres of China, Japan, Singapore, India, South and North Korea.
- The Western European urban centres including cities of Germany, U.K, France, Netherlands, Belgium, Italy, etc.
- The South Africa urban centres including: Pretoria, Johannesburg, Durban, Cape Town, etc.
- The Urban centres in Northern Africa including the cities of Libya, Morocco, Tunisia, Algeria and Egypt.

11.2.3. Factors influencing urban development in the world

Urbanization is the function of socio-economic changes that take place through time. The following are its determinants, which are mainly economic, social and demographic.

- The economic determinants are the types of economy, degree of commercialization of agriculture, the extent of diversification of economy, the changing size of agricultural landholdings, the stage of economic advancement and the degree of development of means of transportation and communication.

- The social factors that determine the nature and magnitude of urbanization are the degree of socio-economic awakening, the social value system, the stage of technological advancement, the public policies and the government decisions.
- Among the demographic factors, the rate of population growth, magnitude of migration and pressure of population are significant.
- Improvement of transportation can bring raw materials to any point quite cheaply.
- Improvement of information and technology which raises the population awareness about the available opportunities in other urban centres.

11.2.4. Functions of urban centres and ports

Most towns perform several functions. In some towns, one activity is predominant, and the town is known for that function. But many towns are now multi-functional. The following are the most important functions that cities perform:

Predominant activity	Description
Mining and Quarrying town  Kimberley city in south Africa	These are towns whose primary activity is mining precious metals like gold, silver, etc. E.g.: Gold mining of Johannesburg in South Africa; coal mining town of Kiruna in Sweden; coal mining city of Kalgoorlie and gold city of Coolgardie in Australia; coal mining city of Pennsylvania in the U.S.A, nickel city of Sudbury in Canada.

Industrial town  Nagasaki city in Japan	There are towns that developed manufacturing sector, where industrial production is the major function. There are known as an industrial towns. These towns turn the raw materials into finished products. For instance, Halifax, Birmingham and Glasgow in England; Essen in Germany; Osaka and Nagasaki in Japan; Chicago in the U.S.A, etc.
Transport Towns  London city airport, UK	These towns either produce transport equipment or serve as main transport junctions. They are generally situated at a rail, road or water route terminus. Examples of cities located on coast areas: Channai, Calcutta and Mumbai in India, London in U.K, Yokohama in Japan, Shanghai in China, etc. Examples of towns situated at the meeting point of transport routes: Agra and Nagpur in India, Berlin in Germany, Paris in France, Kigali in Rwanda etc.
Commercial towns  Shanghai city in China	Various commercial activities are carried out in such towns and they may be classified on the following basis: Agricultural market towns like Winnipeg and Kansas in the U.S.A., Evesham and Hansen in Denmark, Port towns like Tokyo, New York, London, Calcutta, Shanghai, etc.

Administrative towns  Kigali city in Rwanda	This includes for instance capitals of countries like, Kigali, Nairobi, Kampala, Paris, London, etc.
Defence Towns  Munster city in Germany	These towns serve primarily as a base for the armed forces. There are also called garrison towns. Examples: Portsmouth and Plymouth in England, Halifax and Nova Scotia in Canada; Aldershot in England, Munster, Osnabruck and Berlin in Germany are some examples of defence towns. Three towns of Rwanda have been created for defence reasons by Germany colonialists against British and Belgian colonial powers on the eve of the First World War. Those are Musanze in 1909, Rubavu in 1907 and Rusizi in 1913.
Cultural Towns  Jerusalem city	These are towns, which perform cultural functions like provision of education, art, religion, etc., are included in this category. There is Cambridge and Oxford in England for education; Mecca, Varanasi, Jerusalem, Lourdes and Rome for religion activities.

Health and Recreation Towns  Cannes in south of France	Famous recreation centres are: Stratford on-Avon, the birthplace of William Shakespeare, film making centres like Hollywood (California), film festival centres like Cannes in Southern France.
Educational towns  Mumbai city	Are those towns that developed because of the development of educational institutions. The good example is Huye Town in Rwanda.

11.2.5. Impact of world urbanization on the environment

Urbanization might cause the following problems:

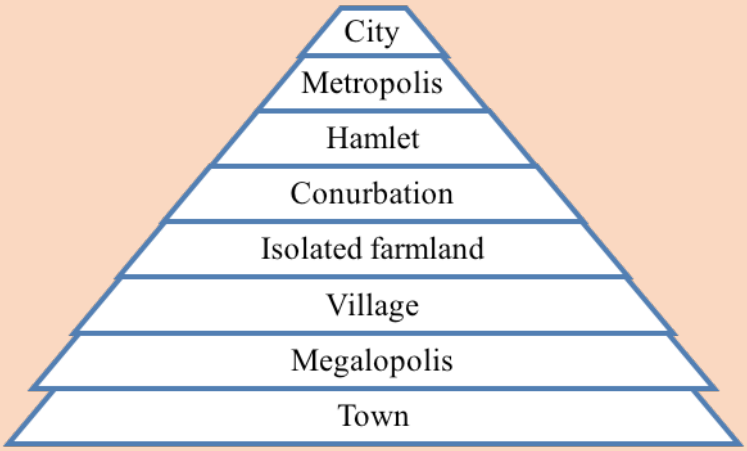
- Urbanization results into pollution of land, air, water and noise. This is because of poor disposal of garbage from the domestic and industrial remaining. It also results into noise pollution from industry machineries, vehicles, and other means of transport,
- High energy consumption increases the release of CO2 in the atmosphere. This leads to global warming.
- Most people do not have access to safe drinking water especially in developing countries. Thus, poor sanitation and poor quality of drinking water result into water-borne diseases like Cholera, Typhoid, tuberculosis, dysentery and gastro-enteritis.

– Sewage also provides nutrition to a vast array of microbes, bacteria and fungus adding to the eutrophication of surface water bodies, seriously affecting the human environment and the entire food web in the eco system. Even the ground contaminated by the industrial effluents in the atmosphere, brought down by precipitation.
– Waste disposal is a major problem in large cities.

Application activities 11.2

1. Assess the effects that urban centres have on the environment.

2. With reference to the below pyramid, arrange the settlement from the lowest to the highest level



3. Describe the main functions of the towns of Rwanda.

11.3. Case studies of cities in developed countries: New York City, London, Tokyo

Learning activity 11.3

Map showing major world urban centres

1. With reference to the map above and the help of any other geographical documents, locate and describe the factors that have favoured the development and the growth of New York, London and Tokyo cities.

2. Analyse the main functions available for each city mentioned above.

3. Identify challenges facing the above cities.

11.3.1. New York

New York City is one of the most populated metropolitan area of the United States of America and the world. The city's population is estimated at 19 million people distributed over 17,400 km2. It was established in 1624 as a trading center of Dutch colonialists and it was named New Amsterdam in 1626. It became under English control in 1664. Thereafter it was renamed New York after the Duke of New York who was a brother to King Charles II of England. The New York served as Capital City of US between 1785 and 1790.

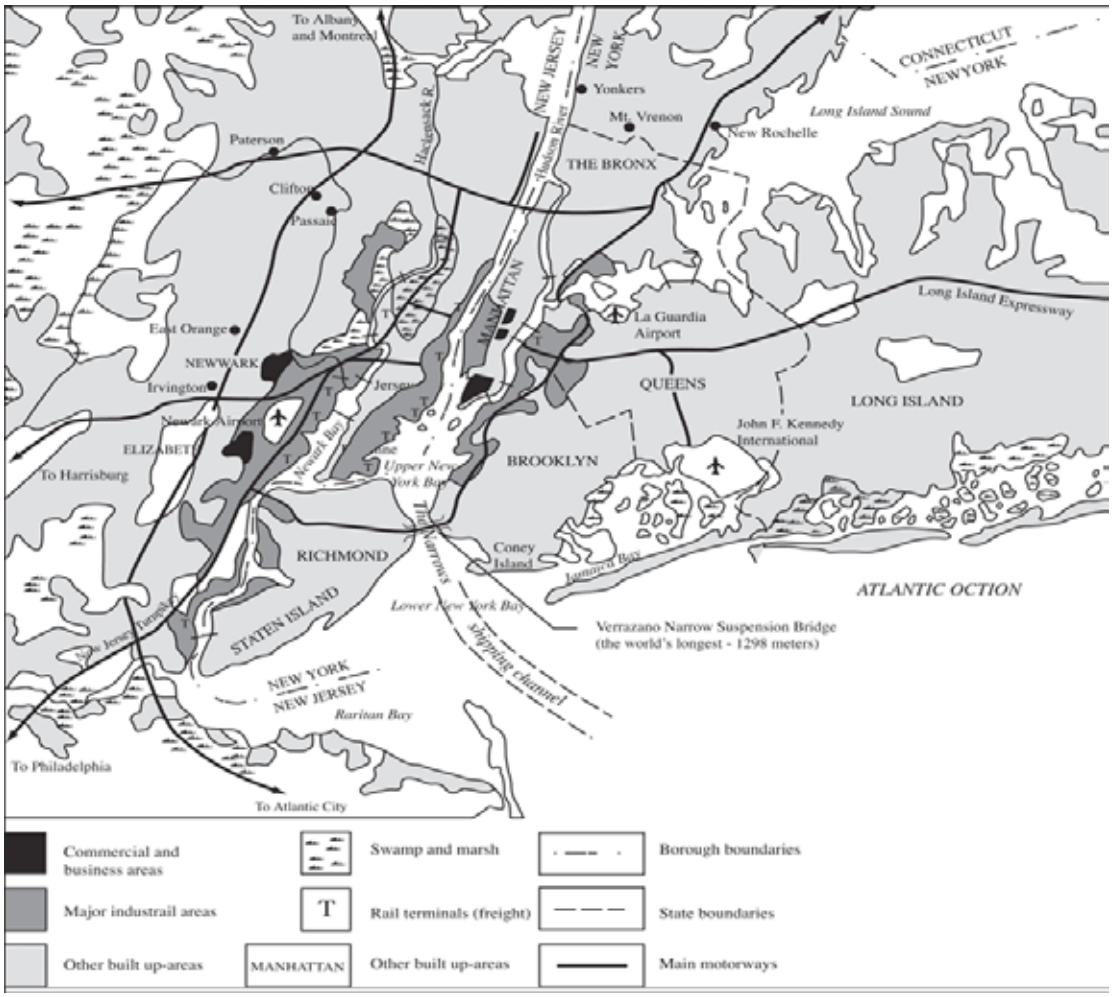


Figure 11.270: New York City

The city of New York has the following functions:

- **Financial centre:** New York is the world's leading financial capital and the headquarters of the most principal business firms in the United States. The New York's financial centre is based on Wall Street where the New York Stock Exchange is located.
- **Commercial centre:** New York conducts a considerable proportion of internal trade of the country as well as international trade. This makes it an international and national commercial centre.
- **Industrial centre:** Many heavy and light industries have been developed in New York. The heading industries include oil cracking, heavy engineering like ship building, manufacturing, chemical processing, leather tanning and sugar refining making it an industrial centre.

- **Transport and communication centre:** New York is a leading sea port worldwide. It has also three international airports: J.F. Kennedy, Newark and La Guardia. It is also served by canals e.g. New York state Berge and Erie Canals that connect the city to the Great Lakes.
- **Administrative Center:** Besides being an administrative centre for the state of New York, it serves also as headquarter of several international organizations such as headquarter of the United Nations (UN) and the World Bank.
- **Education Center:** New York City is a home to many universities and colleges well reputed worldwide. Example: New York State University and Columbia University.
- **Cultural centre:** It is a leading cultural centre hosting the most heterogeneous population. Its cultural diversity has made it a leading fashion art and cultural centre in the world.

11.3.2. London

London is the capital of England and the United Kingdom. It is the largest metropolitan area in the United Kingdom and the largest urban zone in the European Union. London has been a major settlement for two millennia. Its history going back to its founding by the Romans, who called it Londinium. London's ancient core, the City of London, largely retains its square-mile mediaeval boundaries. Since 1831, the name London has also referred to the metropolis developed around this core. London is the political, industrial, cultural, and financial centre of the country. It has an area of 1,706 square km and consists of two regions: The Inner London comprises 14 of London's 33 boroughs and Outer London encompasses the other 19 boroughs (municipalities).

Figure 11.271: Map of London city

Functions of London

- London is leading European city in the arts, commerce, education, entertainment, finance, healthcare, research and development, tourist and transport.
- London is considered as a world cultural city. It hosts a range of people with various cultures.
- It is among the top ten world's most visited cities through its air transport.
- London has more than 50 universities which are highly rated in the world. It therefore has an educational function.
- London hosts well known football teams and it has been given the opportunity to host the summer Olympic games many times like in 2012. Therefore, it has a recreational function.

11.3.3. Tokyo

Tokyo is called also 'Eastern Capital' and officially Tokyo Metropolis. It is one of the 47 prefectures of Japan. It is located on the Eastern side of the main island Honshu. It includes the Izu Islands and Ogasawara Islands. Tokyo Metropolis was formed in

1943 from the merger of the former Tokyo Prefecture and the city of Tokyo. It is the capital of Japan, the center of the Greater Tokyo Area, and the largest metropolitan area of Japan. It is the seat of the Japanese government and the Imperial Palace, and the home of the Japanese Imperial Family.

The Tokyo Metropolitan government administers the 23 special wards of Tokyo. Each is governed as a city. Those wards (districts) cover the area that was the city of Tokyo, 39 municipalities in the Western part of the prefecture and two outlying island chains. Tokyo is the world's most populous metropolitan area with 38 million people and the world's second largest metropolitan economy ahead of New York City.

Figure11. 272: Map of Tokyo

Functions of the city of Tokyo

- Tokyo hosts most of top governmental and non-governmental institutions of the country.
- Tokyo is a major international financial Centre. It hosts the headquarters of world's largest banks, insurance companies, industries among others.
- The largest Japanese stock exchange is found in Tokyo and it is the third largest worldwide.
- The road and railway transports are very developed in Tokyo city. This can be testified by the fact that more than 40 million passengers use rail system daily.
- Tokyo houses a big number of international universities which are highly ranked worldwide.
- It is known to have many museums like Tokyo National Museum, Traditional Japanese art, National Museum of Western art, National Museum of Science and Ueno Zoo.
- The city of Tokyo has many well-constructed theatres facilitating it to host different festivals and sporting events like 1964 Summer Olympics.
- Tokyo is considered as the world's most environmentally friendly as it uses renewable energy with superb energy security.

Problems facing New York, London and Tokyo Cities

The following are the main problems facing the Cities of New York, London and Tokyo:

- **Lack of space for expansion:** The fact that New York and London are boarded by the water of Atlantic Ocean in the East and West respectively while Tokyo is boarded by Pacific Ocean in the East result into lack of enough land for city expansion.
- **Shortage of housing:** There is lack of adequate and decent accommodation for middle class in New York, London and Tokyo.
- **Slum development:** The cities are experiencing the problem of slums with poor housing for the people with less income. They are especially found in Harlem and the Bronx in New York.
- **Unemployment:** Many people migrating from different parts of the world are directed to these cities of developed countries hoping to find better jobs there.
- **High crime rates:** The crime rates are very high because of the high number of unemployment people living in these cities.
- **Traffic Jams:** New York, London and Tokyo are overpopulated which result into congestion of many cars especially during the pick hours.

- **Pollution:** Air, water, land and noise pollution are among the main problems facing the city of New York, London and Tokyo.
- Tokyo faces several natural hazards such as earthquakes, volcanic eruptions, Tsunami and tropical cyclones.

Application activity 11.3

Search on internet and other geographical document to supplement your answers. answer the following questions:

1. Suggest the appropriate measures to be taken to deal with problems facing London and Tokyo.
2. Discuss the role of land values as a factor in the internal functioning of cities. Nairobi

11.4. Case studies of the cities in developing countries: Brasilia, Johannesburg, Nairobi

Learning activities 11.4

1. With the help of geographical documents and other relevant sources of information, describe briefly Brasília, Johannesburg and Nairobi cities.
2. Locate Brasília, Johannesburg and Nairobi cities on the world political map.

11.4.1. Brasilia

Brasília is the capital of Brazil. The city and its District are in the Central-West region of the country, along a plateau known as Plan Alto Central. According to 2008 census, it has a population of about 2,557,000. This makes it the fourth largest city in Brazil. It is listed as a World Heritage Site by UNESCO. Brasília was hosting 122 foreign embassies in 2014. The city of Brasilia was planned and developed in 1956 by Lucio Costa as the principal urban planner and Oscar Niemeyer as the principal architect. On April 22 of 1960, it formally became Brazil's national capital. Viewed from above, the main portion of the city looks like an airplane or a butterfly. It has a unique status in Brazil, as it is not a municipality like nearly all cities in Brazil.

Figure 11.273: Brasília city in Brazil

Functions of the city of Brasília

- Brasília is the seat of all three branches of the Brazilian government.
- The city also hosts the headquarters of many Brazilian companies such as the Banco do Brazil, Correios and Brazil Telecom.
- The city is a world reference for urban planning. Planning policies such as the locating of residential buildings around expansive urban areas as well as building the city around large avenues and dividing it into sectors.
- Brasília city hosts several national financial Centre, banks, insurance companies, industries among others.

11.4.2. Johannesburg

Johannesburg also known as Jozi, Joburg or Goli is the largest city in South Africa, by population. Johannesburg is the provincial capital of Gauteng which is the wealthiest province in South Africa and obviously in Sub-Saharan Africa. It is the world's largest city not situated on a river, lake, or coastline.

Johannesburg metropolitan includes four regions: Ekurhuleni, the West Rand, Soweto and Lenasia. It hosted around 12 million people in 2017. The municipal city's land area is 1,645 km2 with population density of 2,364 /km2. Johannesburg includes Soweto, which was a separate city from the late 1970s until the 1990s. Soweto is considered as the largest slum area in Sub-Sahara Africa. Johannesburg was developed from Gold mining activities which started since 1880s.

Figure 11.274: Location of Johannesburg within Gauteng

Functions of the city of Johannesburg

- Johannesburg is the hub of South Africa's commercial, financial, industrial and mining activities.
- It has the largest stock exchange in Africa.
- Johannesburg contributes up to 16% of national South Africa's gross domestic product and it accounts around 40% of the economic activities of Gauteng Province.
- Johannesburg has towers which are among the tallest in Africa. There are for instance Sentech, Hillbrow-(Vodocom tower), Carlton towers, etc.
- Johannesburg is a major international financial center which houses the headquarters of world's largest banks like Standard ABSA, Nedbank, insurance companies, and industries among others.

- It hosts a very big airport named Oliver Tambo International airport which is connected to different international and domestic airports of the world.
- Johannesburg has well developed both private and public universities like Witwatersrand and Johannesburg universities.
- It hosts well known soccer teams and it has been given the opportunity to host FIFA final world cup in 2010.

11.4.3. City of Nairobi

Nairobi was founded in 1899 as a rail depot on the railway linking Mombasa to Uganda. It was also a colonial settlement. It became British East Africa in 1907 and eventually the capital city of independent Republic of Kenya in 1963.

The name Nairobi comes from the Masai sentence "Enkare Nairobi" meaning the cold water. This Nairobi was a name of a river in Masai language meaning that the city is extended around this river. According to the 2012 census, Nairobi had a population of 3,138,295 inhabitants living on an area of 696 km2.

Figure 11.275: Location of Nairobi city

Functions of Nairobi

Despite Nairobi being the capital city, it has other several functions. Among these functions are:

- **International center:** Nairobi is cosmopolitan (Multicultural) city with residents drawn from all over the world. It has conference facilities like Kenyatta International Conference Centre (KICC). It hosts several international headquarters such as United Nations Environment Programme (UNEP) and International Centre for Research in Agro forestry (ICRAF), etc.
- **Transport and communication centre:** Nairobi, is a nerve cardinal centre for transport and communication lines. All roads in the country converge in Nairobi. It has international airports with air links to the rest of the world. The national communication systems centred in Nairobi are also linked to the communication systems of the world.
- **Education centre:** There is variety of education institutions in Nairobi. These include the University of Nairobi and many tertiary colleges and technical institutions.
- **Tourist centre:** Its central location in East Africa makes it an important transit point for tourists. Moreover, Nairobi also has many tourist attractions for instance Nairobi National Park, museums and animal orphanages besides excellent accommodation in hotels of international standards.
- **Administrative centre:** Nairobi is a residential base for all the foreign missions in Kenya. It is also the provincial headquarters for Nairobi province as well as the seat of the Kenyan government.
- **Industrial centre:** Nairobi is the leading industrial centre in East Africa. The Industries found in Nairobi are motor vehicle assembly, steel rolling, food processing, garment making and radio and television assembly.
- **Cultural centre:** Nairobi has several theatre groups operating at the Kenya National Theatre, French Cultural Centre and other cultural centres. Various dancing troupes operate from Bomas of Kenya and tourist hotels while art exhibitions are held in art galleries.
- **Commercial centre:** Nairobi is the leading commercial centre. Through the Nairobi Stock Exchange, a huge volume of transactions is made on daily basis. It is also a centre of banking and financial instructions.

Problems facing cities in developing countries: Brasília, Johannesburg and Nairobi

Although cities of Brasília, Johannesburg and Nairobi are having remarkable records in terms of economic development. They also face many common problems which include:

- The loss of culture identity of the society: This is as result of the interaction of different cultures from different people including foreigners.
- The pollution of land, air, water and noise: This is because of poor disposal of garbage and the existence of very many vehicles and industries.
- The shortage of land for agriculture: As towns expand, land for agriculture is reduced in favour of settlement and this in turn may result into a decline in food production.
- Unemployment and under employment: This is because of the high urban population that competes for the low employment opportunities.
- Urbanization creates congestion especially during rush hours when people go to or come from the work.
- The big number of population in Brasília, Johannesburg and Nairobi cities has led to the problems of insecurity. The security personnel are overwhelmed by the rising crime rates.

Solutions to the problems facing cities in developing countries

In order to overcome problems related to the development of urban centers in developing countries, both the government authorities and the inhabitants of those cities need to cooperate to find the appropriate solutions. Here are some of the solutions to the problems faced by cities:

- The problem of accommodation can be solved or reduced by the construction of skyscrapers or stored houses which occupy little space on the ground and can accommodate very many people.
- Enlargement of roads by constructing high ways and subways for vehicles and pedestrians in addition to strict laws governing traffic.
- Enforcing tight security and punishing law breakers like those involved in robbery theft murder and prostitution.
- Garbage within urban cities should be cleaned by forming cleaning association and be dumped in particular places where they are burnt or recycled into other useful products.

- Attracting foreign investors to establish more industries both in rural and urban centers to provide employment to the majority and where necessary to form labour organizations.
- Good urban planning strategies to avoid further slum development, digging water tunnels to direct water and replacing semi-permanent structures by permanent structures.

Application activities 11.4

3. Explain how cities in developing countries are involved in environment degradation.
4. Identify the main factors that led to the development of Brasília, Johannesburg and Nairobi cities respectively as big cities in developing country.

End unit activities

1. With reference to Kigali city explain why towns are constantly growing both in population and area.
2. Analyse the major problems that are shared by both developed and developing countries cities.
3. Suppose you are one of the urban planners, design a program that would address the problems caused by urbanization.
4. Describe the different functions of urban centers. Give at least two cities as example for each function.
5. Kigali is currently experiencing rapid urban development in our region. From the knowledge acquired in this unit, identify the major factors which are contributing to that urban development.

UNIT 12
AGRICULTURE IN THE WORLD

UNIT 12: AGRICULTURE IN THE WORLD

Key unit competency:

By the end of this unit, I should be able to explain the impact of agricultural activities on the sustainable development of different countries in the world

Introductory activity

Source:*https://www.independent.ie/business/farming/dairy/dutch-cows-have-to-mooove-out-of-turkey-amid-diplomatic-row-35537303.html*

Look at the photographs above and answer the following questions:

1. How can one associate the above photographs with the word "agriculture"
2. Identify the contribution of agriculture in socio-economic development of Rwanda.
3. Describe different types of crop cultivation.
4. Discuss the main challenges facing agriculture?

The world "agriculture" comes from the Latin words "ager" which means land or field and "culture" means cultivation. So, literally agriculture means the production of crops for economic purpose by cultivating soil for growing crops and rearing animals.

The primary aim of agriculture is to generate production from the land, and, to protect it from deterioration and misuse. It is associated with farming, the production of food, fodder and other agro-industrial materials.

Agriculture contributes in feeding a large number of people in the world.. Farming is not a mere planting of seeds and the subsequent harvesting of the crops. It involves also rearing of nimals, soil management and manufacturing of agro-based machinery and agro-based industries.

12.1. Types of crop Cultivation

Agriculture is practiced in different parts of the world. It is categorized as a primary activity since it involves the production of raw materials that can be used by other industries. The following are the main types of crop cultivation.

12.1.1. Subsistence farming

Learning activity 12.1.1

1. Identify different crop cultivation methods used in farming
2. How does small subsistence farming differ from large scale farming?

Subsistence farming is form of primitive agriculture. This type of farming refers to the growing of crops for domestic consumption. It is defined as a self-sufficiency farming system in which the farmer focuses on growing and rearing of animals enough to provide food to feed themselves and their entire families. The root term, subsist, means "to survive". However, despite the priority of self-sufficiency in subsistence farming, nowadays most subsistence farmers are actively participating in trade to some degree.

Subsistence farming is commonly practiced in developing countries in Africa, Asia and Amazon basin in South America.

Characteristics of subsistence farming at small scale

The following are the main characteristics of subsistence farming:

- It involves the use of members of the family to provide labor force.
- Subsistence farming involves use of rudimentary tools like hoes, pangas to cultivate and sometimes usage of animals is practiced.
- Multi-cropping or intercropping (growing many crops in the same field) is practiced. .
- The cultivated land is most of time small.
- The production is mainly used for home consumption.
- There is limited or no use of technology.
- Organic manure and mulching are sometime applied on the land to improve its fertility.

– The common crops grown include maize, cassava, millet, beans, sunflower, fruits and vegetables.

Advantages and disadvantages of subsistence farming

Advantages of subsistence agriculture	Disadvantages of subsistence farming
– It is less costly because the operations involved are easy to control. – It provides employment opportunities to the family members. These accept to work for small wage or sometimes with no pay at all. – Food crops are usually grown and this ensures food security to the family members. – Little capital is or not required to establish and maintain the farms. – Multiple cropping and intensive farming ensures maximum utilization of land – Small farm sizes ensure the ease control of pests and diseases – The well maintained small plots lead to low incidences of soil erosion	– It is difficult to apply machines in subsistence farming such as tractors because of small farming size. – There is a low productivity because of the small area coverage. The farmer cultivates a small piece of land usually less than a hectare. – The farming system leads to land fragmentation. The land is divided into small pieces and sometimes scattered to distant places. – Pests and diseases are spread easily since farm lands are near each other. Especially when the neighboring farmers are growing similar crop. – It encourages the overuse of land leading to soil exhaustion – The production is too low since there is limited use of inputs.

The following are main types of subsistence farming:

(i) Shifting cultivation / Non sedentary farming

Shifting cultivation, is an agricultural system in which plots of land are cultivated temporarily, then abandoned and allowed to revert to their natural vegetation while the cultivator moves on to another plot. It is also known as slash and burn because under shifting cultivation, farmers clear the natural vegetation, cut it into pieces and then burn the cuttings or cleared vegettion.

Source: http://www.scienceclarified.com/Ro-Sp/Slash-and-Burn-Agriculture.html

Figure 12.276: Slash and burn or shifting cultivation

Shifting cultivation is practiced especially in tropical region of Africa (example: Chipanga in Zimbabwe, Chitemene in Zambia and Masole in DRC), Central America (Milpa) in Mexico and South East Asia (Ladang in Malaysia).

The main crops planted under shifting cultivation are mainly starchy foods such as cassava, sweet potatoes, maize, millet, yams, etc.

Characteristics of shifting cultivation

- The farmers grow enough food to feed themselves and their families.
- Practiced by remote tribal people residing in forests.
- The land to be cultivated usually is cleared from virgin forests.
- The farmer uses fire in the process of clearing of land for cultivation.
- The pieces of land cultivated are usually very small. They rarely reach beyond 1-2 hectares.
- The plots of land cultivated are isolated from each other. Such are separated from one another by patches of forests.
- Traditional tools are used. These include digging sticks, pangas, and simple hoes.
- The farmer usually uses family members as labour force.
- The farmer abandons the piece of land when the crop yields decline and goes to a new part of forest to cultivate.

– The yields produced hardly support the food demands of the family. This calls for supplementing the crop yields with fruit gathering and bush meant from hunting.

Advantages and disadvantages of shifting cultivation

Advantages of shifting cultivation	Disadvantages of shifting cultivation
– Different crops grown increase productivity in terms of food crops. – Burning involves production of ashes which assist in soil fertility. – It is simple because does not require large sums of money to clear the forest patches. – Family labour is used in the production process. – Burning helps to improve soil fertility because it adds potash to the soil. – Burning also improves aeration of soil because it creates cracks and softens soil making it easy for water and air saturation. – Regular movements guarantee fresh sites, which are fertile. – Soil erosion is not serious because only small patches are affected and these support many crops so that little bare soil is seen.	– Although burning helps to increase soil fertility, it destroys organic matter and soil bacteria hence affecting soil formation. – Low productivity because the plots are small and due to poor control of pests and diseases, and soil management measures. – This practice involves deforestation that leads to environmental degradation. – The system can be applied on the sparsely populated areas. – It leads to destruction of valuable tree species, which would otherwise be used for timber and other wood products. – Destruction of ozone layer due to burning of bushes and grasses. – It does not encourage the development of monetary economy as farmers produce crops for their own consumption. – Under shifting cultivation there is uneconomical use of land. – It does not facilitate the development of infrastructure such as roads, health centers and schools since people are constantly shifting.

(ii) Bush fallowing

Bush fallowing is a system of farming whereby the farmer cultivates one piece of land for some years and leave it thereafter with the aim of restoring naturally its fertility. Meanwhile, the farmer will be cultivating another piece of land.

Fallow land is a land that is left dormant between planting seasons in order to allow the soil to regenerate its mineral base. In general terms, fallow means field where nothing is growing and left to rest to gain fertility.

Bush fallowing method differs from shifting cultivation in that farmers are settled and hence are rotating rather than shifting to a new home. This system of cultivation is the simplest form of sedentary farming. It replaces shifting cultivation after this has failed to perform well due to rapid increase in population.

Bush fallow farming practically occurs mainly in the humid tropics of Africa, South and Central America, Southeast Asia, and parts of Oceania.

Characteristics of bush fallowing

- It is mainly practiced by peasant farmers due to lack of agricultural inputs.
- Simple tools are used.
- The family is the main source of labour.
- Farmers are settled but the farms are the ones which are rotating.
- Bush fallowing is practiced where population density is very low.
- Farmlands are left to fallow after one or two years of cultivation.
- Farming is based on permanent and semi-permanent settlements.
- Farming depends on natural conditions for example rainfall, temperature and soil.

Advantages and disadvantages of bush fallowing

The following are the main advantages and disadvantages of bush fallowing:

Advantages	Disadvantages
– It helps natural restoration of soil nutrient during the fallow period. – It ensures continuous sustenance during period of failure. – The constant move results into less risk of pests and diseases. – Soil erosion is not very serious since the land is left under fallow after few seasons. – Many crops are grown in the same field which reduces the risks of pests and diseases.	– It leads to wastage of land which could have been used for crop growing. – Although burning bushes helps to increase soil fertility, it destroys organic matter and soil bacteria hence affecting soil formation. – Slashing and burning can lead to environmental degradation as well as loss of biodiversity – There is low production because of use of low technology and simple tools. – Burning bushes leads to destruction of valuable tree species, which would otherwise be used for timber and other wood products. – It leads to land fragmentation due to increase in population. – A lot of time is wasted by clearing the fallow and bushes each time the farmer opens the fresh patch (plot) or comes back to the former field. – It does not encourage the development of infrastructures such as schools, hospitals and leads to backwardness in agriculture. – It can only be practiced in areas with sparse population where land is covered by forests and woodlands.

(iii) Small holder

This is a type of farming that is practiced in densely populated areas of the tropics. It is a more advanced form of subsistence farming where the lands are frequently cultivated and the community stays permanently in one spot. Crop rotation, mixing, inter cropping, application of fertilizers etc. are applied. Farmer grows both food and cash crops which may either be intercropped or grown separately on small pieces of land. Cash crops may include small scale coffee plantations, tea, sugarcane, etc. It is sometimes referred to as sedentary subsistence agriculture.

Source:*https://www.edie.net/news/7/Mars-launches-Farmer-Income-Lab-to-eradicate-smallholder-poverty/*

Figure 12.277: Small holder's farmers

Characteristics of small holder farming

- It is practiced in densely populated areas of the tropics.
- Both food crops and cash crops are grown intensively on the same piece of land as well as rearing of very few animals.
- Farm plots are very small and fragmented.
- As the land is small, crop rotation is practiced to preserve soil fertility as well as mulching techniques.
- Use of better farming techniques like irrigation farming on small scale, pesticides and herbicides. Manure as well as artificial fertilizers are applied on the plot.
- Available land is subdivided into small uneconomical plots to be cultivated.

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Advantages and disadvantages of small holder farming

Advantages of small holder farming	Disadvantages of small holder farming
– A variety of crops are grown and this increases production. – Constant spraying and addition of fertilizers leads to increased yields. – Since food crops are sometimes inter-planted with cash crops, the farmer earns some money from cash crops. – Soil erosion is controlled though crop rotation, mulching and agro-forestry. – Through research and demonstration schemes, the farmer acquires knowledge in crop improvement. – There is less risk of pests and diseases since plots may have different crops. – The farmer can easily get loans from farmer's credit saving schemes as well as other money lending institutions. – On small holder farms, there is maximum utilization of land. This ensures maximum supply of food throughout the year	– There is land fragmentation. This leads to loss of labour because the farmer has to travel several distances to cultivate scattered plots. – Plots are small and cannot allow plantation farming to be practiced. – Rapid population increase cannot fully be supported by small holder farms. – Crops grown on smallholder farms can easily be destroyed by natural disasters such as floods, locusts and many others. This may lead to famine. – Soil may easily lose its fertility because of repeated cultivation without giving it time to rest

12.1.2. Cooperative farming and Plantation farming

Learning activity 12.1.2

1. In your understanding, what does cooperative farming mean?
2. Describe the advantages and disadvantages of cooperative farming
3. Examine the main features of plantation farming

(a) Cooperative farming

This is a system of farming where farmers with similar interests pull their resources together to increase production and benefits. Individual farms remain intact and farming is run under cooperative organization. The object of this organization is to help each other in agriculture for their common interests. There is collective ownership of land. The farmers are also registered and governed by laws or rules and regulations sometimes established by the cooperative members themselves.

Characteristics of cooperative farming

- There is collective ownership of resources such as factories, stores, and means of transport.
- Labour is provided by the members themselves. Only few technical personnel is sometimes hired.
- Profits and losses are shared equally by members.
- Credit facilities are available to the members from the funds collected.
- The members are educated and informed about new developments from time to time.
- The farms are either scattered or consolidated into one big unit.
- Land ownership may be on collective basis.
- Marketing of the produce is done collectively.
- Cooperatives are officially registered and governed by laws and regulations.
- There is quality control of the products.
- There is easy access to credit facilities to the members from the collected funds.

Advantages and disadvantages of cooperative farming

Advantages	Disadvantages
– Cooperative societies help farmers to procure all important inputs of farming. – Cooperative farming enables farmers to consolidate their small units of land for better utilization. – A single and poor farmer cannot purchase the machinery but a cooperative society can easily purchase various machines. Hence, the reduction of the cost of production and increase in output per acre. – Cooperative farming enables farmers to live in harmony. Whereby, it creates the brotherhood and love for the members as they work for the common purpose. – Belonging to the cooperative is a better position to get efficient guidance and training that will contribute to the increase of production. – About marketing, the cooperative farming will bargain for a favourable market and this results into selling the products at maximum price. Hence the income of the individual farmer will increase. – Cooperative farming leads to the generation of employment opportunities in marketing, processing, research and other sectors. – By pooling different resources such as capital and labour together, farmers expect increase of productivity	– Cooperatives may hinder personal initiatives. The group influences and may discourage hardworking and enterprising members. – In most developing countries, processing plants set up by cooperatives often breakdown. A delay in acquiring the necessary spare parts hinders the smooth running of the cooperatives as well as mass production. – Some cooperative famers are unable to compete effectively with the more dynamic businessmen involved in the marketing and processing of production. – Sometimes there is unfair behaviour of elected or salaried executives leading to lack of confidence of farmers towards leaders. – The farming operation especially crop growing depends on natural factors. In case of climatic changes such as drought, output is therefore affected. – There are social misunderstandings and disputes created because of many people of varying personalities working together under cooperative organization. – It favours misuse of cooperative properties and sometimes are embezzled by the cooperative members.

(b) Plantation farming

Plantation farming is a form of commercial agriculture where a single crop is grown on a large area for profit. Countries that have plantation farming are those usually experiencing high annual temperatures and receive high annual rainfall. It is very distinctive type of agriculture which is practiced within the tropics especially in Africa, Asia and Latin America.

Source: *https://www.yorkshiretea.co.uk/brew-news/rwandas-fields-of-gold*
Figure 12.278: *Tea plantation in Rwanda*

Among the most important crops found on plantations are coffee, tea, rubber, oil palm, cocoa, sugarcane and wheat. Besides, fruits such as pineapples and bananas as well as fibers like cotton, hemp, jute and sisal are examples of crops that can also be grown under plantational agriculture.

Characteristics of plantation farming

- A huge labour force is required comprising of skilled, semi-skilled and unskilled workers.
- A selected crop is grown on large estates covering thousands of hectares and run by a large company or under government.
- Plantation farming requires heavy capital investment to purchase machinery and establishment of infrastructure.
- Production is mainly for the market and not for the farmers' consumption.
- There is specialization of labour.

- Plantations are scientifically managed. They use machineries, selected improved seeds, weed control, application of fertilizers etc. which results in high yields.
- Plantations are mainly owned by foreigners, large companies, the government or cooperatives which have the capital required to inject in the business.
- The crop is processed where it is grown for example sugarcane grown in Kabuye.
- There is less wastage of crop, e.g. from sugarcane the following are obtained; sugar, sweets, animal feeds, cardboards, fertilizers, etc.
- Plantations cover large scale of land/area at least over ten hectares.
- The plantation farms have well developed networks of transport connecting plantation areas, processing industries and markets.
- Plantations are normally established in sparsely populated areas.

Advantages and disadvantages of plantation farming

The following are advantages and disadvantages of plantation farming:

Advantages	Disadvantages
– Plantation farming offers employment opportunities. Many people skilled and unskilled labour are intensively employed. – Plantation farming stimulates the development of industries especially the agro-based industries because they provide raw materials. – Plantation farming leads to the development of infrastructures such as roads. – The country raises foreign exchange when the crops are exported. – It offers social services to the workers: e.g. medical care, educational services, recreational facilities, etc. – It is a source of income to the government through taxation. – It improves the standard of living of the people as it provides market to rural people. – It has helped to foster international relationship with other countries through international trade. – People living nearby the plantations get the technical knowledge of how to grow similar crops besides the plantation. – It provides market to the out growers – It leads to the development of urban centres. – Marketing of crops is much easier and relatively cheap. – Plantations owners can easily get loans from the government. – Favours training of farmers and development of cooperatives.	– The cost of setting up a plantation is very high. This discourages small farmers to establish estate farming. – The agricultural produce such as tea and coffee are subject to price fluctuations. This leads to severe losses when the prices go down. – The cultivation of one type of crop (Monoculture) exhausts the soils hence, reducing their fertility and therefore productivity. – It is expensive because many people cannot manage. – It can lead to famine because food crop cultivation is neglected. – Repatriation of profits to their home country instead of developing the country where the plantation is. This is because of plantations are mainly owned by foreigners. – Plantations lead to the displacement of people because large areas are required. – Plantations are costly because long gestation periods where investors have to wait for a long before first crop harvest. – When there is an outbreak of diseases or pests, the crop may be destroyed and the investor many have no alternative crop to depend on.

12.1.3. Market gardening, Horticulture and Truck farming

Learning activity 12.1.3

1. How does Market gardening differ from horticulture?
2. Describe the main features of truck farming.

a) Market gardening

A **market garden** is a form of farming that is relatively small-scale specializing in cultivation of fruits, vegetables and flowers as cash crops, frequently sold directly to nearby consumers and restaurants. This form of farming is an example of intensive commercial farming. This so because it involves growing of crops on small plots of land which are scientifically managed.

Most of market gardens are located near the cities or outside the city suburb areas. This practice is best developed in densely populated industrial and urbanized countries such as the Netherlands, U.S.A, Germany, Denmark, Belgium, Canada etc.

Source: https://permaculturenews.org/2011/06/09/planning-our-organic-market-garden/
Figure *12.279: Different horticultural crops are grown on the same plot*

Characteristics of market gardening

- Farms are generally small.
- The land is intensively farmed, i.e., getting maximum yield from limited land.
- Vegetation may be grown on the field or under glass.

- Fertilizers and manures are applied to improve on the fertility of the soil.
- It is carried out mostly in urban and semi urban areas.
- The products are sold while still fresh to avoid risk of perishability.
- The products have high demand especially in urban centres.
- A lot of capital is invested and used in the farming activities.
- Much attention is given to the crop and most of the work is done by hand labour. It is therefore labour intensive.
- Irrigation is always practiced.

Advantages and disadvantages of market gardening

The following are advantages and disadvantages of market gardening:

Advantages	Disadvantages
– This farming practice provide large profits to the producer, investors or the owners. – It does not require large tract of land. – Farmers have more opportunities to obtain farming skills such as application of fertilizers, controlling pests, seed selection and irrigation and nursery management – Under this farming, the Government gets much revenue from taxes. – Market gardening creates employment opportunities since most of the activities are labour intensive. – It develops infrastructure since its products are sold while still fresh to avoid risk of perishability	– It puts traditional farmers out of business. Since intensive farming allows the production of much greater volumes of fruit off a much smaller area of land, traditional farmers are unable to compete. – Sometimes it is very harmful to the environment due to the use of highly concentrated liquid fertilizers and a lot of deadly chemicals. – It encourages use of marginal lands near urban centres which promotes environmental degradation and ecological problems. – Fluctuation in market prices of the crops grown hence affecting the income of the farmers.

b) Horticulture

Horticulture may be broadly defined as the science and art of growing fruits, vegetables, flowers and crops like spices, condiments and other plantation crops. The word Horticulture is derived from the Latin word "Hortus" meaning enclosure (garden) and culture meaning cultivation. Thus Horticulture means culture or cultivation of garden crops. The horticultural activity involves planting and tending to planted ornamental and food plants.


A


B

Figure 12.280: A Nursery Plants at Nyagasambu *B Tulip flowers garden, Amsterdam*

This type of agriculture is well developed in densely populated industrial districts of North West Europe, north Eastern United States of America and the Mediterranean regions. The Netherlands specializes in growing of flowers and horticultural crops especially tulip.

Characteristics

- Most of the work on the farm is done manually while machines are used in some cases where farms are fairly large.
- Modern tools of crop production are used to ensure high yield.
- The farms are relatively small in terms of size and are located where there are good transportation links with the urban centre where high income group of consumers is located.
- The land is intensively used in order to obtain maximum produce.
- Irrigation is highly recommended in this farming.
- There is use of greenhouse and artificial heating in colder regions or seasons.

Advantages and disadvantages of horticulture

The following are advantages and disadvantages of horticulture:

Advantages	Disadvantages
– The horticulture needs small plots and not huge plot of land. – It brings immediate income to the farmers. – Ability to transplant without waiting. – The study of horticulture has led to cross-bred species of plants that increase the nutritional value of the fruits or vegetables the plant yields. – It is environmental friendly because of using less pesticides and herbicides. – It is easy to be managed and controlled as it is practiced on small plots. – There is high sustainability and biodiversity conservation. – Horticulture doesn't need the removal of all the trees in order to use farm. – It is possible to cultivate different plants at the time and on the farm even if it is a small plot.	– Horticulture needs a lot of labour. – The size and significance of the horticultural sector is not always supported in the farm community and by policy makers. – It cannot be applied on a larger scale because its maintenance is not easy.

(c) Truck farming

Truck farming is a horticultural practice of growing one or more vegetable crops on a large scale for shipment to distant markets. It is usually less intensive and diversified than market gardening. At first this type of farming depended entirely on local or regional markets. The common crops grown include apples, asparagus, cabbages, Irish potatoes, string beans, cherries, and lettuce. Truck farming is another term for market gardening.

Characteristics of truck farming

1. It is basically been used when the agriculture field is not relatively close to the city where the product has to be sold.
2. It is basically used for the products like flowers, vegetables, fruits which have a risk of being spoilt fast.
3. This form of farming is used when the product is in accurate quantity and low weight products like vegetables, fruits, milk etc.

Advantages and disadvantages of truck farming

Advantages of truck farming	Disadvantages of truck farming
– Truck farming produce more fruit per unit of land. – It requires less resources and less labour. – Truck farming provides fresh fruits and vegetable to consumers. – It enable farmers to grow a variety of fruits and vegetable in the same plot – Trucks used in this farming are able to reach many potential client in distant urban centers.	– Risk of decay when trucks delay in the way due to traffic jam. – It puts traditional farmers out of business. This means that traditional farmers are unable to compete with truck farming that produce much great volume of fruit and vegetable on smaller area of land. – It is often mechanized hence less jobs. Such rises the rate of unemployment. – It is sometimes harmful to the environment since there is use of chemicals and fertilizers. Finally these often find their way into the surrounding environment through rainwater runoff, where they contribute to soil and water pollution.

12.1.4. Collective agriculture and Commune farming

Learning activity 12.1.4

1. In your own words, explain collective agriculture.
2. Agriculture is the best motor of growth for many countries especially developing ones:

(i) State two forms of farming adopted by Russia and China respectively.

(ii) Analyze the main features of commune farming system.

a) Collective agriculture

Collective farming is cooperative organization in which farmers joined together to collectively grow crops on land worked in common. This form of farming is practiced in communist countries such as Russia, Poland and Bulgaria. It involves the voluntary or compulsory grouping of land into large units with the purpose of increasing productivity and modernizing agriculture.

This form of farming was established by the government to reduce unequal distribution of land which was a bottleneck to production. Three types of farm units thus, emerged in the Russia. These are: Soviet Union Collective farms (Kolkhozes), State farms (Sovkhoze) and small private plots.

Characteristics of collective farming

- Farms are merged to form a larger farm unit either voluntarily or compulsorily;
- The types of crops grown are specified;
- On the farms, there is a use of machines;
- Farms are managed communally or selected committees;
- The proceeds from the sale of farm produce are shared among the members;
- The marketing of the produce is under control of the state;
- Farmers are allowed to take some limited quantity of produce from their own crops and livestock.

Advantages of collective farming	Disadvantages of collective farming
– New techniques in farming are learnt by peasant farmers (e.g. irrigation, disease control) which help to increase the production of food and cash crops. – The amalgamation of farms resulted into large-scale production and therefore increased output. – Farmers receive income in return for the work they do, this has increased their standards of living. – The profit obtained depends on individual skills, performance, the nature of their work and the hours they spent. – Collectivization allows the diversification in farming and the economy. – The opening of new lands has greatly encouraged and promoted the development of infrastructure such as roads, canals and railways. – There has been easy provision of social facilities such as hospitals, transport facilities, water, electricity etc. – The increase in agricultural products for export has led to increased foreign exchange earnings. – Under this type of farming, it has been easy for the government to supervise all activities as long as there is a uniform type of land tenure. – Since all farmers work together, this has created a strong friendship and unit amongst the members.	– The farming system did not take account the peasant's aspirations. – The central government took the bulk of the harvest at fixed prices far below the prevailing market prices. – Payment to farmers was very low and this contributed to the low standards of living. – The use of force provoked uprisings among the peasants, particularly the so -called women's revolts in Ukraine. – Collectivization reduces the yield because the collective farms were poorly run and managed by inexperienced cadres. – Land owners that resisted giving up their land, even as little as two thirds of an acre, were often executed. – Farmers were forced to work on the farms and those who refused to work were punished. This acted as a discouragement time for them to work.

b) Commune farming

A commune word literally means a large gathering of people sharing common life. Communes were formed in the late 1950s as Chinese president named Mao tried to force rural people to live a more communist way of life. The Chinese commune is not merely an agricultural commune. Instead a standard for "unified management and deployment of labour power and means of production on a larger scale"

The structure of the commune was such that households were organized into teams, then teams formed brigades, and brigades formed the commune. Each level of organization was responsible for given activities.

Characteristics of communes

- Land was collectively owned by the members of the commune.
- Work on the land was done collectively. All members worked together to plough the land, plant, weed and harvest.
- Preparation of meals for the members of work-team was done in one place and serving was by cafeteria method and kitchen utensils were owned collectively.
- Returns from the farm were shared equally by all members of the team.

Advantages and disadvantages of communes in China

Advantages	Disadvantages
– Through this system, the Chinese have been able to increase agricultural output to feed the larger population with the crops grown such as rice and wheat. – Under commune farms, cooperation and teamwork among farmers are strongly encouraged. – Communes are contributed to the growth of urban centres such as Shanghai and Nanjing as each commune has its own headquarters. – Under this system, industrial development is taking place. – Any surplus produce from the commune is exported and this earns the country foreign exchange. – Communes help to have access to modern farming techniques, conservation of the soil and economic use of land. – Communes undertake research to improve agricultural production under the government support.	– Governmental policies often are implemented using forceful approach in all regions. These however, may not be suitable for every region. – The system of farming discourages advanced forms of farming since labour intensive techniques are emphasized. – The compulsory grouping of people into large units discourages individual initiative – Decisions such as what to grow, when to grow, how to grow and where to grow are undertaken by central communities with so many people to consult. – Yields are sometimes affected by harsh climatic conditions especially drought during summer months and a severe frost during winter. – Sometimes overproduction leads to price fluctuation of the produce that in turn it affects income.

Application activity 12.1

Using your knowledge and skills acquired in the previous lessons,

1. Examine the effects of rapid population growth on small scale agriculture.
2. Using geographical documents and internet, discuss on the use of cocoa and rubber.
3. Collectivization in Russia was set as possible solution to the food crisis. In your view, did this system resolve the problem?

12.2. Factors for increasing the agricultural production and problems affecting the agriculture in the developing countries

Learning activity 12.2

Discuss factors that contribute to the increase of agricultural production.

Explain the major challenges facing agriculture in developing countries.

12.2.1. Factors for increasing the agricultural production

Many factors act together to influence the productivity and profitable income from the agriculture. These factors include some of the following:

- **Relief:** The farming system adopted depends on the relief of the area. So, relief may influence the increase of agricultural production in different ways:
  a. Lowlands, such as flood plains, are more productive agriculturally.
  b. Steep slopes are obstacles to the machinery use and have thinner soils. On the other hand, gentle slopes are less prone to soil erosion.
  c. For some crops like Tea and coffee crops do well in the well-drained soil on hill slopes, while rice and sugar do well in lowland areas.
- **Soil:** The type and characteristics of soil in a certain area determine the type of farming to be practiced. Areas with fertile soils encourage crop farming, while places with poor and thin soils discourage crop growing, instead, favour rearing of animals.
- **Drainage**: Market gardening and horticulture prefer swampy areas just because of the presence of permanent water. On general perspective, many crops grow well in areas that are well-drained.
- **Climate:** Agriculture is highly dependent on climate. It is known that an increase in temperature and carbon dioxide can increase some crop yield in some places. But to realize these benefits, nutrient levels, soil moisture, presence of water, and other conditions must also be met. A prolonged drought season leads to drying of crops and pasture for animal leading to poor yields. On other hand, a reliable rainfall in an area is vital for crop growing.
- **Capital**: This is factor that supports all agricultural practices. Capital is the money the farmer must invest in agricultural activities. It is useful to increase the amount of different inputs into the farm, but this requires capital. If a farmer is capable of affording to have adequate capital, yields will immediately rise. This can create big profits in turn which could be used for more investment.
- **Technology:** Advanced in technology development play a big role in agriculture. Proper use of technology helps in extending the area of optimal conditions and maximizes the expectations of farmers.

- **Market:** The wish of any farmer is to grow crops which are highly demanded. Therefore, for agriculture to flourish, there must be already market for the produce.
- **The Government policy**: The government may influence a given agricultural practice. Policies such as mechanization of agriculture, agricultural regionalization, and establishment of a friendly pricing system have a direct impact on the prosperity of agriculture.

12.2.2. Problems affecting the agriculture in the developing countries

Here are some problems facing farmers in developing countries:

- **Harsh climate:** Despite the great advances that have been achieved in technological development, people do not have any control over climate. Example, they cannot increase rainfall in the deserts nor they cannot prevent the rivers of the temperate regions from freezing. So, agriculture is affected by the seasonal nature of rainfall which makes agricultural planning more difficult.
- **Infertile soil**: Soil is a medium in which plant grow. Large areas of the tropical region have infertile soils. This affects crop productivity.
- **Rugged relief:** It refers to the mountainous landscape. Very high mountainous areas hinder agricultural activities because of the extreme low temperature, thin soils and steep slope. Steep relief limits the agricultural mechanization.
- **Lack of information**: Most of small scale farmers in Africa and developing world are not informed of new and improved methods of farming. Some especially those living in remote areas have no access to information and modernization at all. Even in cases where there is some access to information, most poor farmers are unable to discern due to illiteracy which is high in most of rural areas in developing world.
- **Limited capital:** Most farmers in Africa are poor financially making it almost impossible for them to adopt new farming practices. Financial support enables farmers to grow, expand, and maintain their yields by purchasing farm machinery, agro-chemicals, fertilizers, better seed varieties and to open up irrigation systems and other agricultural inputs.
- **Poor transport system**: This is a major challenge facing agriculture and the economies in general throughout developing world. Most of the farm produce in these countries just get wasted in the remote areas. This is because such areas are not connected to market centres. This is because farmers find it very difficult transporting their farm produce to the market to sell.

- **Poor market**: Lack of market facilities and poor government regulations make it almost impossible for farmers especially small-scale farmers to market their farm produce. Another issue is low prices paid to farmers for their harvest which sometimes discourage some of them.
- **Poor technology:** Farmers in developing countries are still using simple tools like hoes, axes, pangas and digging sticks which results into low yielding per unit area.
- **Limited research**: Research is a key to develop high-yielding crop varieties. In many developing countries, carrying out research in agriculture is limited due to insufficient financial support and lack of technical personnel to conduct the research.
- **Rapid population growth:** Population pressure on land results into land scarcity, fragmentation and overexploitation of land leading to soil exhaustion. This has ultimately resulted into environmental degradation and poor crop yields.
- **Natural hazards:** Many risks and uncertainties are involved in agriculture. These include floods, landslides, drought, and heavy rainfall that destroy crop yields. In the end, poor harvests led to famine.
- **Political instability:** Some countries in Africa and Asia do not experience adequate peace and security due to alternate and continuous conflict in their regions. This results in abandonment of farms as people are constantly fleeing wars. The wars destroy farm machinery and does not allow a long-term planning necessary to develop and improve the agricultural sector.

Application activity 12.2

The African land can provide all that people need to survive. Unfortunately, much of this land is untapped. What can people do to improve agricultural productivity?

In reference to Rwanda, discuss factors affecting the agriculture in the developing countries.

12.3. Case studies of crop growing in selected countries

12.3.1. Sugarcane in South Africa and Rubber grown in Liberia

Learning activity 12.3.1

Describe the conditions required for sugarcane growing in South Africa

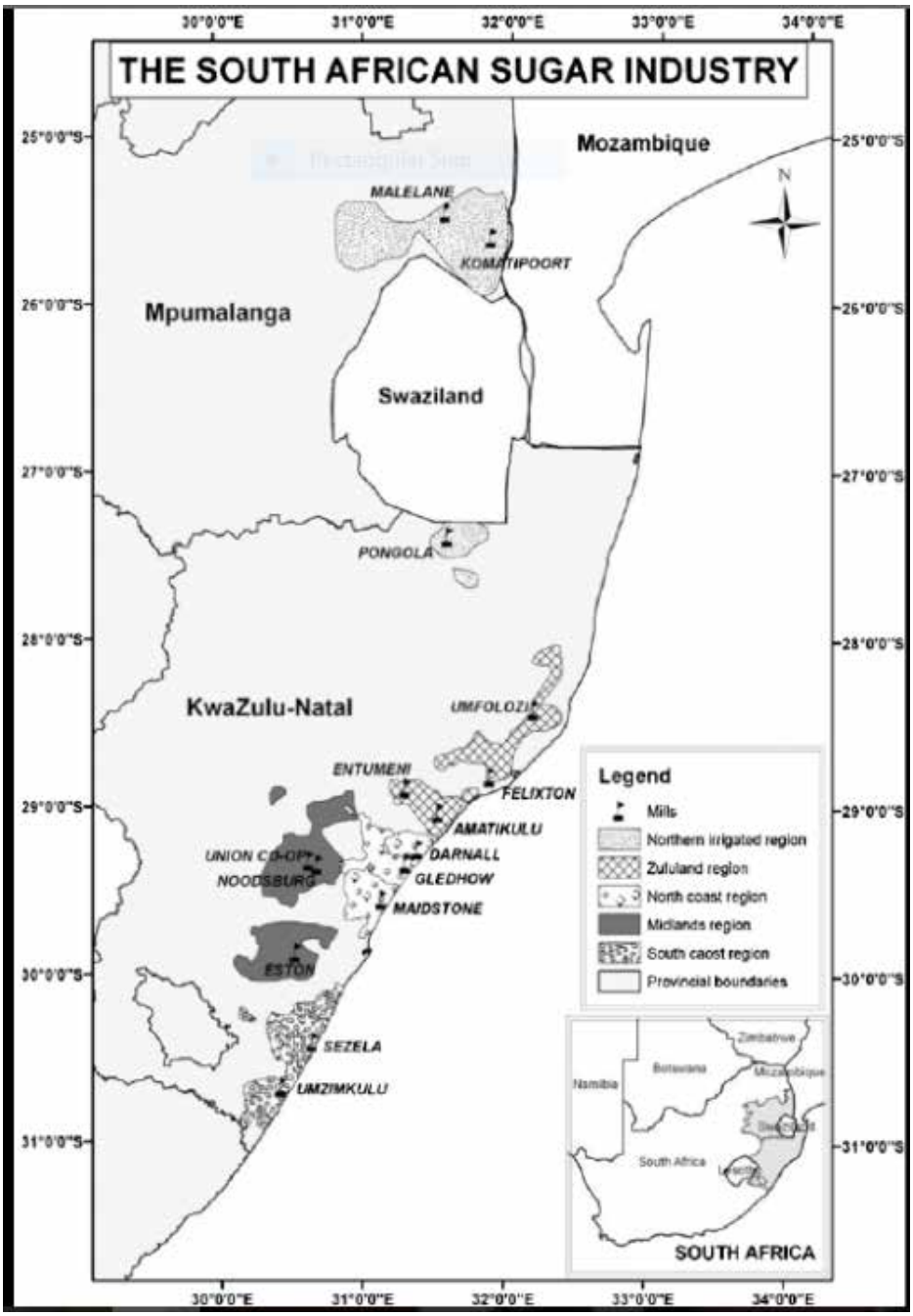
Explain four major problems facing rubber growing in Liberia.

a) Sugarcane in South Africa

Sugarcane is a tall perennial plant that grows between 2 and 5 metres. It is common in tropical and subtropical countries. Several different horticultural varieties are known, and they differ by their stem colour and length. A sugar stem is cut from the sugarcane at 12 to 16 months after it has been planted. The sugarcane is the second largest South African field crop by gross value which is only surpassed by maize. The South African sugar industry is consistently ranking in the top 15 out of approximately 120 sugar producing countries worldwide. The approximately 22,500 registered sugarcane growers annually produce on average 19 million tons of sugar from 14 mill supply areas. Approximately 21,110 are small-scale growers, of whom 12,507 delivered cane in 2015, producing 9.4% of the total crop.

(i) Major sugarcane production areas in South Africa

The sugarcane is mainly grown in KwaZulu-Natal, Mpumalanga and the Eastern Cape Province. In KwaZulu-Natal province, it is produced in Pongola, Umfolozi, Felixton, Amatikulu, Darnall, Gledhow, Maidstone, Sezela, Umzimkulu, Dalton, Noodsberg and Eston areas. In Mpumalanga province, it is produced at Malalane and Komatipoort. Today KwaZulu –Natal has some of the best sugar crops in the world.



Source: https://www.researchgate.net/figure/Map-of-the-SA-sugar-industry-showing-mill-supply-areas-and-agro-climatic-regions_fig1_257214148

Figure 12.281: The South African sugarcane industry.

(ii) Factors favouring sugarcane growing in South Africa

- **Favourable temperature:** Sugarcane grows best in warm, sunny and frost-free weather areas. It requires a tropical or subtropical climate with a minimum of 600 mm of annual moisture. It can grow well where the temperature ranges from 20 to 35 °C.
- **There is flat relief**: This provides hot conditions necessary for sugarcane growing and facilitates the establishment of transport network to the processing factories for sugar.
- **Warm current:** The presence of Southward flowing warm Mozambique current in combination with on shore winds that blow over the area bringing warm moist conditions to coast areas especially at of Natal.
- **Irrigation systems**: South Africa has numerous water bodies which help in irrigation depending on the stage of development of the cane.
- **Presence of labour**: There is both skilled and unskilled manpower from within the country and neighbouring countries.
- **Various means of transport**: Availability of well-developed transport network facilitates both internal and international trade.
- **Availability of fertile soil**: The coastal areas have alluvial soils due to the presence of delta. This supports the growth of sugarcanes.
- There is an extensive land for sugar cultivation.
- **Powerful management:** Cane growers are represented by the South African Cane Growers Association which is one of the most influential cooperatives in South Africa and the whole world at large.
- **Presence of large ready market**: South Africa has a large population as well as its neighbours. This provides a large internal and external market for the produced sugar. The South African Customs Union (SACU) is the primary market for the South African sugar industry. The SACU market comprises South Africa, Botswana, Lesotho, Namibia and Swaziland.
- Availability of enough capital to invest in the growing and processing of sugarcanes: Sugarcane growers belong to cooperatives hence, inject a huge sum of money in plantation agriculture. This money contributes in purchasing of equipment, housing estates, establishing the processing industries, hire large labour force and use of fertilizers.
- **Use of high technology**: South Africa has developed a high and sophisticated technology to use in sugarcane plantation and sugarcane processing.

(iii) Socio-economic contribution of sugarcane plantation in South Africa

Sugarcane plantations have provided the following benefits to the country as follows:

- **It provides employment** opportunities to many South Africans. According to the South African Sugar Association estimates 69, 79,000 direct jobs and 350,000 indirect jobs are associated with sugarcane production and processing in South Africa.
- **Infrastructural development:** Sugarcane growing has stimulated the development of infrastructure in different domains such as educational, health facilities, roads and railways for workers on the plantation.
- **Source of foreign exchange:** It has promoted international trade where sugar is exported to generate foreign exchange.
- **Industrial development:** The plantations has promoted the establishment of factories in the area and provides raw materials for the sugar processing industries.
- **Provision of sugar as beverage:** South Africa produces enough sugar for its population and her neighbouring countries. Thus, saving the country from the high costs associated with importation of sugar.
- **Development of towns:** Various towns have developed in the sugar growing regions due to establishment of sugar plantations and sugar factory processing.
- **Government revenue:** The government has collected a lot of revenue through taxation of workers, owners of the plantations and industries.
- Sugarcane is used for sugar production, as raw material of livestock fodder and fertilizer. Sugarcane is then used in producing an infinite number of products. Such as sucrose which is used as a sweetening agent for foods and in the manufacturing of cakes, candies, preservations, soft drinks, alcohol and numerous other foods.
- Sugarcane has also been used to manufacture biofuel which serves as a replacement for oil-based fuel and related products.

(iv) Challenges facing sugarcane growing in South Africa

- **Pest and diseases:** Sugarcane is usually affected by a variety of diseases and pests. Many insects and infections that spread quickly attack sugarcanes, which results into low output.
- **Weeds:** Sugarcane is most susceptible to weed competition during the first eight to 10 weeks after sugarcane begins to sprout.

- **Soil exhaustion:** Sugarcane is grown on a large area under monoculture which promotes soil erosion. This results into soil exhaustion.
- **Foreign competition:** South Africa competes with other sugar producers such as Nigeria, Sudan, Egypt, Malawi, DRC and Zimbabwe. With such competition, they sell at a bargaining price that reduces the profit margin.
- **Shortage of labour:** Sometime there is inadequate labour supply during busy period of harvesting.
- **There is flooding episodes:** As the sugarcane plantations are in lowland areas; they are frequently destroyed by flooding episodes.
- **Poor sugarcane variety:** There is general lack of improved seed varieties of sugarcane. This has made the plantations to only depend on the indigenous ones which have a low yielding capacity.

b) Rubber grown in Liberia

Rubber also known as Hevea brasiliensis is a fast-growing upright tropical tree crop which is primarily cultivated for its production of latex. Latex is a milky plant liquid that serves as a basis for various rubber products. It is a typical plantation crop in Liberia. The first rubber plantation in Liberia was established in 1926 by American great company; Firestone. The rubber plantation areas in Liberia are shown on the map below.

Source:http://www.kleanindustries.com/s/environmental_market_industry_news.asp?ReportID=615360
Figure 12.282: Map of Liberia showing rubber growing areas

Since 1926, rubber has been the cornerstone of the Liberian economy, even in post-conflict Liberia. This commodity remains the country's most important cash crop.

(i) Factors favouring rubber plantation in Liberia

Rubber is a perennial crop and its growth requires the following physical, and social and economic factors:

- The tree's growth requires deep soils to sustain rubber for a long period of time without application of artificial fertilizers.
- Heavy rainfall ranging from 1500-2500mm which is well distributed throughout the year.
- Relatively stable high temperatures of 240C to 270C and continuous moisture throughout the year.
- Suitable grown and harvested over large uniform areas (3,000 to 5,000ha) around a central treatment unit to allow for a relatively rapid industrial handling after harvesting.
- Bright sunny days of about 6 hours per day, particularly during harvesting.
- Presence of investors, especially big American companies such as Firestone and Allan L Grant, have injected much money for rubber production.
- Favourable government policy towards rubber plantation where for example, the government provides free hectares of land for any organization that would use the land for farming or plantation.

(ii) Contribution of rubber growing to the Liberian economy

- Rubber is currently Liberia's most important export commodity, and the five largest companies in Liberia operate in this sector.
- The companies operating in Liberia are deeply committed to providing jobs to many people. For example, in 2016 an estimated 30,000 people were employed by commercial rubber farms and up to 60,000 smallholder households were involved in growing of rubber trees.
- Firestone has spent much money in infrastructural projects that include building new housing for employees, building schools, medical centers and rehabilitating roads.
- Firestone provides free education for the children of their employees.
- Besides the rubber growing, companies conduct research on other subsistence and cash crops appropriate to Liberia's soils and climate.
- Government earns revenue from the rubber growers, workers and plantation owners through taxation.

- Workers acquire skills from rubber plantations especially in relation to better methods of rubber growing. These are used to improve their own small-scale farming as out growers.
- Rubber growing has stimulated creation and development of new towns in the area.
- It is used to manufacture shoe soles, rubber boots, tires and tubes. It is also used in manufacturing of balls for sports, doors and window profiles, latex foam, cables and wires, battery boxes, air bags, life jackets and life floats, adhesives, tubes, belts, carpets/mats, condoms, gloves for medical use, household and industrial use.

(iii) Challenges of rubber growing in Liberia

The following are the key challenges facing the rubber growing in Liberia:

- The sector is reportedly on the verge of collapse as many of the smallholders lack the capital to renew the plantations which are coming to the end of their productive life.
- There has been price fluctuation on rubber market. This has negatively affected small farmers who depend on big plantation owners to buy their rubber and do the marketing on their behalf.
- Sometimes natural rubber competes with synthetic materials from petroleum which is cheaper compared to natural rubber.
- soil exhaustion because of continuous monoculture growing.
- Rubber is a perennial crop which means it takes about six years to mature. Meanwhile there is no income gained during such a long gestation period.
- Occurrence of environment degradation due to repeatedly application of fertilizers and chemicals to improve the quality of the soil and control of the pests.
- The growth of new urban centers in the area is associated with problems such as congestion, high crime rates and unemployment.

12.3.2. Coffee growing in Brazil and Cotton grown in Sudan

Learning activity 12.3.2

Explain the significance of coffee growing to the economy of Brazil.

Describe conditions required to grow cotton in Sudan.

a) Coffee grown in Brazil

Brazil is the world's largest producer of coffee for the last 150 years. The total area covered by coffee plantations known as fazenda is 27,000 km2, mostly located in the Southeast states of Minas Gerais, Sao Paulo, Espirito Santo, Bahia, Rondonia and Parana. These areas provide a conducive environment and ideal climate for coffee growing. The first coffee tree in Brazil was planted in the state of Para in 1727.The largest buyers of the Brazilian coffee in the world are: Germany, United States, Italy, Japan and Belgium. Brazil is not the only first exporter of coffee worldwide. However, it is one of the leading consumers of coffee with an estimated total population of 210,867,954 (2018).

Source: http://www.brasilbar.com/blog/archives/brazils-coffee-regions

Figure12. 283: coffee plantation areas in Brazil

Santos is and has historically been the main gateway for coffee exports in Brazil. The Brazilian coffee is mostly exported as: Green coffee, soluble coffee, roasted and ground coffee, concentrated and essential extracts and coffee residues.

(i) Factors favouring coffee growing in Brazil

The following are conditions favouring coffee growing in Brazil:

- Abundant rainfall in Brazil due to its location around equator which encourages the growth of coffee.
- Presence of well-drained soils like the terra-roxa which contain much potash as well organic material, favour the growth of coffee.
- Coffee growing requires a large labour force because the job of picking is done manually.

- Coffee growing as any other plantation requires a huge sum of capital. This is because during the first three to four years returns from coffee plantation are nil and expenditure are more.
- Presence of well-developed transport for both internal and external connections.
- Coffee grown in Brazil is internationally known. Brazil produce a high-quality coffee. This has abled the country to compete at international market.
- Increased investments in improving labour skills and incorporating new technology.
- Liberalization of trade and accepting more completion from foreign producers in local and international markets.
- Privatization of States-owned enterprises.

(ii) Contribution of coffee growing in Brazil

- Coffee is considered as the most important export items. It generates foreign exchange and has a major impact on the gross domestic product of the country.
- Coffee growing generates employment opportunities to many people in Brazil and in the region.
- The growing of coffee is associated with the development of other sectors of economy in Brazil.
- Coffee production has stimulated the commercial activities in Brazil. Hence, enabling the country to participate in the world trade.
- The government earns revenue through taxes from big companies.
- Development of towns and cities in places around coffee plantation.

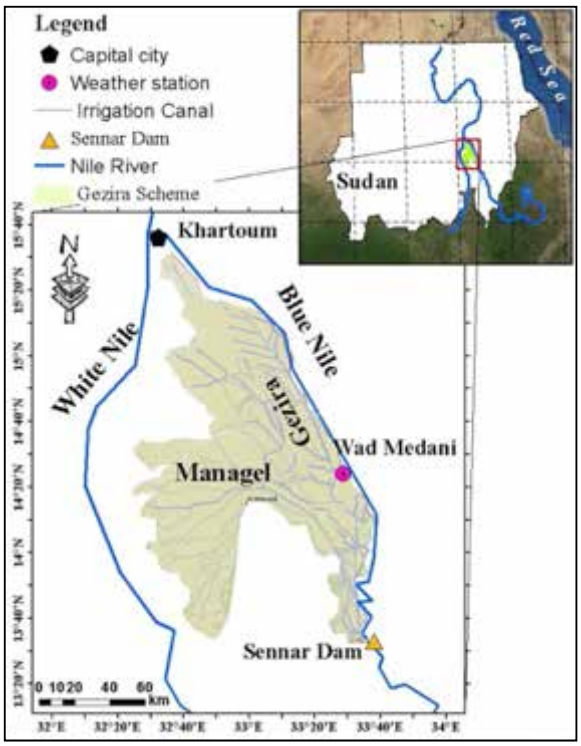
(iii) Problems facing coffee growing

- Presence of pests, diseases and fungi have become a real threat for many coffee producers. The notorious coffee leaf rust has caused many damages.
- Coffee producers are poorly paid compared to other rich industries.
- Harsh climatic conditions due to changes in climate that have resulted into the rising of temperatures. This has made the growing of Arabica coffee challenging, because it needs to grow under cooler temperatures than any other species.
- Unpredictable heavy rainfall causes serious problems during harvesting and processing period.
- Shortage of workers because coffee processing requires manpower at every stage.
- Sometimes growers get low profits relatively to their efforts due to the price fluctuation in the international market.
- High cost of production has also reduced the profits expected by the coffee growers and the companies engaged in processing of coffee.

b) Cotton grown in Sudan

Knowledge of cotton planting in Sudan goes back to the 19th century when it was grown for the first time in Eastern Sudan (Tokar area). Commercial growing started in 1905 at Zeidab Pilot Scheme in Northern Sudan. In 1925 there was a landmark in irrigated agriculturalproduction in Sudan after the establishment of Sennar dam. Since then, cotton assumes a leading role as a cash crop.

The organization of cotton production in Sudan started through establishing large governmental administrations which involved farmers. After the enforcement of the Gezira Scheme Act in 2005, this relationship started to change. Such resulted into the relaxation of Government's strong grip on the scheme's operations and management. At least, there is minimal participation of Government and active private sector involvement.



Source: https://www.sciencedirect.com/science/article/pii/S0308521X14001413

Figure 12.284: Gezira scheme in sudan

(i) Factors encouraging cotton growing in Sudan

- The availability of water resources: rain, rivers and surface water. Cotton is planted in Sudan on both areas associated with flood irrigation systems and rain-fed areas.
- Sudan has a vast land with diverse soil. Cotton succeeds in various soil types from heavy clay to light sandy soils; it also has a good tolerance to soil salinity, but it requires good drainage.
- Availability of extensive land to set up large irrigation scheme.
- The area under cultivation has increased due to the establishment of Gezira irrigation scheme.
- Presence of ginneries and textile factories in addition to oil mills.

– Warm temperature during the growing season of about 250C.
– Well distributed rainfall during the growing season between 500-700 mm (but enhanced with irrigation since it is an arid area).
– Many areas have fertile alluvial soils deposited in times of river flooding. For example, the area between the Blue and White Nile has fertile soils deposited in time of flooding.


Figure: *12.285: Cotton in the field* *harvested cotton*

Source: *http://sanda-halcyondays.blogspot.com/2012/09/in-land-of-cotton.html*

(ii) Importance of cotton to the economy of Sudan

– The Gezira scheme has been used as modal to develop other irrigation schemes in Sudan.
– It is a source of employment which generates income that satisfies families' needs and services, stimulating the stability, development and security of the population.
– Cotton is a source of foreign exchange earnings, since it is a cash crop and exported abroad.
– Cotton is also processed locally for weaving and spinning. It has also supported cotton oil industry.
– There are direct and indirect benefits of cotton production. Examples are noticeable through its use. for example,

a) Cotton is used in making clothes in the textile and garment industries.

b) It is used in making of cattle feed such as cotton seed cake from the cotton seeds.

c) It is used in making cotton seed oil which is used for cooking.

e) Cotton is used to make soap (the remains of the cotton seeds from cotton).

d) It is used in the production of cellulose and margarine.

e) It is used as a lubricant in industries to extract metal oils.

f) It is used to make mattresses for bedding.

g) Cotton seeds are used to make diesel fuel.

h) Cotton wool is used for medical purposes such as for covering wounds and in operation of patients to prevent excessive blood loss.

(iii) Challenges of cotton in Sudan

The following are the major challenges facing cotton production in Sudan:

- Inadequate and inappropriate use of agricultural inputs like fertilizers, chemicals and pesticides.
- The low cotton yields, coupled with the high costs of production and low gross return, has detrimental effects on a farmer's decision to grow cotton. This affects Sudan's competitiveness in international cotton markets.
- There is a decline in exports due to the reduction in the area under cotton growing especially in the Gezira Scheme because of low yields.
- The cotton and sugarcane are grown as the main crop on the Gezira scheme. This results in the soil exhaustion.
- The cotton on Gezira scheme requires a large land. This has led to displacement of people which necessitated the formation of resettlement schemes.
- The use of chemicals and fertilizers has led to the pollution of water and soil.
- Low level of competition: The schemes are engaged in the production of agricultural products such as cotton, sugarcanes, wheat and other products whose prices fluctuate on the world market due to low level of competition.

Application activity 12.3

1. In reference to Rwanda, discuss the contribution of coffee in socio-economic development.

2. Identify the key factors influencing coffee growing in Brazil

3. Examine the reasons for success of cotton growing in Sudan.

4. Suggest measures that should be taken to address the challenges facing sugarcane growing in south Africa, and rubber growing in Liberia.

12.4. Livestock farming

12.4.1. Pastoralism

Learning activity 12.4.1

Using the knowledge acquired, skills and internet or other geographical documents answer the following questions:

1. Give the meaning of livestock farming?
2. Identify the major characteristics of nomadic pastoralism.
3. Describe challenges facing nomadic pastoralism in Africa.

Livestock farming refers to the keeping/rearing of domestic animals such as cows, goats, sheep and poultry (birds, donkeys). It is practiced for either commercial or subsistence purposes and it takes several forms. The following are the major types of livestock farming: nomadism, free range, transhumance, ranching, dairy farming, zero-grazing, aquaculture, poultry farming, apiculture etc. Some of these are explained below:

Pastoralism is a system of farming where farmers move with their livestock grazing especially cattle, goats and sheep to graze on natural. The movement of both people and animals is dictated by the shortage of grass and water in the area. This form of farming is divided into the following types:

(i) Pure nomadism

This is extensive form of animal grazing on natural pasturage, involving constant or seasonal migration of the nomads and their animals in search of water and pastures. Nomadic herding is confined to rather sparsely populated parts of the world where the natural vegetation is mainly grass. Many people often consider pastoralism and nomadism as being the same. But, the main difference is that pastoralism is the occupation of herding animals, especially cattle, while nomadism indicates a way of life that is attributed to "not settling in one place" or wandering.

It is practiced in West Africa among the Fulani, East Africa among the Maasai and Karamojongs, Ethiopia among Nuba, the Touareg of Sahara and the Hottentos of Botswana, Mozambique and the Republic of South Africa. It is also found in Saudi

Arabia among the Bedouins, and Central Asia among the Mongols.

Pastoralism in the world

Source: https://www2.palomar.edu/anthro/subsistence/sub_3.htm

Figure 12. 286: Location of pastoralism in the world

Characteristics of nomadic pastoralism

- Nomadism depends primarily on animal rearing rather than crop growing for survive. Nomads take milk from the animals for food and skins and hairs for clothing and tent.
- There is either seasonal pattern of movement or steady/regular movement in search of grasses and water for reared animals. These movements depend on the availability or lack of grasses and water for animals in a given climatic season.
- Extensive keeping of livestock all year round on a system of free-range grazing.
- It is practiced in the areas of low and unreliable rainfall which are typical dry season.
- Animals are kept for family subsistence and not for sale.
- The ownership of livestock is individual, but the land belongs to the tribe or community.
- Nomadic pastoralists do not value education.
- Nomadic pastoralists find prestige and pride in keeping large herds of cattle without considering of the quality of products. This is because the animals kept are of poor quality and low value.

- They prefer quantity than quality of the livestock.
- It takes place where the population is low and scarce.

Advantages of nomadic pastoralism	Disadvantages of nomadic pastoralism
– It can be done in dry areas where there is no way to grow land. – It is cheap since there is no much attention required. – It offers an alternative form of land use for otherwise unproductive marginal lands. – It ensures food for the family especially when the animals are many. – Some traditional varieties of animals are resistant to diseases hence adaptability to any environmental hardships.	– The animals produce little milk and low value that cannot satisfy large population. – This system of farming requires a lot of time to move from one place to another. – This system of livestock keeping causes soil erosion and desertification. – Many animals perish due to shortage of veterinary services

(ii) Free Range farming

Free range means a method of farming husbandry where the reared animals roam freely outdoors, rather than being confined in an enclosure for 24 hours each day. On many farms, the outdoors ranging area is fenced, thereby, technically making this an enclosure, however, free range systems usually offer the opportunity for extensive movement and sunlight prevented by indoor housing systems.

The purpose of this form of livestock farming is to achieve reduced feed costs, produce higher-quality products. This method of raising animals is carried out on a relatively large piece of land.

Free range is adapted in both developed and developing countries. In developed countries, people have become more aware of the disadvantages of factory farming. Consequently, big companies are responding by labelling their products "all-natural", "free range", "free-roaming", or "organic" to inform people that their products are free from antibiotics.

Characteristics of free range farming

- Animals roam freely for a period of the day.
- Animals reared under free-range are usually confined in sheds at night to protect them from predators.

– Or kept indoors if the weather is particularly bad.
– Mostly grazed on natural pastures.

Advantages of free range farming	Disadvantages of free range farming
– Free range farming provides organic and high-quality meat or products. – Free range farming enables farmers to save money on commercial animal feeds. This is because animals eat or graze on wild pasture respectively. – Meat of animals kept in free range present a deep and pleasant flavour because of good and healthy setting environment. – Animals kept in free range are stress free compared to the caged animals that have higher chances of developing stress and irrational behaviour leading to some diseases.	– Basing on better conditions for free range animals, they do tend to fetch high profits for the farmer. – There is a high risk from predators since animals roam freely in the open-air setting. – Animals are probably exposed to the robbers since they are raised in remote areas. – Free range animals require much attention because they may go beyond their place. For example, road, neighbour's plot etc.

(iii) Transhumance

Transhumance is the practice of moving livestock from one grazing ground to another under seasonal cycle. It involves two movements: The animals are grazed on pastures in the high parts of the Mountains in warm seasons and lower altitudes the rest of the year. Most people who practice transhumance involve in some form of crop cultivation too. Hence, relatively permanent settlement is in existence. Such type of livestock farming is practiced for instance, in Kenya and Tanzania by the Masai who are semi-nomadic in nature.

Characteristics of transhumance

– Transhumance involves constant / seasonal migration of the nomads and their livestock in search of pasture and water.
– Livestock are moved between mountain pastures in summer and lower areas for the rest of the year.
– Herders have a permanent home: this means that only the herds and the people necessary to tend them travel. The whole family lives in tents all the year round, moving with the herd but with a permanent homestead in a specific area.

- Nomads mainly rely on natural vegetation for their pasture.
- Large number of herds is kept as a sign of pride or prestige.

Advantages of transhumance	Disadvantages of transhumance
– There is manure deposition on farmers' crop fields leading to the increase of crop productivity. – Availability of animals for purchase at low cost. – Availability of milk for farmers and promotion of local trade.	– There is easy spread of diseases due to the seasonal movement of livestock. – There is abusive cutting of trees. – Damage to crop since little attention is given to the animals. – Increase in conflict between livestock farmers and crops farmers. – There is a long distance travelled by transhumant herders to look for pastures and water.

12.4.2. Factory farming, dairy farming and ranching farming

Learning activity 12.4.2

1. Describe the major features of factory farming
2. Discuss on factors favouring dairy and ranching farming

a) Factory farming

The factory farming refers to the type of farming practice which involves keeping of animals at high stocking densities and modern technology is used to facilitate faster animal growth, lower illness and death rates, and higher production outputs.

Factory farming is a production approach towards farm animals to maximize production output, while minimizing production costs. It is also known as intensive farming that refers to animal husbandry, the keeping of livestock farming such as cattle, poultry, and fish at higher stocking densities.

The idea of factory farming started because as the population continued to rapidly increase, food production wasn't happening fast enough. Therefore, to feed everyone food production needed to happen faster. This means without factory farming in densely populated countries, meat and dairy products would be rare and more expensive than it would be today.

Its primary objective is to produce adequate products and gain as much profit as

possible. The main products of this industry are meat, milk and eggs for human consumption.

***Figure 12.287**: confined hog and cow production respectively*

***Source:**https://www.learner.org/courses/envsci/visual/visual.php?shortname=confined_hogs*
***Source**: https://english.vov.vn/trade/vinamilk-imports-6000-cows-to-boost-production-328568.vov*

Characteristics of factory farming

1. Large numbers of animals are usually held together indoors in closed confined pens and sheds.
2. There are physical restraints to control unnecessary movement of animals.
3. Under factory farming, huge amount of antibiotics and pesticides are used to fight the spreading of diseases and bacteria.
4. Factory farms are highly standardized for efficiency.
5. Sigle type of animals is reared.
6. Feed crops are created highly unified through gene manipulation to help increased yielding to ensure consistent production every year.

Factory farms provide many benefits, but they can also lead to several drawbacks:

Advantages of factory farm	Disadvantages of factory farm
– It not expensive: With introduction of factory farming, the prices of food have dramatically dropped. The reason for this is that food is being processed and produced at faster rate through employing efficient processes – It is does not dependent much on human labour: Factory farming always uses modern technology. For this reason, it has freed farmers from manual labour constraints. Now, willing laborers are only picked for some tasks that really require them. While a few individuals just use machinery to do more than their hands can ever could. This brings about many benefits, including one where farmers can afford to hire better workers to complete specialized or individual tasks. – It allows for greater availability and variety: It has led to the creation of hybrid varieties of plant or and animals. Those that are disease-resistant are produced. – It has fewer geographic limitations: With factory farms, farmers have greater access to water because of irrigation. Aside from this, they have easy access to fertilizers and other technologies, such as greenhouses that minimize the impact of weather and seasonal changes on the growth of animal feeder crops. – It encourages technological development: Since factory farming is dependent on modern technology, it encourages scientists and engineers to improve existing tools and equipment and even invent new machines that make food production faster and more efficient. These innovations are helpful not only to factory farms but also to businesses in other industries since they contribute new knowledge and techniques, which can be used to improve technology as a whole.	– It risks the occurrence of animal cruelty: Animals could fall could be subjected to difficult and cruel conditions. That is, animals are kept in small pens or cages where they don't have the space to run around and do what they naturally do. In most cases, their living areas are not cleaned as often as necessary, so they're constantly surrounded by filth. – Animals in factory farms are also forced to feed on substances that make them grow faster, get bigger, and/or become ready to reproduce earlier than what nature intended. This affects their natural growth. – It can lead to high animal death rates: Because animals would be exposed to difficult conditions, they die sometimes because of stress, diseases and even heart attack. – It can have a negative impact on the environment: The hundreds or even thousands of animals in factory farms produce a large amount of waste that the farms can't handle. As a result, many of them opt to dump the wastes in rivers and streams and end up polluting water bodies. – It can produce low-quality food: Since animals in factory farms are kept in unsanitary conditions, they develop illnesses that may not be treated by antibiotics and pass these on to the people who consume products obtained from them.

b) Ranching

Ranching is a modern form of pastoralism that aims at rearing of animals on a large scale for commercial purpose in balance with the carrying capacity of the farm land. Under ranching, a piece of land called a ranch is allocated and a limited number of animals reared there.

Ranching is more developed in United States of America, New Zealand, Western Australia, Argentina, South Africa, Botswana, Zimbabwe, Zambia, Kenya, Tanzania and Uganda.

Characteristics of cattle ranching

- Livestock ranching is the commercial grazing of livestock over an extensive area which is associated with a very large land requirement, capital and human resources.
- Ranches have a continuous vegetative cover such as alfalfa, Lucerne and clovers.
- One type of animals is kept either for dairy or beef production. Therefore, the choice of the animals is done very selectively.
- There is little or no movement from one area to another since animals are confined in paddocks.
- Ranches are scientifically managed through selective breeding, use of hybrid species, research and control of animal diseases.
- The animals are reared for sale (they are kept for commercial purposes).
- It is carried out in sparsely populated areas and far from urban area.
- Ranches are managed, and scientific methods are applied. The animals kept are guarded from various disease through regular vaccination, crossbreeding and programmed attendance of veterinary surgeons that treat the animals.
- It is practiced in areas where rainfall is low and unreliable to give place to the crop cultivation.
- The animals in the ranches are kept for highly organized markets thus high revenue from sale of beef, hides, and dairy products.

Advantages of ranching	Disadvantages of ranching
– The production is very high due to the high level of specialization and improved quality animal breeds. – It has promoted the development of villages and towns which act as slaughtering, processing and packing centres. – It promotes industrial growth through the establishment of processing facilities. – The high yielding animals increase the income for the farmers. – Livestock ranching promotes development of infrastructure, for example roads which link the ranching areas and marketing areas. – It increases the agricultural production due to provision of animal humus to the crops. – Animals are kept in an enclosure (fenced areas) this ensures protection from predators. – It is environmentally friendly because manure and urine goes back into the soil to help plants grow, and grass makes cattle fat and happy.	– Cattle ranching is a hard work job and involves far more responsibilities and levels of skills. Thus, not everybody is able to engage in ranching. – A high capital investment is required to establish and maintain the ranches. – This type of farming is very limited in tropical areas because of abundance of diseases, insects and high amount of temperature and rainfall. – Ranching practice promotes overgrazing and deforestation. Such contributes to global warming. – This practice requires fencing to keep animals in the ranch and out of arable areas. This increases the expenses. – It does not directly favour crop farming.

c) Dairy farming

Dairying farming is the specialized rearing of cattle to produce milk and other products like cheese, butter and cream. Milk is a perfect food, as it has the major nutrients. Several milk products are consumed by people all over the world. Cheese ranks high in protein and it is a substitute of meat, while butter is like fat, supplying the deficiency of starchy foods. Dairying is the most dominant animal-based industry.

Characteristics of dairy farming

- Dairy farming aims at raising cattle to produce milk.
- Dairying on commercial basis has developed in humid temperate regions, because cool temperate climate is ideal for cow-rearing.
- Capital intensive techniques of production are used.
- Selected cattle breeds which yield a lot of milk are raised. Example, Jersey, Ayrshire, Alderney and the Friesian breeds.
- Rich and nutritious grasses are planted to supplement the natural pastures to feed the animals.
- The farms are scientifically managed. Pests and diseases are controlled.
- Benefits are very high due to the input and capital injection.
- Many farms own their processing plants or dairies.

Advantages of dairy farming	Disadvantages of dairy farming herding
– Scientific management ensures high yields per cow, averaging 5,000 litres of milk per cow per year. – It leads to maximum utilization of land as the practice does not require much space. – Export of products earns foreign exchange. Hence farmers enjoy a happy and healthier living standard. – Continuous production ensures a high and steady income for the farmer.	– Dairy farming is very expensive in terms of vaccination and feeding. Hence it requires a plan and budget to be successful. – It has a negative impact on environment since livestock are regularly injected antibiotic. As results, they affect the bacteria in the soil and water. – There is loss of local breed due to the crossbreeding. In addition, the loss of their special genetic traits that enable indigenous breeds to adapt to any environmental conditions. – Cattle in dairy farming always need food and water, as well as clean stalls and medicine if sick. There is additional care related to milking and birthing calves and makes the whole work tiresome.

Application Activity 12.4

1. Explain why it is necessary to improve livestock farming in your community.
2. Discuss how industrial food impacts people's health.
3. Explain the advantages and disadvantages of technology in agriculture.
4. Analyze the economic and social benefits of pastoralism.

12.5. Factors and problems affecting the livestock farming and ways of improving the livestock farming

Learning activity 12.5

1. Describe factors influencing livestock farming.
2. Analyze problems facing livestock farming.
3. Identify different ways of improving livestock farming.

12.5.1. Factors affecting livestock farming

The following are the main factors influencing livestock farming:

- **Topography:** The areas having gentle and undulating terrains consisting of relatively flat plains and plateaus are favourable for Livestock farming. This makes it easy for animals to move freely from one place to another.
- The main determinant elements of climate are the following:

  - **Temperature**: The degree of warmth, the duration, and the intensity of sunshine, all affect the welfare of animals to a certain extent. The moderate temperature is favourable for livestock farming.

  - **Moisture:** Moderate to high mean annual rainfall is essential for livestock farming. This ensures an abundant supply of drinking water and pastures for the animals.

- **Soil:** The soil which is composed of a variety of minerals and organic substances, forms the physical support of plants to feed the animals.
- **Land Tenancy:** It includes all forms of tenancy and ownership in any form. Land tenancy and land tenure affect the livestock farming. The land in pastoral areas is communally owned. This facilitates communal grazing and free movement of their livestock.

- **Size of Holdings:** The large tracts of land in sparsely populated areas are needed for pasture. The size of holding and the size of farm influence the number of animals to be kept in farm. In general, the larger the size of the farm, the greater the capacity of the farmer to produce more. This, in turn, would affect the extent of specialization and the nature of technology and equipment to be used.
- **System of ownership:** The collective ownership is preferable for having a very large pasture and terrain for livestock.
- **Labour:** The availability of labour, its quantity and quality are determined by the technology used in livestock farming. Traditional farming methods require a big number of employees while advanced technology requires a few numbers of skilled people.
- **Capital:** Capital subscribes definite limitations to the size and type of livestock farming to be practiced. All livestock inputs like insecticides, pesticides, feeding stuffs, purchase of land, machinery, vehicles, buildings, and veterinary services require capital. All the farmers make their decisions basing on capital to invest.
- **Mechanization and Equipment**: The levels of technological tools to be used play a vital role in the selection of livestock to be farmed and decision making at the farm level.
- **Availability of market:** Availability of market for the products from livestock farming is a very important factor influencing livestock farming activities.
- **Availability of transport means:** A well-developed means of transport with appropriate equipment is very necessary for transportation of animal's products to the market.
- **State of diseases:** Animals farmed may be hindered by diseases, insect-pests and wild animals. It is good to choose the areas free from those harmful biotic factors.
- **Cultural belief:** Some types of animals are not grazed by a given society due to beliefs, customs or personal convictions. For example, Muslims cannot keep the pigs.
- **Government policies:** Government policies can encourage or discourage modernization of livestock. Some countries, such as Rwanda and Britain encourage the productivity and efficiency of farming by a system of donation and subsidies to farmers. The government determines the ways in which farmers develop their farming. It provides tax holidays to farmers. All these put together, support the development of dairy farming

12.5.2. Problems facing livestock farming

The following are some of problems affecting livestock farming:

- **Limited rainfall**: Unreliable rainfall limits the growth of pastures. This is associated with harsh climatic conditions especially during the dry seasons when the pasture dries up, wells and springs disappear. Therefore, the growth rate of animals is reduced and such affects production.
- **Population pressure:** The world population is increasing incredibly. This reduces the availability of livestock farming and natural resources. Therefore, the number of animals that should be in stock is low.
- **Shortage of water**: The facts that the surface of water for livestock is limited, there is always a serious problem leading to death of animals in some parts of Africa. This results to yielding of poor quality products.
- **Disease and pest infection**: Shortage of supply of skilled labour that is required in the modernization of livestock farming contributes to the spread of different diseases. For diseases which are not treated correctly, the condition can prove fatal.
- **Institutional problems:** Lack of adequate and supportive institutions in livestock farming sector. Sometimes policies are suggested and written but not implemented. This does not meet the satisfaction of a large population in terms of quality milk and meat.
- **Limited capital**: Most rural farmers do not have enough capital for developing livestock farming, the building of storage reservoirs, or the provision of veterinary services.
- **Many cattle keepers are less knowledgeable:** They keep large herds of cattle which have led to over stoking and overgrazing.
- **Most potential grazing areas within the tropics are remote**: They are poorly served with transport network and social infrastructures. This creates limitations in facilitating commercializing livestock products.

12.5.3. Ways to improve livestock farming

Livestock can be improved through the following ways:

- **Settling the nomads:** In many African countries and the rest of the world, nomads hold many herds of cattle. The government should try and encourage settling nomads so that they can get essential veterinary services to keep their cattle healthy.
- **Empowering animal keepers through education:** Efforts should be put in place and enlighten livestock farmers on new innovations and technology that will bring a high-quality animal productivity.

- **Government support:** Government should be an initiator for livestock farming support by establishing adequate infrastructure, easy access to the loans to boost the livestock farming. This will benefit the country and farmers in general
- **Adoption of modern livestock farming methods**: Through government support, efforts need to be put in place to convince rural farmers to switch from traditional livestock farming to modern livestock practices which are more profitable.
- **Provision of livestock healthcare:** Extending veterinary services to all the areas where the livestock keeping is practiced is a good step to improve livestock farming. This helps to reduce the incidence of pest and diseases.
- **Encouraging tree planting on pasture land**: This minimizes the dangers of environmental deterioration in addition to provision of shelter to animals. This helps in improvement of grazing and watering management.
- **Adequate livestock feeds and nutrition:** The provision of feeds that are adequate both in quality and quantity is an extremely good for livestock farming
- **Introduction of crossbreeding:** To achieve local breeds of animals have been replaced with the exotic. This primarily to increase the output and enhance the off springs' economic value.

Application 12.5

1. Examine the impact of livestock farming on environment.
2. Discuss the importance of livestock farming.
3. Suggest ways problems affecting livestock farming can be solved.

12.6. Case studies of livestock farming in selected countries

Learning activity 12.6

Using your own experience and research through textbooks and internet; explainfactors that have favoured ranching and dairy farming in Botswana and Netherlands

respectively

12.6.1. Ranching in Botswana

The Republic of Botswana is a landlocked country found in Southern Africa. About 70% of the country's land area is covered by the Kalahari Desert. It lies between longitudes 20° and 29° East and latitudes 18° and 27° South. The mean altitude is 1000 meters above sea level.

The two main challenges that Botswana faces are drought and desertification. Only less than 5% of agriculture can be done with reliance on rainfall. The average annual rainfall varies from about 650 mm in the North East to less than 250 mm in the extreme South West. Short rain season occurs from November to March with no rain for the rest of the year. Consequently, the remaining percentage of the country depends on cattle and livestock keeping. Botswana is one of Africa's few countries where successful ranching has taken place.

Factors favouring the cattle ranching in Botswana

The following are the main factors:

- The occurrence of unfavourable climatic conditions for crop cultivation resulting to the development livestock farming as major economic activity in the region.
- The nature of the terrain which is relatively flat that enables easy movement of animals in search of water and pasture.
- Availability of grasses that is served as natural pasture for livestock.
- Presence of large land and low population.
- There was a strong desire to switch from traditional methods of livestock farming to modern one, which is more profitable.
- Availability of ready market both domestic and abroad.
- Availability of capital to set up demonstration ranches from both the government and the European Union.

12.6.2. Dairy farming in Holland

Holland or the Netherlands is a Western European country bordering the North Sea, between Belgium and Germany. It is a low-lying country with a quarter of the total area located below the sea level.

About a half of all the agricultural land in the Netherlands is under grasslands. The Netherlands is one of the largest milk producers in the European Union and accounted for 9.4% of milk production in European Union 2016. The dairy production is mainly oriented to export markets, where the Netherlands has around 5% of world dairy products market.

The Dutch milk production per cow is among the highest in the world. Due to the optimal climatic conditions and the ideal strategic location in Europe, the international competitive position of the dairy sector is good. Thirty-five percent of the total Dutch milk production is marketed in the Netherlands, 45% in other European Union member-states and 20% in the other countries.

Currently the average farm size is around 56 ha, which is an increase of 47% compared to 2000. Also, the number of animals increased by 64% to an average of 101 animals per farm in 2016. This growth resulted in an increase in average revenue per farm of 93%.

Characteristics of dairy farming in the Netherlands

- Dairy and livestock farming production is highly specialized and technologically advanced.
- Extensive grasslands provide grazing for dairy cows and beef.
- Dutch farmers have some of the highest yields of beef and milk in the world (behind only the United States and Great Britain).
- The country is self-sufficient in dairy production and most dairy goods are exported. The main diary exports include butter, cheese, and condensed milk.
- Milk production is more intensive in terms of money to purchase inputs, machines, fodder and veterinary services.
- Due to its limited land endowment, milk production is more intensive in the use of capital and purchased inputs, achieving one of the highest milk yields per cow in the European Union.
- The Netherlands has a shortage of land and labour. As result, the production systems used in agriculture are generally intensive.
- Dairy farmers make increase in productivity possible by a continual adaptation of new technologies like milking robot machine.

12.6.3. Sheep rearing in Australia

Sheep farming is rearing and breeding of domestic sheep. It belongs to the branch of animal husbandry where sheep are raised mainly for their meat, (lamb and mutton), milk and wool. Sheep stations, equivalent to the ranch are usually located in the South-East or South-West of the country.

According to the database of the United Nations Food and Agriculture Organization, in 2013, the five countries with the largest number of heads of sheep were mainland China(175 million), Australia (75,5 million), India (53,8 million), the former Sudan (52.5 million), and Iran (50.2 million).

Source: *http://www.agscopetfm.com/wp/industry_specialisation.html*
Figure *12.288: Sheep keeping area in Australia*

The production of wool is historically Australia's well known and most successful rural industry. This has been regarded as a support of the national economy for a long time. Consequently, the country earns much income from wool export which supports their economy. Therefore, sheep industry contributes much to the economy of Australia. For example, in 2015-2016 it accounted for around 6% (3.2 billion) of the gross value of agricultural production and around 4% (1.8 billion) of agricultural export income.

Factors favoring sheep rearing in Australia

- Presence of the varieties of indigenous plants, which provide nutrients to maintain enough sheep to provide enough wool.

- Availability of enough good quality drinking water. Surface water is scarce in much of sheep pastoral country, but over a wide area adequate water is obtainable from the various artesian basins.
- Low incidence of diseases and/ or parasites likely to kill or reduce the productivity of sheep.
- Large and ready market for sheep and sheep products
- The experience and expertise of Australian farmers in selecting preferable animals for breeding purposes.
- Using the harsh Australian climate which does not favour crop cultivation to produce clean, fine wool of high strength.

Application activity 12.6

Using your own experience and knowledge acquired in past studies explain:

1. How is sheep wool important to human kind?
2. Analyze the advantages of raising exotic breeds over local breeds.
3. Examine the challenges facing dairy farming in Holland.
4. Explain how cattle ranching affects forests.

End unit assessment

Read the passage below and answer the questions that follow.

The university of Lincoln is physically located in the center of the United Kingdom's agri-business industry. Recently, 25 students had an internship in relation to farm experience in different African countries. In Gabon, they found farmers burning forests as a way of preparing land for crop growing, in Kenya farmers grow tea for sale and livestock farmers in the North of Kenya keep large number of local cattle in an open land where they always move while in Rwanda, most cows remain inside the stall.

1. Describe the type of crop farming practiced in Gabon.
2. How does the practice mentioned in (1) above affect the environment?
3. Analyze the economic importance of crop cultivation cited in Kenya.
4. The above livestock farming mentioned in Kenya faces many problems. Suggest possible solutions.
5. Pastoralism affects the environment in different ways. Suggest measures to prevent overstocking and overgrazing in areas of pastoralism.

UNIT 13
FORESTRY IN THE WORLD

UNIT 13: FORESTRY IN THE WORLD

Key unit competence:

By the end of this unit, I should be able to explain the impact of forests and forestry in sustainable development.

Introductory activity

By using different geographical documents and resources, answer the questions that follow:

1. Examine the implications of lumbering to the sustainable development of any country.
2. Analyse the negative effects of lumbering on the physical environment and show how forested areas of the world can be conserved and protected.
3. Using the acquired competences from Unit 9; name the major types of forests of the world and identify their characteristics..

The term forestry refers to the process of exploiting the forested areas of the world in a sustainable manner, managing the forests to ensure their conservation, protection and better use. The forests of the world have varying characteristics that distinguish them from each other. These characteristics are studied under Unit 9 of senior five. Forestry differs from Lumbering because lumbering refers to the economic activity that involves cutting down trees, extraction of timber and logs for various purposes or commercial reasons.

There are many products that forests provide. Some are for meeting man's commercial needs while others are for subsistence (man's survival). Therefore, when man utilizes the forest resources to meet his or her needs, it is called forest exploitation. This implies that forests can be exploited in varying ways including: Collecting mushrooms and firewood, tourism activities, collection of building materials, gathering of fruits, herbal and medicinal products, charcoal making, hunting, wild honey collection, creating homesteads for tribal and bush men.

13.1: Importance of forest exploitation and problems affecting lumbering

Learning activity 13.1

Study the photograph provided below and use it to answer the questions that follow:

1. Name the activity taking place in the area shown in the photograph above.
2. Assess the problems affecting the activity taking place in the area shown in the photograph.
3. Suggest the ways of promoting sustainable utilization of forest resources in a country like Rwanda.

13.1.1. Products from lumbering

There are products or resources obtained from forests and are later used to produce other products. Such products include those that fall under lumbering products or products from lumbering. The following are the major products made from lumbering:

Photograph of a product from lumbering	Name of the product from lumbering
	**Timber:** This product is extracted from the logs of trees cut from the forests. It is used to make a wide variety of items for consumption.
	**Poles** These are averagely sized logs that are extracted from the trees. The tree branches are trimmed off and logs taken for treatment. They are used as electric poles, telecommunication poles and enclosing structures among others.
	**Wood fuel pallets** They are formed from compressed sawdust of the lumbering sawmills or the waste materials from lumbering. They are used in a similar way as charcoal,
	**Fuel wood** The big parts of the trees or remains of logs are spilt into pieces of reasonable size. These small chucks of wood are thereafter used as fuel wood.
	**Particle board** This is a wooden board made from wood chips, sawmills shavings, sawdust etc., that are bonded together with the use of suitable binder such as synthetic resin. They are then compressed with a machine to make a particle board.

	**Sawn wood** This is wood got from sawing of logs using sawing machines. The barks of logs are removed, and the logs cut into varying length and shapes. Usually, sawn wood is extracted from logs to form products that indicates rectangular timber sections and solid timber beams.
	**Oriental strand boards** This is one of the products from lumbering also known as flake board. It is formed by getting wood flakes, mixing them with adhesives and getting them heavily compressed using machines. These are used in construction.
	**Ply wood** These are products obtained from gluing together very thin sheets of wood known as veneer.
	**Fibreboards** This is a lumber product made from wood fibres. Wood fibres are obtained from breaking down hardwood or softwood remains using the defibrator. The wood fibres processed are further mixed up with resin binder and wax. The mixture is therefore subjected to intense temperature and great pressure to form panels.
	**Veneer** This a product got from lumber, where a thin slice of wood (thinner than 3mm) is peeled from the timber. It is used to make flat panels such as doors.

13.1.2: Importance of forest exploitation in the world

Below is a detailed explanation of the importance of forest exploitation in the World:

- **Source of raw materials:** Forests help human to have access to the raw materials that are needed in making various products such as furniture, pulp and paper.
- **Provision of building materials:** Forests provide different types of materials used in the construction sector. Poles and timber needed in building homes are all got from the forests.
- **Source of wood fuel:** Forests provide wood fuel in the form of firewood and charcoal that support both remote and urban low-income earners.
- **Source of foreign exchange:** There are several countries of the world whose economy depends on the export of forest products such as pulp and paper, hardwood, softwood, timber among many other. These countries use the foreign exchange earned to cater for national development programs. Examples of such countries include; Gabon, DRC, Ghana, Finland, Canada and Sweden.
- **Creation of employment opportunities:** There are a big number of people that are employed by the forestry sector. There are those who work as forest rangers, lumbermen, and forestry conservation officers.
- **Urban development:**The exploitation of forests resulted into the growth and development of urban centres in the regions where they exist. The companies that are engaged in lumbering set up social facilities such as schools, hospitals, and others that support their employees. The increase of people who come to work in this sector provides business opportunities such as hotels and trading activities. All these, put together, influence the development of urban centres. These towns and cities, whose development is based on the activities related to forests and forestry, include Solderhamn, Umea, harnosand in Sweden; Trondheimn in Norway; Lambarene and Port Gentil in Gabon. The coming up of such towns and cities supports the general development of the area.
- **Homeland for flora and fauna:** The availability of fauna in a given area contributes to the development of the eco-tourism which has had its positive contribution towards the socio-economic development of the world.
- **Recreation:** Forests are suitable places for relaxation and leisure activities. Several people go to forests and camp there for camp fire or retreat associations. While others go for hunting, forest walking, animal tracking and canopy walking.
- **Source of food:** Forests are reliable comprehensive food baskets for many primitives and communities that live near them. Special nuts, fruits, greens in the form of vegetables, mushrooms, yams among many others, are all collected at a free charge from the forests. These have enabled man to live a healthy life.

- **Source of herbal medicine:** Most of the medicines both processed or locally extracted originate from forests. The good examples are chinchona whose bark is used to make Quinine that treats malaria.
- **Support capital flow**: There are many local and foreign investors that contribute huge sums of capital into the economies of countries where forest exploitation is concerned. These investors come along with skills that are taught to the locals.
- **Homeland for primitive tribes:** Forests have for many centuries provided lodging for primitive tribes. There are still several tribes that find their livelihood from forests. It is believed that more than 1000 tribes are still dependant on forests for food, settlement, protection against other hostile tribes and wild animals.

13.1.3: Problems limiting forest exploitation

The lumbering activity is the main activities that foster for exploitation of the forested areas. However, there are various problems affecting lumbering as mentioned below:

- **Inaccessibility of some forested areas:** There is a problem of failing to access the appropriate tall and reasonably sized trees that can yield the best timber or logs. This is attributed to the jungle nature of most of the forests characterized by thick undergrowth, creeping and climbing plants; especially the tropical rainforests and monsoon forests. The good example is Amazon and Congo basins.
- **Trees do not appear in pure stands:** The lumbermen find it difficult to get trees that occur in pure stands and in close proximity. The few that appear in pure stands are scattered all over and locating them is more laborious and time consuming.
- **Long gestation period:** Most of the trees of commercial value such as mahogany, iron heart, Ebony, okoume, Azigo and many others take long to reach maturity. This has made it hard for lumbermen to get a quick regeneration of the felled trees.
- **Harsh climatic conditions:** Most of the forests where lumbering takes place are associated with climatic conditions that put the lives of workers and lumbermen in general at great risk. The wet and humid conditions make the forested area less unsuitable for humans to spend long days there. This discourages people to work as a lumberman. There are winter conditions that affect lumbering such as coldness e.g. Scandinavia, Sweden and British Columbia.
- **Shortage of enough market:** The creation of other products that have substituted timber products has reduced the demand for forests products. There are metallic bars and plastic/fibre products that are used in the building of houses and industrial installations.

- **Limited adequate capital:** The capital needed to fund the lumbering operations is inadequate. This has made it difficult to modernize lumbering sector and hire the appropriate skilled labour. Therefore, the lumbermen are challenged with purchasing the advanced equipment.
- **Political upheavals:** The forested areas have steadily remained the bet hideouts for rebels and war mongers. This has made it difficult to conduct lumbering from such areas. The good example is the Congo basin in DRC.
- **Limited research:** There is little, or no research carried out in relation to lumbering in some countries. This has made most of the lumbermen to remain devoted to elementary methods of tree felling. This reduces the scale of production of lumber.
- **The bulky hardwood:** Most of the woods extracted from forests, especially in the tropical world, are of high density. They are bulky and very heavy. Transporting them using cheap means of transport such as water, or floating them on rivers is not possible.
- **Stiff competition:** There is increased competition between the countries of the world engaged in lumbering. This has made it difficult for some countries to profit from the lumbering sector because of being ousted. Examples: Sweden and Norway.
- **Unsustainable exploitation of forests:** There is a challenge of using the methods that have indiscriminately led to the over exploitation of forests. This has limited continuous production of lumber products in a sustainable manner. This is common in Gabon, DRC and South American countries such as Brazil.
- **Poor technology used:** The lumbering sector in most of the developing world still faces the challenge of using poor equipment, methods of felling and transporting lumber products. The logs are dragged out of the forests by elephants which is difficult and time consuming. The simple axes and pangas are used. Such is a common practice in Gabon.
- **Shortage of labour supply:** Lumbering is affected by lack of enough labour force of all kinds. This has made it hard for the companies engaged in lumbering meeting to operate. The few available skilled employees are hired at high expenses/costs.
- **The existence of buttress roots**:There are trees that have big roots exposed above the ground level. These make the extraction of timber and felling of trees in general more challenging, risky and time consuming.
- **Fire outbreak:** The lumbering sector is greatly affected by bush fire outbreaks. This is a common occurrence in the developed world where temperate and coniferous forests are common. It results in the destruction of equipment.

Figure 13.289: Forest under fire and lumbering halted Source:

Prolonged drought: Climate change has resulted in rain failure and drought in many parts of the country. This has led to the shrinking of the forest cover.

Application Activity 13.1

1. List the products which are extracted from the lumbering sector.
2. Describe the three ways through which lumbering can be conducted in a sustainable manner without affecting the environment.
3. Identify the major problemsaffecting the forest exploitation in the world and suggest their solutions.

13.2:Methods of forest exploitation/lumbering and forest conservation measures

Learning activity 13.2

Using the past studies and geographica documents,internet research on the following:

a. Describe the methods of forest exploitation.

b. State and explain the forest conservation measures to be used to ensure sustainable forest exploitation.

13.2.1: Methods of forest exploitation

The methods of forest exploitation involve the ways of utilizing the forest resources but in a sustainable way; and at the same time ensuring that sustainable forest management is practiced, making sure that there is continuous utilization of forests.

(i) Preparation: the first stage is to survey the area to be exploited. It is important to find out where the best stands of timber are, or where the most valuable trees are most numerous, so that the best parts of the forest can be used.

(ii) Felling: This is the second step in the lumbering process or forest exploitation for lumber. It involves cutting down trees by the lumbermen. Therefore, the selected and marked trees in step on are cut down. This means that only the marked trees are felled down, leaving the young ones to grow to maturity.

(iv) Bucking: This is the third stage in the forest exploitation/lumbering. It involves cutting a felled and lumbered tree into logs of varying lengths. This is carried out to facilitate the easy transportation of logs to the collection centres and at the same time to make it easy to extract lumber from them. The branches of felled tree are trimmed off. The parts of the tree that are cracked or not straight are chopped off too.

(v) Yarding or dragging: This is the fourth stage of the lumbering process. It involves removing logs or the trimmed trunks from the inner part of the forest to the collecting centres ready for transportation to the extraction points (sawmill areas) also called booming ground. Sometimes these logs are dragged to the banks of rivers where they are dropped into the river to float to the collection centres.

(vi) Loading process: This stage involves loading the logs onto the heavy trucks to be transported to the booming centers. At the booming place lumber and other assorted lumber products are extracted from the logs.

(vii) Barging: This process involves taking logs to the booming grounds using heavy trucks. It is commonly practiced using water transport where logs are floated on watertowards the collection centres. The logs of less density are the ones that float on water and flow downstream up to the collection points.

(viii) Booming ground (Extraction of lumber/other products): This is the final stage that involves the extraction of lumber and other products from the logs. Here, heavy and high technology are used. Machines are used to extract lumber from the logs. The varying products produced are then packed and readied for marketing or export.

13.2.2: Forest conservation measures

Forest conservation refers to all the ways and processes of protecting, managing and ensuring the sustainable utilisation of forests and their resources. Forests play a great role in making our physical environment suitable for human habitation. Without them the climate of our planet would become hostile. Their significant contribution towards making our world good and meeting the demands of man through the provision of forest products justifies the need to protect and conserve them.

The following are some of the appropriate measures for forest conservation:

(i) Mass education: The local population settled around the forested areas are sensitized on the positive contribution of forests to both the physical environment and man's survival. In this case it will enable them to develop a positive attitude towards forest conservation measures.

(ii) Reforestation: This is a forest measure that involves planting trees in the places that have been seriously deforested. Usually, such places are planted with quick maturing tree species.

(iii) Putting strict laws in place: The government should enact laws that govern and regulate forest exploitation. This will extend the hand towards punishing even the people who misuse and destroy forests.

(iv) Forest reserves: This measure aims at setting aside some forested areas for the purpose of reserving forest resources for future use. Such places are controlled and protected by the Law. In such protected forests there are times when exploitation may be allowed but under strict observation.

(v) Increased licensing fee: This limits the number of companies that are interested in forest exploitation. The higher the licensing fee, the less the number investors and the greater the chances of having forests which are not exploited.

(vi)Intensive research: There are intensive research findings in the sector of forms of energy and power that are put in place. These have replaced the use of wood fuel with Biogas and hydroelectric power.

(vii) Forest products substitutes: This emphasises the use of materials that can serve as those of forest products. These are called forest products substitutes. They include metallic bars, plastic materials and ceramics. This assists in the reduction of the demand for forest products, whereby for example instead of using timber for roof making, metallic bars are used.

(viii) Agro-forestry programs: This is a forest conservation method that is being advocated by most of the countries of the world. It involves growing crops alongside the trees in the same piece of land. It increases the number of trees planted and at the same time enables the environment to be protected. It reduces the population pressure on natural forested areas since other sources of forest products will be in place.

(ix) Training the Forest officers: Qualified personnel is trained and deployed to various regions of the country as forestry extension officers. They monitor the forest conservation measures being implemented and provide technical advice to the local communities neighbouring the forested areas.

(x)Construction of look-out towers: These are established to enable the forest guards to watch at least the greatest part of the forest against any fire outbreak. They are usually above the forested area and they use binoculars to be able to have a coverage of line of sight to greater distance.

Application Activity 13.2

Study the passage below and answer the questions that follow:

One country in the Southern part of Africa has registered a very high percentage of deforestation as a result of shifting cultivation, wood harvesting, and settlements established in the conserved forested areas. Thereafter, the government and non-governmental organizations have come up to rescue the situation. One of the NGOs that have worked to conserve the forests is RIPPLE Africa. This NGO had several meetings and mass education programs with all the parties concerned by deforestation. From the initiative of RIPPLE Africa, strict laws have been enacted to protect the forests from destruction. The NGO has emphasized agro-based farming, zero grazing, and forest reserves identification and creation.

However, the local population require wood resources for various uses. The government has registered some few lumbering companies and got them license for lumbering, but they need help and expertise from people of good will"

1. Suppose you are hired by the country mentioned in the passage above, show how you would be of great help towards the restoration of its environment.
2. Identify the forest conservation measures indicated in the passage above.
3. Describe the various methods which may be used in forest exploitation.

13.3: Forestry studies in selected countries

Learning Activity:13.3

1. Use the text books and other learning materials available such as the school library, ICT tools, to research on forestry in Gabon, Scandinavia, Sweden and British Columbia.
2. Discuss the forestry in each of the countries listed above

13.3.1: Forestry in Gabon

Gabon is 80% covered by dense forest for an area of 22 million hectares in which 20 million hectares is productive. Gabon is ranked first in terms of forest surface per habitant (22 hectares per habitant). Gabon's forest is gifted with a large diversity of exceptional species, which makes it essentially a forestry country.

Gabon's forestshave always supplied many of the necessities of life, especially fuel and shelter. The forests contain over 400 species of trees, with about 100 species suitable for industrial use. Commercial exploitation began as early as 1892, but it is only in 1913 that okoumé (Gabon's most valuable wood) was introduced to the international market.

Forestry was the primary source of economic activity in the country until 1968, when the industry was supplanted by crude oil as an earner of foreign currency. Gabon is the largest exporter of raw wood in the region, and its sales represent 20% of Africa's raw wood exports. Forestry is second only to the petroleum sector in export earnings. Gabon's reserves of exploitable timber include: okoumé, ozigo, ilomba, azobé and padouk. Gabon supplies 90% of the world's okoumé, which makes excellent plywood, and also produces hardwoods, such as mahogany, kevazingo, and ebony. Other woods are: movingui and zingana.

The logging or lumbering operations have now shifted towards the interior after increased pressure on the coastal forested regions. The country has several ports that handle the exports of raw wood. These include Port Gentil, Port Libreville, PortOwendo.

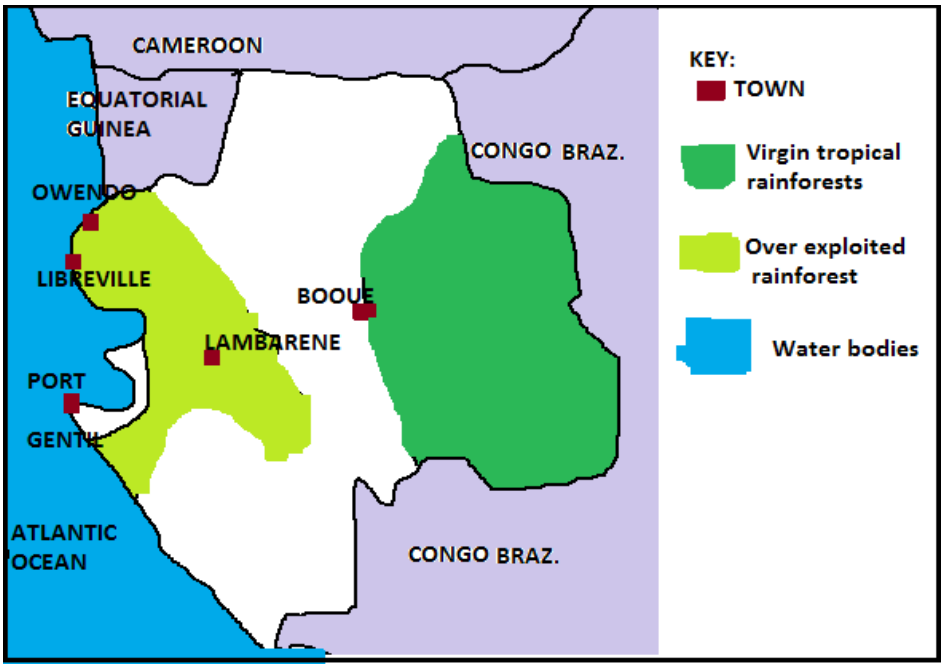


Figure 13.290: Areas covered by forests in Gabon

Factors favouring forestry development in Gabon

The forestry industry of Gabon is supported and favoured by several factors as follows:

- **Good climatic conditions:** Gabon is geographically located in the region covered by equatorial climate. This region receives heavy rainfall throughout the year. This has supported the growth of a variety of trees as mentioned above.
- **Warm conditions:** Gabon experiences high temperatures (25°c and above). These support the growth of luxuriant forests that have supported the development of the Gabonese forest industry.
- **The availability of various tree species:** There are more than 400 species in the forests of Gabon. This has given the forestry industry to meet almost any order placed by the consumers locally and internationally. Some of these tree species are hardly found else in the world.
- **The presence of various rivers:** There is a network of rivers radiating from the jungle forested areas of the interior. These have supported the development of forestry industry in Gabon. The logs of less density are floated on rivers to the collection centers.

- **Relief:**The terrain of Gabon is gentle and generally flat in some parts. This factor has favoured the creation of transport facilities within and around the forested areas. It has made it easy for the lumbermen to access the forests.
- **Presence of enough Hydro-electrical power (HEP**): The rivers originating from the interior forests, which are commonly referred to as water catchment areas, have contributed to the generation of HEP. This has played a great role in the development of Gabonese forest industry. The power generated is used at the sawmill centres in the loading and unloading of the forest products.
- **Low population:** Gabon is known for its low population density. This fact has left large vast portions of land under forests. It has reduced the risk of human's encroachment on the forests and it has supported the forest industry in the country.
- **Availability of fertile soils:** The availability of suitable and fertile soils has played a role in supporting the growth of luxuriant trees in the forests.
- **Strategic position:** Gabon is strategically positioned near the Atlantic Ocean. This position favours the establishment of sawmills and extraction of plants along the coast. It gives Gabon the advantage of accessing foreign markets for its forestry products.
- **Availability of required capital**: This has resulted from the revenues from the huge production of oil while the country has a low population, which means that there are less expenses on social challenges.
- **The governments involvement:** The Gabonese government has invested in forestry operations. It owns large companies that process the lumber within the country. These companies add value to the forest products before export, hence making the products able to compete favourably.
- **The presence of foreign companies:** There are large concessions or investment companies from foreign countries. These companies provide large sums of capital and technical skills to the industry. It has boosted the development of the Gabonese forest industry. An example is a Swiss company known as CompagnieEquatoriale des Bois (CEB).
- **Availability of enough market**: The presence of adequate markets for the Gabonese forest products. The markets are provided by several countries including China, Israel and other Asian countries.
- **Availability enough labour force**: There is a steady supply of labour force provided by both the local population and neighbouring countries. This workforce is supplemented by foreign expatriates who come along with foreign investors. All these have contributed to the development of the forestry in Gabon.

- **Presence of improved technology**: The forestry sector in Gabon is currently run by modern techniques. This has come about due to improved technology. The lumbermen now use power driven saws, tractors and bulldozers to carry out the dragging of logs from the forests to the collection centres.
- **Favourable government policies**: The Gabonese government has designed and introduced the policies that aim at ensuring the sustainable utilization of forests. The need to create more employment opportunities to the local people has become the driving force behind the development of this sector.
- **The increased level of industrialization**: There has been and still is need for raw materials to feed the upcoming industries especially paper and pulp, furniture and construction industries. This has made the forestry a recursive economic sector that is worth to invest in.
- **Availability of developed road and water transport**: The presence of better means of transport has contributed to the successful forestry industry in Gabon. There is a network of improved roads, a well-developed railway system and water transport. These enable penetrations into the remote interior areas hence the exploitation of virgin wood enriched areas.

13.3.2: Forestry industry in Scandinavia

The Scandinavian region is geographically located between 550 and 70° north latitudes. This region includes Sweden, Finland and Norway. The dominating forests are: taiga, coniferous, boreal and temperate forests. This area is known for its well-organized and developed forestry industry. The forest exploitation programs are well organized with high respect for sustainable forest management. The exports and revenues collected or earned from forestry support greatly the economies of the three countries. The lumbering sector in this region is highly mechanized and such has helped in developing the forestry sector.

Sweden is the wealthiest country in forestry exploitation among the Scandinavia countries. It comes second after Canada. Sweden competes with Canada for world leadership in the export of wood pulp and is the world's leading exporter of cellulose.

Factors favouring forestry industry in Scandinavian region

The highly advanced and developed forestry industry of Scandinavia is attributed to favourable factors that have made it to happen. These are outlined here under:

- **Forests found in the region appear in pure stands:** This is the characteristic of temperate and coniferous forests. This occurrence supports forest exploitation operations.
- **The soils of the Scandinavian region are infertile and do not support agriculture:** This has left the vast lands of the region to be under forests. It has reduced the competition that would otherwise be between the two sectors.

- **Most tree species that grow in this region mature faster**: this ensures a steady supply of forest products.
- **Favourable climatic conditions** allow the growth of temperate and coniferous forests.
- The Scandinavian region has been **politically stable** ever since after World War II. This situation has made the region attractive to many local and foreign investors. The economies of the countries in the region are stable.
- The region is characterized by a **mountainous relief** that is reshaped by glaciation. The rugged nature of the region discouraged other economic activities but favoured the growth of forests. This hindered the settlements in most areas, and thus reducing the risk of encroaching on the forests, due to low population densities.
- There is high investment by **both the local and foreign companies**. These companies have provided a lot of capitals into the sector. They have introduced advanced technology which has reshaped the quality and standards of the lumbering operation.
- **• The presence of reliable and dependable marketsboth locally and internationally:** The markets for the forest products in the region include countries such as Italy, Germany and the USA. The region has been able to capture these markets due to its high-quality products. Those products include paper and pulp, sawn wood, veneer, plywood, cardboards and timber.
- **The availability of advanced technology** that has eased the exploitation of forests in the Scandinavian region. This has enabled lumbermen to use better methods of felling, dragging and processing the forest products.
- **The presence of many rivers** and inland water bodies that facilitate easy transportation of the forest products. The Baltic Sea and Gulf of Bothnia all provide cheap water transport that assist in the transportation of logs, timber and other related forest products.
- **The governments of the individual countries** in the Scandinavian region have designed and implemented supporting policies. These policies have supported proper and sustainable utilisation of forests to address the socio-economic challenges faced by the masses.
- **There is a variety of tree species of softwood nature:** These include Scots pine, Norway spruce, Fir and Larch. These trees yield softwood, a fact that has supported the growth and development of the forest industry in the region.
- **Steady supply of cheap labour:** The companies engaged in the forest industry have access to labour that is provided by the local population. The high influx of refugees from Asia and the Arab stream such as Assyria and Libya have filled the gap in the labour supply.

– **The presence and availability of cheap hydro-power:** This has also contributed to the exploitation of forests. The presence of various rivers in the rugged areas of the Scandinavian region creates excellent sites for the generation of hydroelectricity. They feed the processing of plants with enough power.

13.3.3: Forestry in British Columbia

British Columbia is one of the provinces of Canada. It is located in the western part of the country. This state has placed Canada high in forestry. The relief of British Columbia is rugged and mountainous in nature, with thin soil that hardly supports agriculture it left no other option for the state apart from forestry.

An average of two thirds of the province is under forest cover. The prevailing forests include coniferous, deciduous and mixed evergreen forests. Strict management laws have been enacted to ensure that these forests are maintained and exploited in the most economical ways possible.

The coniferous forests cover 96% of the total forested land of British Columbia. These forests have a variety of tree species which include; Spruce, Douglas fir, Oak, Aspen and Red cider. The forested areas of British Columbia are: Fort Nelson region, Victoria Island, Fort St. John, Southern Lowlands, Central interior, Prince George.

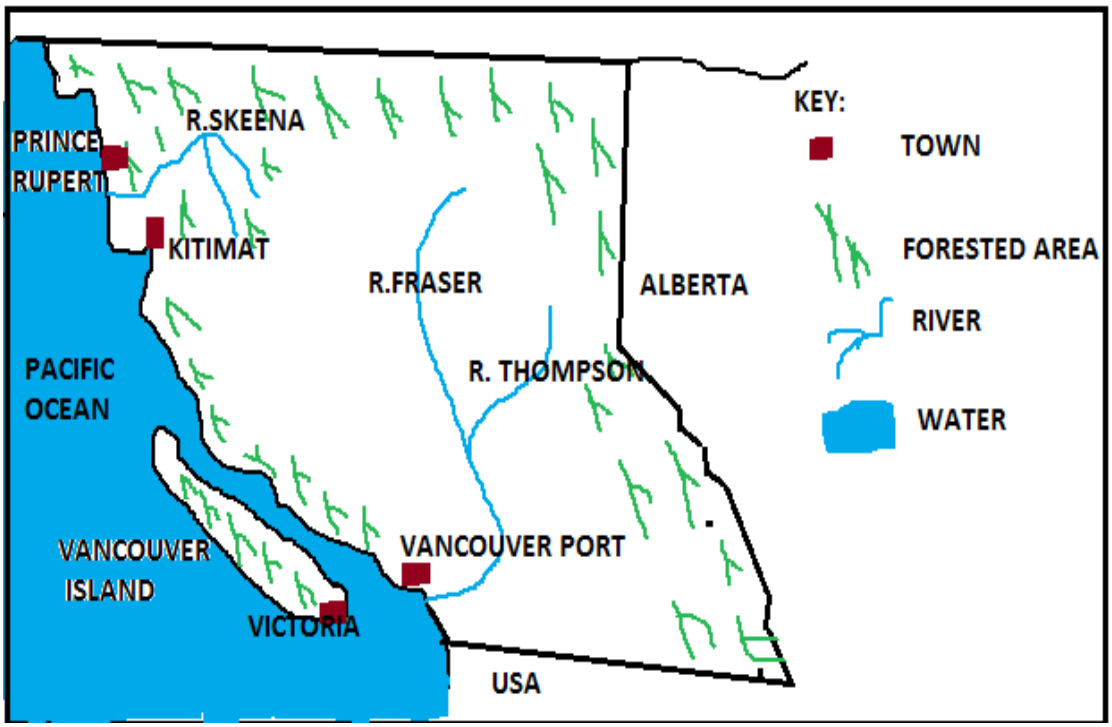


Figure 13.291: Forested areas in British Colombia

Factors favouring forestry industry in British Columbia

- The following are factors that have favoured the development of the forest industry in British Columbia:
- The relief of British Columbia is rugged and mountainous. This has discouraged agriculture and other land use. The only option is forestry since trees can do well in such areas.
- The presence of infertile soils that do not support agriculture but support the growth of trees hence, favouring forestry.
- British Columbia is blessed with snow that feeds various rivers originating from the upper slopes. These have become the convenient means of transportation of logs to the collecting centres.
- British Columbia receives heavy rainfall throughout the year. This has supported the growth of trees and forests.
- The presence of extensive land that is under forests has also played a key role in the development of the industry.
- British Columbia is gifted with a variety of tree species. They include Douglas fir, Red cedar, Western Hemback, Oak and pole pine.
- The area has a cool temperate climate that is necessary for the growth of temperate and coniferous forests.
- British Columbia is sparsely populated. The low population has made large tracts of land to be under forests.
- The forests of British Columbia are characterised by large areas with single tree species. This makes it easy to fell trees and it facilitates the forest exploitation methods such as "patching."
- There is abundant supply of hydroelectric power in British Columbia. This has played a significant role in supporting the extraction, transporting and processing of forestry products. The sawmills are well supplied with reliable power. This is attributed to a number of rivers such as River Columbia and River Fraser.
- The coastal areas of British Columbia are associated with numerous winds. These also ease the transportation of logs from the mainland to the collection centres at the coast.
- The coniferous forests of British Columbia have limited undergrowth. This eases the exploitation of forests hence saving time and making the whole operation less tedious.
- British Columbia has a strategic position next to the coast. This makes it easy to accessing the foreign markets. Several ports have developed along the coast providing excellent physical and geographical advantages.

- Trees appear in pure stands. This makes the felling process easy and less time consuming, enabling a steady supply of the forestry products such as logs.
- There are less destructive winds in the state of British Columbia. This has offered an ample environment for trees to grow without being bent or destroyed by the forces of nature.
- The trees grown mature fast within a short period when compared with those of the equatorial region.
- There is sufficient capital needed to meet the operational demands of forestry industry. The investors are able to pay high skilled labour, purchase equipment and other related services.
- There is a steady supply of labour. This is provided by the locals and foreign immigrants from all over the world.
- There is a ready and accessible market for the products from the British Columbia's forest industry. This is mainly provided by the local companies that are dependent on the forests for raw materials. There is also a wide external market for lumbering products e.g. USA, Japan, China, India and Britain. All these have supported the growth and development of forestry in British Columbia.
- There are favourable and supportive government policies in relation to the forestry industry. The government of Canada subsidises the sector, provides technical assistance and designs good conservation programs that all aim at the sustainable utilisation of forests.
- There are several hydro-electric power stations that have been set up to support the industries that relate directly or indirectly to forestry operations and products.
- British Columbia has an excellent transport network, ranging from railway transport, road transport to water transport. These provide an enabling environment for forestry to thrive.
- There is high industrialisation in Canada. Industries such as those that engage in the production of newsprint, pulp and paper, paper boards and furniture all support the forestry. There are other industries that manufacture inputs such as powered saws, bulldozers and other assorted equipment that are of a significant role in the industry.
- British Columbia and Canada in general is politically stable. This has resulted into a safe environment that has attracted many investors.
- The use of better methods of lumbering has favoured the existence of sustainable utilisation of forests.

- The presence and availability of advanced technology has favoured the mechanisation of forestry operations. There is a wide use of modern equipment that has eased the work.
- There is and has been a long tradition and Canadian culture of growing forests since the 16th century. This has created a people who cherish and value forests and are aware of how to sustainably utilise forests. This has reduced most of the challenges since solutions are always available.
- There has been and there is still continuous research and studies in forestry. This has resulted in the introduction of new tree species that mature quickly and with high quality products.
- The presence of various local and foreign investors has contributed the capitals that have enabled the development of forestry.

Application activity 13.3

1. For either Gabon or British Columbia, give a brief description of the state of forestry in the country.
2. Examine the factors that have favoured the development of the forestry industry in the Scandinavian region.

End unit assessment

1. Suppose you are staying near a forested area:
   a. Using local examples show how you and your community would benefit from the forest.
   b. Assess the impact of forests and forest exploitation on sustainable development.
2. As a student who has studied and understood the topic of forestry, draw a program that can enable your community to utilize the forest resources in a sustainable manner.

UNIT 14

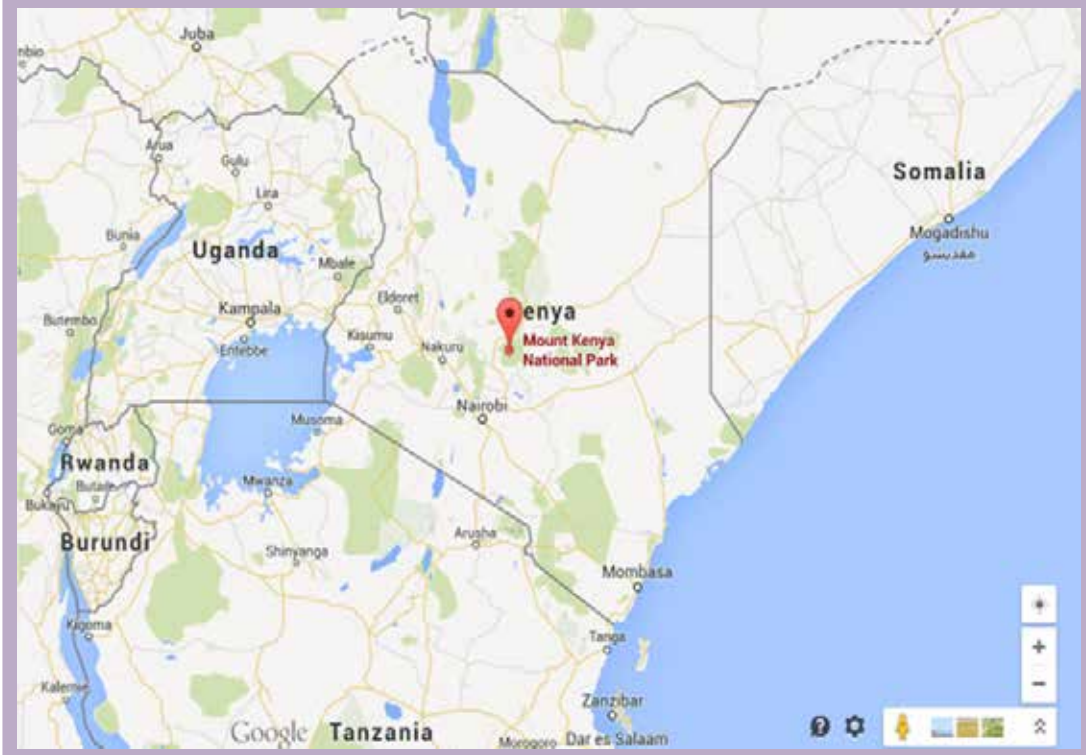
FISHING IN THE WORLD

UNIT 14: FISHING IN THE WORLD

Key unit competence:

By the end of this unit, I should be able to explain the impact of fishing in the sustainable development of the different countries in the world.

Introductory activity



1. Identify the fishing areas presented in the maps.
2. Suppose you are living near a lake or ocean, describe the methods one would use to harvest fish in a sustainable way.
3. In case you are walking, and the minister of natural resources stops his/her car to give you a lift to your destination, and on the way he/she asks you to explain why fishing industry in North Atlantic fishing grounds is more flourishing than that of East Africa. What would you tell him?
4. Research on the fishing industry practiced in Japan and discuss the lessons one can draw from there to improve fishing in his/her country.
5. Analyze the implications of fishing industry on the physical environment of the area in which it ispracticed; and design a program that can ensure sustainable fishing operations.

Learning activity 14.1

Study the illustration of Amahoro Village, and use it to answer the questions that follow:

1. With reference to the illustration, describe what is taking place in the Amahoro Village.
2. Identify and explain the factors that have supported the major activity taking place in the village represented by the illustrated above.
3. At least name the four regions of the world (outside Rwanda) that could be represented by the illustration above.
4. Show how the activity named in (a) above has affected the physical environment represented in the illustration

The term fishing includes all the activities related to the harvest of aquatic animals, especially fish, from the seas and fresh water bodies. Aquatic animals are those that live in water. Fishing has become one of the most significant economic activities in the world because it provides people with food from aquatic animals. The places where fishing is carried out are called fishing grounds. It should be noted that not all water bodies have enough fish, and even some have no fish at all because of unfavourable conditions that do not allow fish to survive there.

14.1.1. The seven major fishing grounds in the world

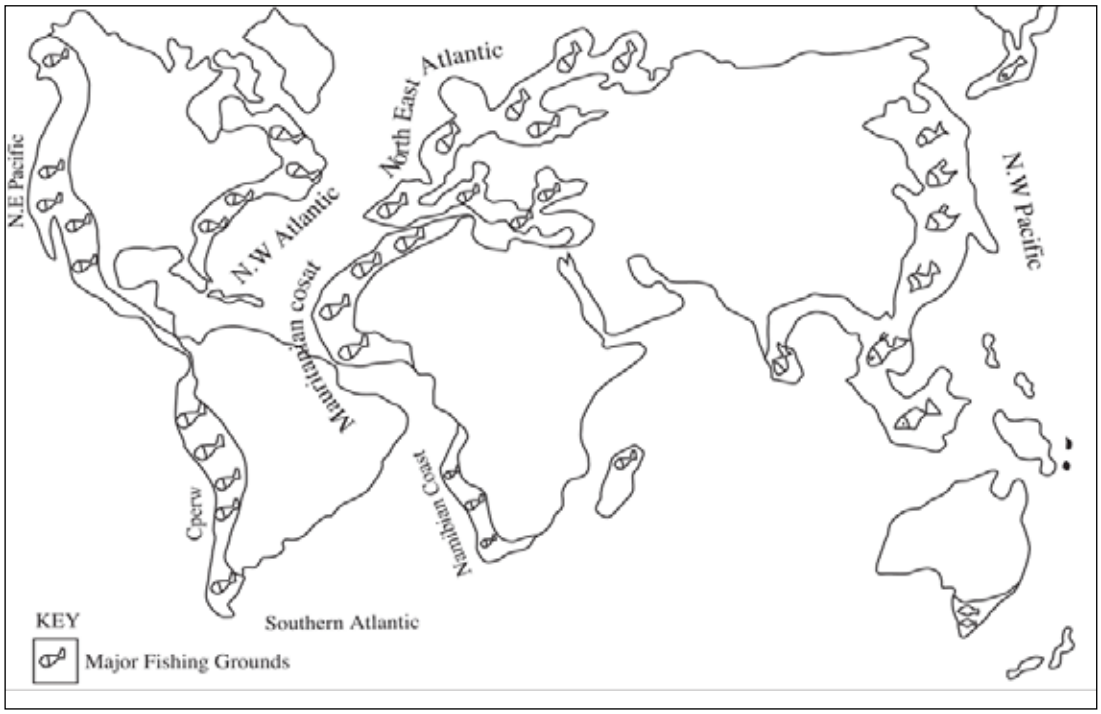


Figure 14.292: The major fishing grounds of the world

There are 7 world's major fishing grounds. These vary in terms of fish production. Some produce huge tons of fish and fish products while others their production is moderately lower. These include:

(i) South East Pacific fishing ground:

The South-East Pacific region spans the entire length of the Pacific coast of South America from Panama to Cape Horn. This region is located along the Western coastal areas of South America.

In spite of its astounding diversity, the region's five countries (Chile, Peru, Ecuador, Colombia and Panama) find themselves united by two overwhelming natural phenomena known as Large Marine Ecosystems. The factors that have favoured its development are: the presence of a wide continental shelf and the cold Peruvian current which encourages the flouring of planktons. The chief types of fish caught include Sardines, Mackerel, Anchovy, Pilchards, Tuna and Mahi-Mahi.

However, the region is under threat from the coastal and marine degradation by land-based and marine-based sources of pollution and other forms of environmental degradation. In addition, theregion is regularly disrupted by the El Niño-Southern Oscillation (ENSO) phenomenon, which originates in the equatorial Pacific, producing dramatic upheavals in local, and ultimately global, climatic conditions.

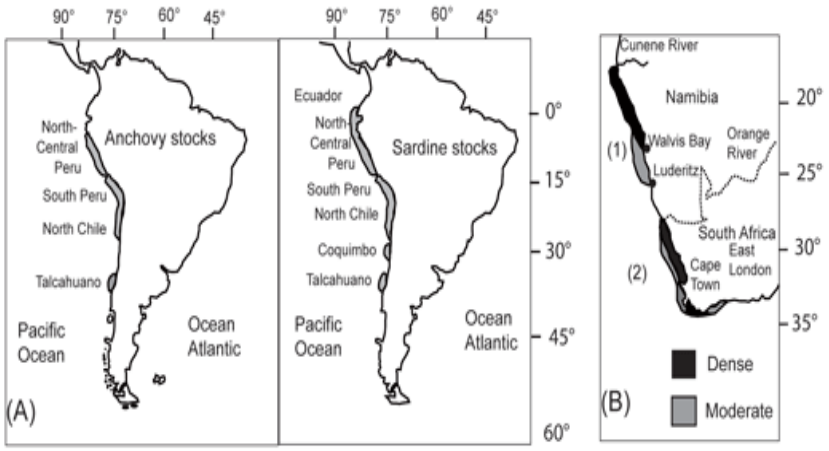


Figure 3. Schematic presentation of areas of distribution of anchovy and sardine stocks in A) Humboldt Current LME (from Alheit and Niquen, 2004; reproduced with permission) and B) Benguela LME, (1) Northern Benguela upwelling system, (2) Southern Benguela upwelling system (from Shannon et al., 2003; reproduced with permission).

Figure 14.293: South East Pacific fishing ground

(ii) North West Pacific: This region extending from the Aleutian Islands in the north to south eastern Asia contribute nearly one third of the world's fish catch. The seas are fished in varying degree of intensity by all the bordering countries, i.e., Russia, Korea, China, Japan, Philippines, and Indonesia.

This fishing ground is favourable due to the convergence of cold Oyashio and the warm Kuroshio currents, extensive continental shelf, indented coastline, use of advanced technology and availability of market.

The major types of fish caught here include Herrings, Salma, Sardines, Mackerel, Yellow tail, Tuna, cuttlefish, Shell fish and Whales.

Figure 14.294: North West Pacific fishing ground

(iii) North East Pacific fishing ground: The region extends from Alaska to California and owes its importance to the large quantities of salmon and tuna, as well as significant amounts of halibut and sardine. The following factors influence the development of this fishing ground: The Convergence of warm Labrador Current and cold California current, indented coastline, presence of land derived minerals, use of advanced technology.

Figure 14.295: North east Pacific fishing ground

(iv) North West Atlantic fishing ground: The region extends from Greenland in the north to cape Hatteras in the south. The fisheries of this region are based on a rich combination of rivers, bays and shallow offshore banks, convergence of cold Labrador Current and warm Gulf Stream current, presence of rugged coast areas mostly in Canada, availability of market, and use of advanced technology.

The fishing banks extend along the coasts of New England and Eastern Canada from Nantucket Island to New Found land and into the Gulf of St. Lawrence. The types of fish harvested from this region include Cod, Herring, Crab, Turbot, Halibut, Salmon, Flounder and Shrimp.

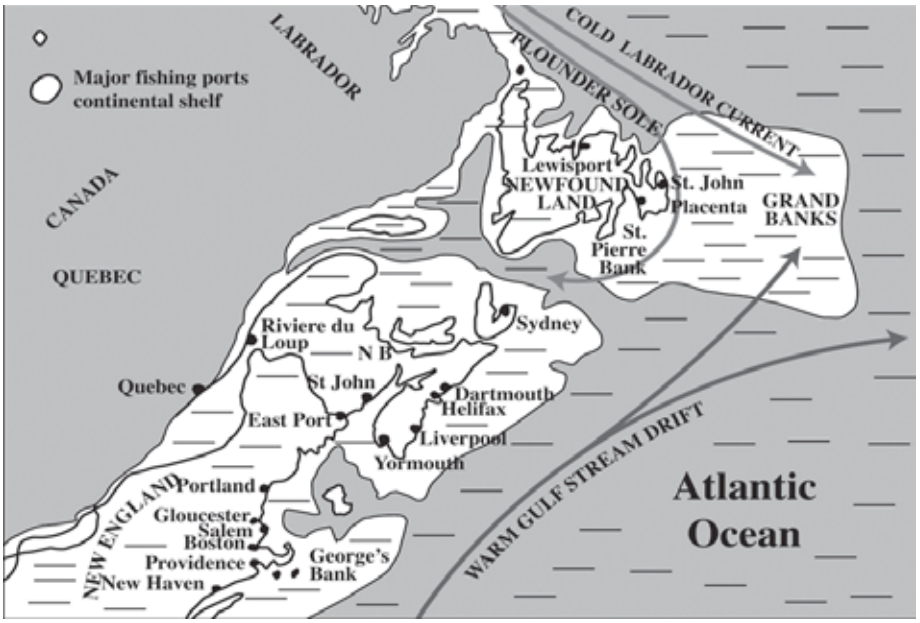


Figure 14.296: Northwest Atlantic fishing ground

(v) North East Atlantic fishing ground: The region includes the fishing grounds of north Western Europe extending from north of the Arctic circle to the Mediterranean Sea. This ground is fished by: Iceland, Norway, Sweden, Denmark, Russia, Germany, the Netherlands, France, and Britain.

This fishing ground benefit from the presence of warm North Atlantic drift current throughout the year, the presence of fiords and inlets, the availability of markets, the use of advanced technology, the presence of rugged and hilly coastal areas. The major types of fish caught here include Mackerel, Halibut, Sprat, Sardines, Cod, Capelin, Dogfish and Haddock.

Figure 14.297: North east Atlantic fishing ground

(vi) The South West African coast ground: This covers the Namibian coast on the western coast and Cape Province in South Africa. The countries found here include South Africa, Angola, Namibia and the islands that belong to Argentina. The types of fish caught here include Anchovy, Mackerel, Pilchard and Tuna. This ground is favoured by the availability of cold Banguela current water which brings planktons close to the surface of water which are fed by fishes.

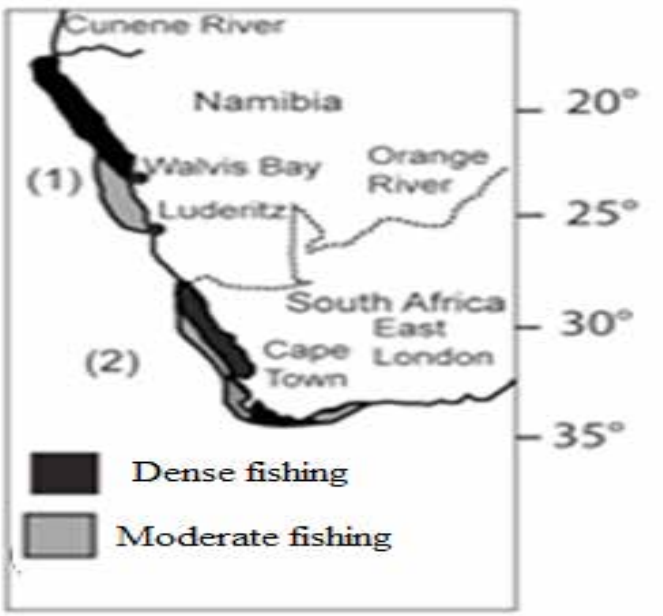


Figure 14.298: The South West African coast ground

(vii) North West Africa fishing ground: This fishing ground covers the coast of Mauritanian up to Morocco in northwest Africa where it is washed by canary current.

Figure 14.299: North West Africa fishing ground

14.1.2: The inland freshwater fishing grounds

The inland fishery is getting more important. This is carried out on the fresh water bodies. They include Nile River, Congo River, Amazon River, Yangtze River (in China), Lakes Victoria, Lake Malawi, Lake Tanganyika and Lake Chad.

Even though these fishing grounds are limited to areas that experience arid conditions, there are regions that make a difference. These are Caprivi and Okavango areas found in North East Namibia. Also, the rivers originating from the Atlas Mountains in Morocco are known for inland freshwater fisheries.

It should be noted that inland freshwater fishing grounds are found in areas associated with Swamps, rivers, Rice fields like those found in China, lakes, streams and wetlands in general. Currently fish farming has gained a reasonable level in the production of fish and fish products.

The inland freshwater fishing grounds are known for the following types of fish: Dagaa, Nile perch, Cat fish, black bass, Tilapia, Trout and mud fish among many others. There are also well-developed inland fresh water fisheries in Japan in Lake Biwa and Kasumiga-Ura where fish species such as eel, carp and several others are caught.

Application Activity 14.1

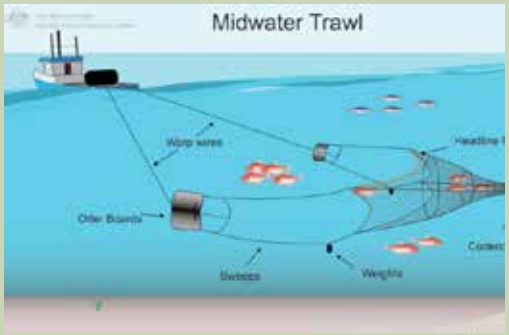
Use the sketch map provided below to answer the questions that follow:

1. Indicate on the sketch map above the major fishing grounds of the world.
2. Name the countries that are associated with any of the two fishing grounds indicated in question 1.
3. Suppose you are living in one of the fishing zones indicated on the map above, explain how you would ensure that there are sustainable fishing practices which do not affect the physical environment.

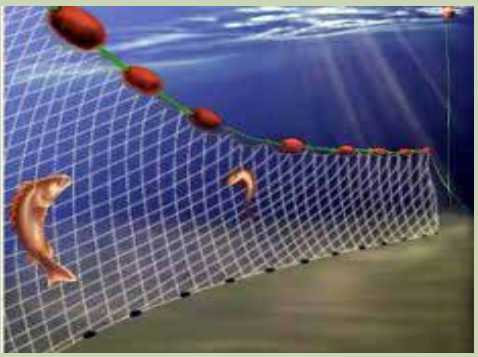
14.2. Methods used in Fishing and Types of fish and fishing in the world

Learning activity 14.2

Study the illustrations shown below and use them to answer the questions that follow:



A



B

1. Name and describe the fishing methods shown by figure A and B above.
2. Describe other fishing methods which are not shown by the figures above.

Fishing methods stand for the ways humans use to catch fish from water bodies. These fishing methods are classified into two types: traditional and modern fishing methods. The traditional fishing methods are usually used for subsistence purposes and they target the pelagic fish. These are the fish that live near or at the surface of the sea, Ocean or any water body.

On the other hand, commercial fishing operations use modern fishing methods that can ensure large catch of fish and at the same time enabling the fishermen to harvest mature fishes.

14.2.1: Traditional fishing methods

These are simple fishing methods. They are used to harvest or catch fish that live in shallow water bodies. As earlier said, also these methods can be used to catch fish that live near the surface of the water body. The traditional fishing methods include the following:

(i) The baited hook method: This is a method that has been used for centuries in various fishing villages. A single line or fishing rod (Made of wood, bamboo, graphite or fiberglass) is used.

A strong string of a reasonable size and length is affixed onto the rod. At the end of the string a V-shaped hook is fixed. The hook is made in a way that can enable it to pierce the mouth of the fish.

The hook or hooks have reversed the point. It was primarily designed to enable the hook to hold the fish. On the hook bait food for fish is affixed to attract and trap the fish. Therefore, when the fish tries to eat the bait on the hook, it is caught by the hook.

The simplicity of this method only enables one fish to be caught at time. This method is used to catch fishes like Tuna, mudfish, Bagras, Squid and Tilapia.

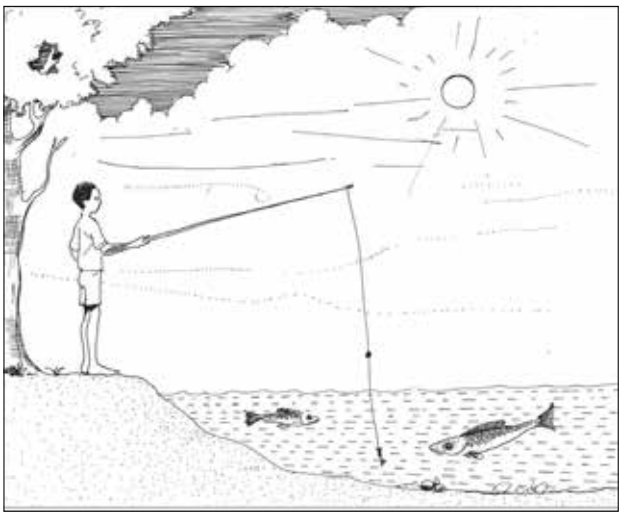


Figure 14.300: The baited hook method

(ii) Basket method:

This is a fishing method also used in shallow water bodies such as lakes, swamps, rivers and streams. A basket made using dried papyrus of crimping plans is used. These baskets are cone shaped. The entrance of the basket is made in a way that it allows the fish to enter and sharpen pieces of reeds are used to design the entrance. These act as a barrier as the fish tries to escape from the basket. A bait is put inside the basket especially termites, or any other food/bait that can attract fish to enter the basket.

At the end of the basket there is an outlet that is usually blocked by the fisherman with a buddle of grass. This is purposely done not to let the fish caught to get out of the basket. At the same time, it enables the fisherman to remove the caught fish from the basket.This method is appropriately used in both fast flowing rivers and water-logged areas such as along the shores of the lake or swamps.

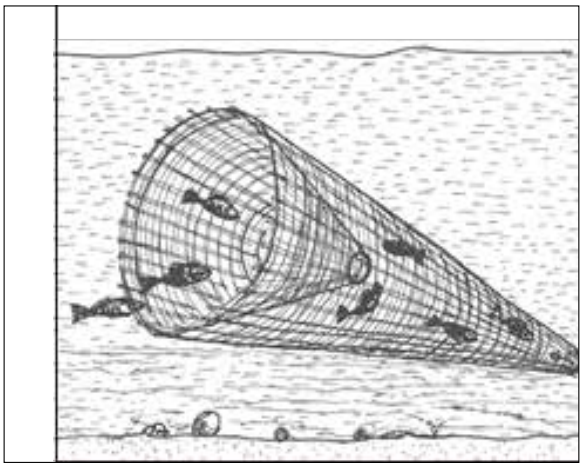


Figure 14.301: Woven basket

(iii) The barrier trap method: In the areas where slow flowing water bodies are in existence, barrier trap fishing method is used.

The method involves narrowing the width of the channel passage using strong poles that are stuck or placed firmly into the water and in aligned form.

The stuck poles are put on both sides leaving a small opening. This increases the speed of the flowing water. Just at the opening, a cone shaped basket is placed. This basket is positioned to allow it to be in contact with the bed of the channel. The velocity of water pushes the fish into the basket. The fish that enters the basket finds it hard to get out because of the strong strength or pressure of the flowing of water. Therefore, fish are trapped. The fisherman after seeing that enough fish have been caught lifts the Basket and scoops the fish out of the basket.

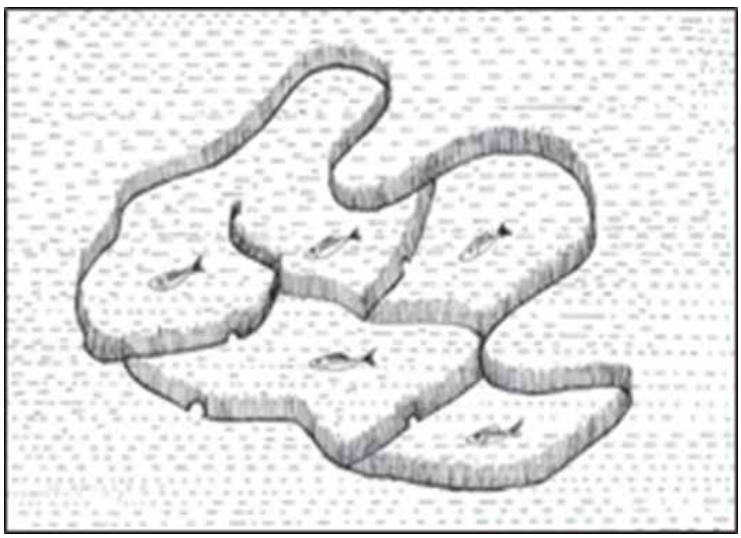


Figure 14.302: A trap

(iv) Use of the scoop nets method: The scoop nets get their name from the name to scoop out, which means raising instantly and at speed lift. The net is placed in the water body. When fish is seen above the laid net, it is then lifted at once from both sides. This is also done at intervals in cases where the fishermen are not able to see the fish swimming above the net. This method can also be used at night but this time, the sharp lights are used to entice fish to come up above the net.

Figure 14.303: Use of scoop nets

(v) Spearing (Harpooning): This involves the use of a sharp pointed metal, which is used to pierce fish in water.The types of spears used are usually sharp with small sized and elongated blade. This allows the spear to penetrate through the fish and keep it onto the spear. The fisherman waits for fish to swim near the surface of the water or near the bank of the river or shores of the lake and spears it. This is the simplest and most traditional method of fishing.

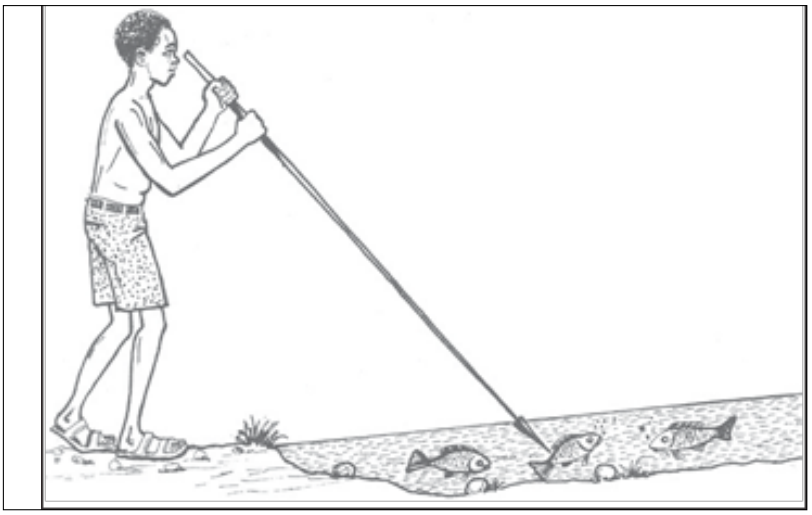


Figure 14.304: Spearing fishing method

(vi) Use of Bow and arrows: Under this method, the fisherman uses the bow and arrow to catch fish. Sharp arrows are shot at the fish, killing it and thereafter taking hold of it. Like under the spearing method, the fisherman waits for fish to swim near the banks or shores then he shots it at once. This method catches one fish at time.

Figure 14.305: Use of bow and arrows

(vii) Poisoning: The fisherman collects the barks of specific trees and crushes them. These plants have a chemical ability to kill the fish but less harmful to human beings. The crushed bark is mixed in the blocked part of the water body. After few minutes, fish start dying and therefore, floating on top of the water. However, this method is discouraged because it kills (i) both young and mature fishes, (ii) other aquatic animals or organisms are also affected by the poisons, (iii) eating continuously poisoned fish may damage the lives of people, (iv) this method pollutes and therefore contributes to general lack of good drinking water.

14.2.2: The modern fishing methods

These methods are used for commercial purposes. Some facilitate the catching of either pelagic or demersal types of fish. The modern fishing methods include:

(i) Drifting or use of drift nets: A drift net is placed into the water body where fish are expected to be. This net is hanged vertically in the sea or Ocean in a comparable way the volley ball net is suspended. They are called drift nets because they keep on drifting. This means that they are mobile in response to the prevailing currents to some extent.

The floats are fixed on the upper edge of the drift net while weights are fixed along the bottom edge. In this way, the drift net is enabled to suspend or hung vertically. When the fish swims into the net, it is caught by their gills in the mesh of the net. It is then unable to either move forward or backwards.

The shape of the fish enables part of the head to penetrate through the mesh of the net and its oval shape makes it hard for the whole body to move forward.

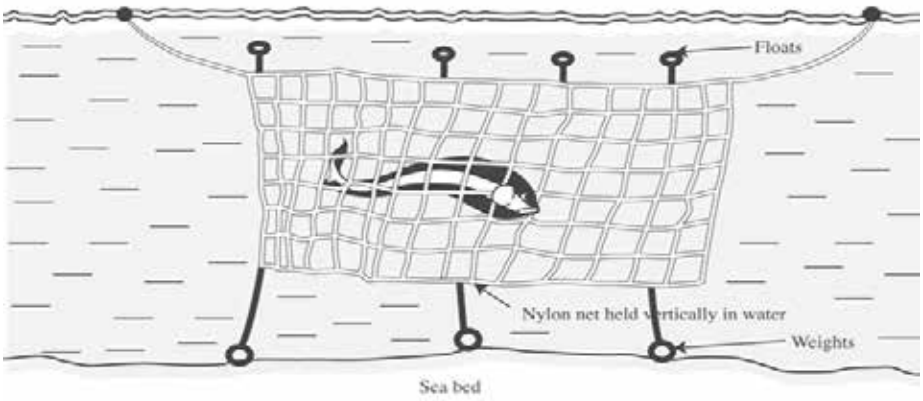


Figure 14.306: Drifting method

(ii) Trawling fishing method: This is one of the modern fishing methods used to catch demersal fishes. A sizeable cone-shaped net known as a trawl is used. The entrance of the net is kept open using the floats that are fixed around the upper part (Entrance). While the bottom edge of the entrance has aligned weights that pull it downwards, therefore, leaving the entrance open to allow fish get a way of entering the trawl net.

The trawl net is then attached to the boat or ship and towed. As the boat or ship tows the trawl net, the fish enter and are trapped into the net. The net is made in a way that its cod end strong ropes are used to allow the net to have the capacity of holding the weight of the caught fish. When the fishermen realize that the net has caught enough fish, then, it is lifted at a uniform speed not to allow the fish to escape. The fish are kept inside the trawl by the currents that keep pushing the fish back into the code-end part.

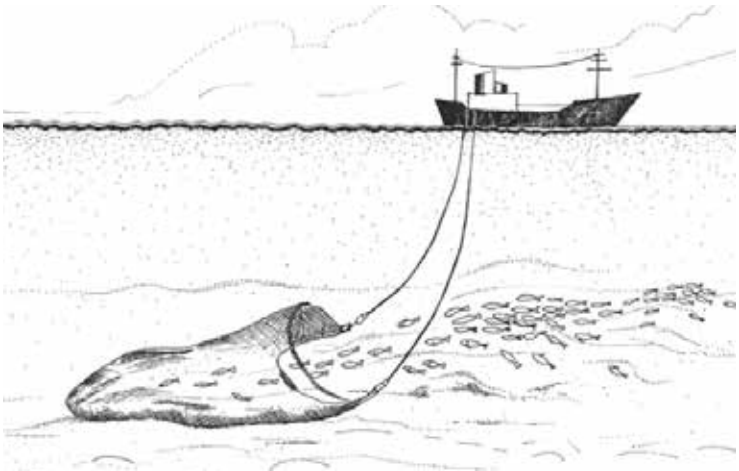
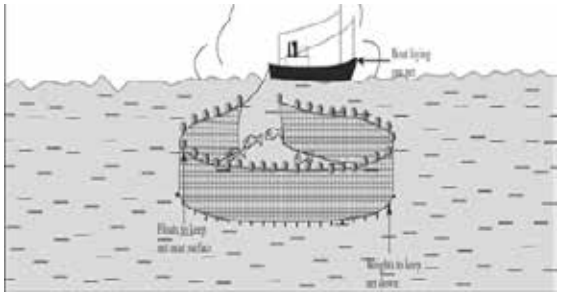


Figure 14.307: Trawling fishing method

(iii) Seining: seine nets such as the haul seine and purse seine have intermediate features between drift and trawl nets. The haul seine is like a drift net, kept floating vertically in the sea like a wall by corks on top and weights below.



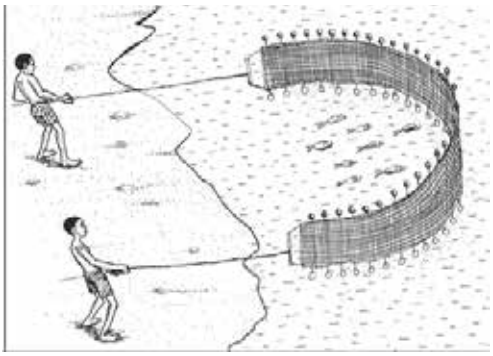


Figure 14.308: (a) Purse seine *(b) Haul seining*

(iv) The gill net method: This is a fishing method used to catch large tons of fish. It involves the use of net like the one used in the drifting method. The upper end edge is fixed with floats and the bottom with weights. The several meshing parts of the net trap fish as they try to pass through the net. The strings of the mesh of the net get stuck into the gills of the fish as they try either to move forward or backwards.

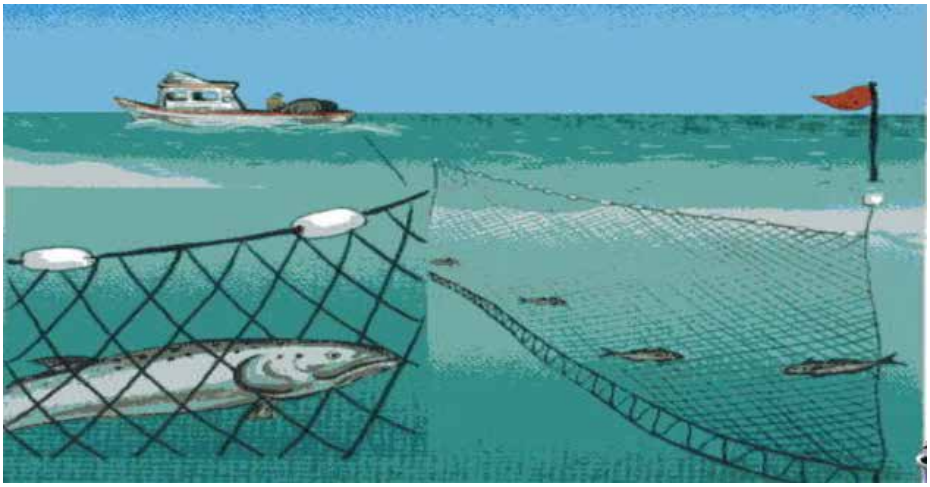


Figure 14.309: The gill net method

(v) Long lining: This method involves the use of several hooks spread out on long lines. The hooks are attached a few meters apart and buoyed at each end. They are baited and cast into water from a moving vessel. The fish are caught on the baited hook as they try to feed.

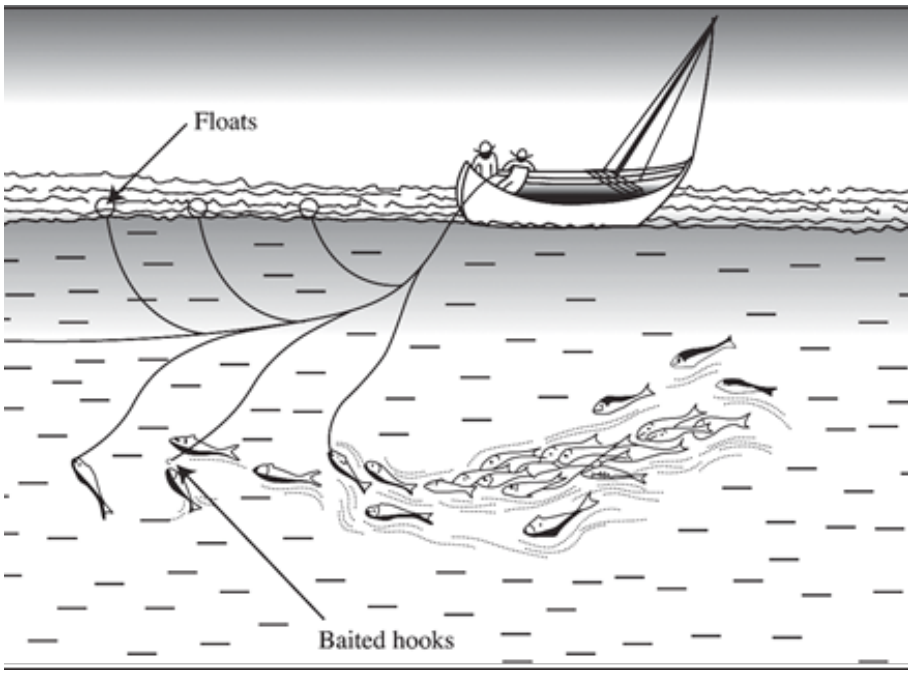


Figure 14.310: Long hook lining method

14.2.3: Types of fish and fishing

Types of fishes

The following are the major types of fishes:

(i) Pelagic fish: This involves the fish that live near or at the upper part of the Sea or Ocean. Pelagic fish are generally small and swim near the surface. Moreover, they are found in large shoals. They may be caught close to the shore or far out at sea. Examples of such fish species include; Anchovies, Brisling, Pilenards, mackerel, Herrings, Sardines, and Tilapia among many others.

(ii) Demersal fish: Demersal fish (often known as white fish) live at the bottom of shallow seas. They prefer the cooler waters and they are found most frequently at depths of about 40 meters where sunlight is just able to penetrate. These include Cod, haddock, Plaice and many others.

Types of fishing

There are two types of fishing which are:

(i) Marine fishing: This is a type of fishing carried out on Seas or oceans of the world. It forms the most important commercial fishing operation. This type of fishing is practiced especially for commercial purposes.

(ii) Inland fresh water fisheries: It is a type of fishing carried out from the water bodies located on the main land. These include rivers, swamps or marshy areas,

lakes and streams. It is less commercial oriented. Usually it is utilized for subsistence purposes. This is mostly engaged in by the remote fishing villages astride the water bodies.

Application Activity 14.2

Read the short passage provided below and use it to answer the questions that follow:

There is increasing great concern in the Area X. The water resources are not utilized in a sustainable way by some people. Various government agencies especially the department in charge of fishing activities and environmental management have tried to educate the masses about restoring the over fished water bodies. The fishing methods being used are not recommendable. However, there are some water bodies, especially the coastal areas, where the Ocean has large schools of fish. Still, if the trend of illegal fishing methods continues to be used, the fishing ground will be depleted of fish. The existing fishing companies produce poor quantity of fish yet the demand for fish is high.

1. With reference to the passage presented above, discuss the concerns of Area X.
2. Identify and describe the fishing methods which should be discouraged in order to ensure sustainable ways of fish harvesting.
3. State and describe the fishing methods which should be recommended to ensure sustainable fishing operations in the world.

14.3: Factors influencing the development of fishing

Learning activity 14.3

1. Using internet and text books, research on the factors that influence the development of fishing in the world.
2. Account for variation in the development of fishing industry in different parts of the world.
3. To what extent are physical factors influencing the growth and development of fishing industry in the world.

There are several factors that influence the development of fishing industry. These factors account for the existence of variations in the level of development of fishing industry in various regions of the world. In some places, there are flourishing fishing

activities while in others fishing is less developed. These features are divided into Physical and Human factors

Physical factors influencing the development of fishing

The following are the key physical factors affecting fishing in the world:

- **Availability of enough plankton**: The basic food supply for fish is plankton, which consists of many kinds of small microscopic plants and animals. In places where there is abundance of plankton, large schools of fish get attracted to such places. On the other hand, places with limited plankton attract less fish as they cannot have enough food to sustain them.
- **The presence of extensive and shallow continental shelf**:These are areas that allow plenty of light to penetrate the sea bed hence promoting the growth of plankton. These areas attract large schools of fish. This explains why deep-water bodies do not support a flourishing fishing industry.
- **The nature of the coast line**:The indented coastline supports the development of fishing industry. The indented parts of the coast create lagoons or parts of the sea or ocean that are less associated with strong sea waves. These become excellent breeding places for fish. Such parts provide nursery points for the young fish. In other parts where the coastline is non-indented, the strong sea waves wash away the young fish and destroy their eggs. In the latter parts, there will be less fishing activities than in the former regions.
- **Off-shore islands:** The areas naturally gifted with a handful of off-shore islands flourish with fishing activities. This because islands usually provide breeding places for fish, as they are surrounded by calm waters and, at the same time, they create conditions that support the growth of plankton. Japan has excellent fishing industry because of having thousands of islands.
- **The cool climatic conditions:** The cool climatic conditions support the fish metabolism. Fish requires cool habitant places for it to survive. The areas where the water temperatures are cool tend to have large schools of fish. On the other hand, those in which the sea or ocean waters are warm, there is limited fishing because such a situation does not favour the life of fish. The cool climate at the same time supports the preservation of fish and fish products for a reasonable time.
- **The presence of various rivers**:Rivers bring food from up-country to the sea, oceans or lakes. This provides enough plankton to fishand attracts large schools of fish to migrate to such areas. Rivers again support the breeding of fish since some salt water fish such as salmon breed from fresh water bodies and when the eggs hatch, the young fish migrate to the sea.

- **Poor soils:**This factor has influenced man to depend on fishing as the only source of survival. Poor soils cannot enable agricultural activities to take place. Therefore, for man to fill the gap, he is forced to develop fishing to meet the food requirements for an ever-increasing population. This is a clear experience happening in Norway and Japan.
- **The presence of vast forested areas:** This supports the building of fishing vessels/ships and boats which are at the centre of fishing operations. Therefore, an area with large stretches of forests will have access to affordable tools that are used in the construction of sailing ships and fishing vessels and packaging facilities. Such an opportunity will enable the investors to maximize the profits and register prosperity. This has played a significant role in the development of fishing in North West Atlantic fishing ground.
- **The nature of ocean currents:**The cold ocean currents create cool conditions that support the existence of fish in an area. This explains why there is a developed fishing industry in the North West Atlantic fishing ground because of the cold Labrador Current and warm Gulf Stream. The two mix up to create ideal conditions for both growths of plankton and fishes. The warm ocean currents allows the water body to be ice-free.
- **Availability of fishing grounds:**The more fishing grounds, the more will be fish production. Japan is favoured in this way.
- **Availability of varying fish species**:The presence of various fish species supports the development of fishing. Actually, when the demand for specific fish species falls, at least the demand for other fish species remains stable, supporting the development of fishing. Such varying fish species includeCod, Salmon, mackerel, Sardines and Pilchards among others.
- **The nature of the sea bed:**The nature of the sea bed may either support the development of fishing or discourage fishing operations. The smooth and non-rugged sea bed makes the fishing of the demersal fish easy and when it is rugged, it becomes hard to fish them and even when the fishermen try, the trawl nets get destroyed, stuck or held by obstacles, which costs them a lot. For example, there is a flourishing fishing industry on the Mediterranean Sea because of its smooth sea bed in Spain.
- **Lack of enough natural resources**:This is a factor that pushes countries to resort to fishing as the only way of economic survival. Countries such as Norway, Sweden and Japan developed their fishing industry because they have limited natural resources. While in countries where natural resources are in abundance, fishing tends to be a forgotten sector, as it is the case in the DRC.

Human factors influencing the development of fishing

The following are the key human factors affecting fishing in the world:

- **Availability of adequate capital:** The presence of adequate capital plays a great deal in the development of the fishing sector. Capital is needed to hire the required labour force, to purchase the fishing gear and generally the inputs such as nets, ships, boats and many others. Without adequate capital, fishing becomes less developed and remains at subsistence levels.
- **Availability and accessibility of adequate labour force**:It should be noted that fishing is another sector that requires enough labour force. There are steps involved in fishing that cannot be done by the machines, for they require the availability of manpower. Therefore, the fishing flourishes in the areas with cheaper manpower. South African fishing sector has developed because of the availability of both local and immigrant labour. The same applies to Norway where the Asian labour supply has supported the fishing industry.
- **Availability of enough market**: Commercial fishing requires a steady market. The investors need to sell what they are producing. That is why in densely populated areas such as China and Japan, fishing has stood a test of time for centuries. In areas where the market for fish and fish products is poor, the development of fishing becomes stagnant and eventually fails to pick up.
- **The presence of better forms of transport and communication:** Fish and fish products are perishable. They go bad very fast. They therefore require to be sold and consumed as quickly as possible. This is possible when there is a steady form of transport that can enable fishermen to transport the fish and fish products as quickly as possible. That is why in countries where fish landing sites are not connected to the market centres, fishing has remained undeveloped.
- **Supportive government policies:** This plays a key role in the prosperity of the fishing sector. The government with well-planned and designed policies such as tax holidays, economic diversification and fishermen being subsidized in times of economic constraints; all put together support the development of the fishing sector. In the regions where government policies are poor, non-discriminating fishing methods are used, pollution of fishing grounds and over taxation take the leading part. Such a case makes the fishing sector less attractive in the eyes of potential investors.
- **Political stability/improved security:** The fishing operations are usually conducted at night times. This implies that, there must be safety and peace that can support the fishermen. The installed fish processing plants need to be protected too. That is why in countries where peace has existed for many years, fishing has become one of the highly developed economic sectors. That is, investors wish to operate in areas where they are assured of peace and security.

- **Modern storage facilities:** As fish areperishable, there is a need to have appropriate storing facilities. In countries like Peru, Spain, USA, Japan and Norway fishermen use refrigerators, deep freezers and refrigerated trucks that transport fish and their products. This has enabled the fishermen to prolong the life span of the fish and their products.
- **Level of research:**This has become an essential aspect in the development of the fishing sector. It includes fish breeding, artificial fertilization of fish eggs and restocking of over fishing grounds with quick maturing fish species. It yields the production of quick maturing fish species especially those that are used in fish farming.
- **Availability of the required technology:** This influences the mode of fishing. The application of improved technology enables the fishermen to use modern fishing methods that support the sustainable fishing operations. It extends to fish processing and fishing gears and in-puts that ease the fishing operations. In areas where technology is poor, fishing operations remain at subsistence levels.
- **Long tradition of sea faring people:** Fishing has developed in countries where there is a long tradition of fish faring. These countries such as Japan, Spain and Norway, fishing is part of their cultural aspect. It creates the love for catching fish and the availability of experienced labour force. There, fishing develops faster than in areas where people know nothing about fishing practices.
- **The existence of several ports**: The more the fishing ports a country has, the more the chances of developing the fishing sector. These ports support the fishing landing operations, selling and purchasing the fishing in-puts. It also means that the more the fishing ports, the more the areas of fishing grounds.
- **The presence of fish cooperative organizations or societies**: When the fishermen are grouped into cooperatives, there are advantages that support their operations. All these provide a helping hand to the development of the fishing industry. They can access market, financial support and at the same time the purchasing of inputs becomes easier. This has been proved right in Norway, Spain and Sweden.

Application Activity 14.3

1. Rwanda has many water bodies, but her fishing sector is still very poor, to the extent that much of the fish and fish-products are imported from the neighbouring countries. Discuss the statement.
2. Account for deficient performance of the fishing sector in Rwanda.

14.4.: Importance of fish and fishing

Learning activity 14.4

1. Examine the economic significance of fishing industry in the world.
2. Analyse the economic implications of fishing in the development of any one country associated with the North West Pacific fishing grounds.

The fish and fishing have become the most significant aspect in the socio-economic development of various countries where they exist. Countries such as Japan, China, South Africa, Peru, Chile among others have had their economies flourishing from fishing activities. Below is a detailed explanation of ways in which fish and fishing are important:

- **Source of government revenue:** Fishing industry has enabled various countries to earn revenues through taxation and payment of company registration fee collections. This is used by those countries to develop their infrastructures and meet the socio-economic needs of their people.
- **Provision of foreign currency:**Fish and fish products are exported to other countries. This results in earning foreign currency. For example, the USA exports fish and fish products to France, China and many other countries. South Africa exports fish and fish products to East African countries. The foreign currency earned is used to fill the gaps in the national budget.
- **Facilitation of infrastructural development:**Fishing industry has come along with the development of various infrastructures such as roads, ware houses, railways and water transport which support the global development of the country.
- **Urbanization:**Several urban centres have developed because of fishing operations in various parts of the world. These urban areas are a positive contribution to the development of the economies. Cities such as Shanghai, Seattle, Baltimore, Osaka, Yokohama and many others; their existence is attributed to fishing activities taking place there.
- **Generation of employment opportunities:** Thousands of people are directly or indirectly employed by fishing industry. There are those who work in the harvesting of fish, others in fish processing, while others are employed by the industries that deal with the production of the in-puts needed in fishing operations.
- **Supportof economic diversification:** The occurrence of fishing industry has enabled various countries to diversify their economies. This has a handful of additional advantages. The countries are therefore able to have a wide range of sources of foreigncurrency and revenue. In other words, instead of

depending on one economic activity, they are now having another economic activity. Fishing has led to the development of other economic sectors such as forestry, tourism and industrialization.

- **Sustainable utilization of resources:** Fish is one of the natural resources provided by nature. Therefore, to be able to utilize fully the available resources especially those related to water bodies, fishing must be performed. This has enabled countries to maximize the use of the resources.
- **Development of industries:**There are several industries that have come up because of fishing. These include ship building, those that produce fishing nets and other marine related equipment. These too have a positive role to play in the entire development of an economy. There are fish processing plants that contribute millions of dollars to the economies. Fishing companies have invested a lot of capitals in the development of marine technologies that can provide solutions to their challenges. These technologies are later used by other sectors such as military and researchers.
- **Provision of markets for other products:**Fishing industry provides ready and steady markets for the products produced by other industries. These include agriculture (which provides food stuff to the fishermen), ship building industries, etc.
- **Research and study:**Fishing industries has provided excellent ground for research and education. There is a great deal of scientific research in relation to the creation of quick maturing fish species. Students who are taking fisheries as a career do their internship in various fishing companies.
- **Promotion of better international relations:**Fishing industry has enabled the countries to forge better international cooperation. For example, Japan and Germany are allies because of the interdependence that has come up as Germany imports fish from Japan.
- **Acquisition of skills:**Fishing has become a centre of skills acquisition. Fishermen have become experts in marine technologies and in understanding marine life and weather conditions. Deep sea diving, research skills and manufacturing of equipment are used in fishing and the acquired skills may be transferred in other sectors of activities.
- **Source of proteins:**Fish and fish products are part of the meals that many families, worldwide put on their table each day. Fish provides proteins to mankind and such has enabled many to live a healthy life.
- **Medicinal contribution:**Fish is used in the production of medicine for human beings. For example, the cod liver oil and insulin are used as medicine. The whale oil is also used to make soaps that treat skin diseases.

- **Support of tourism:** Many tourists come to various fishing spots to see the types of fish, for example how the whales look like or track their long journeys. This has indeed supported the development of tourism as a sector of the economy. Thousands of people travel up to Japan to see the Ise Bay and Osaka Bay.
- **Source of raw materials for other industries:**There are several products that are obtained from fishing industry and that work as raw materials in other industries. The fish bones and inferior fish are used in the manufacturing of fertilizers to be used in the agricultural sector.

Application Activity 14.4

Read the passage provided below and use it to answer the following questions:"There are hundreds of foreign investors that have visited Rwanda. They are moving around the world seeking for business ventures that they can invest in their huge sums of capital. Suppose that you are part of the team that will market the fishing sector"

1. Explain how you will market the fishing sector to influence the investors to select Rwanda's fishing industry.
2. Asses the contribution of the fishing sector to the socio-economic development of Rwanda.

14.5. Problems affecting marine fisheries and Solutions

Learning activity 14.5

Study the photograph provided below and use it to answer the questions that follow:

1. Comment on the above photograph in relation to fishing industry.
2. Apart from the challenges affecting Marine fishing shown in the photograph above, identify and explain the problems faced by the marine fisheries of the world.
3. Discuss the problems affecting the fisheries of the world and suggest the possible ways that can help sort them out.
4. With specific examples, examine the problems faced by the inland fishing industry and suggest viable solutions.

Like any other economic activity, fishing industry is also challenged with several problems. The severity of these problems varies from one place to another but at least they all share similar impact on the prosperity of fishing and the physical environment in general.

To have a prominent level of clarity, the problems and solutions are dealt with simultaneously using the table below:

Problems affecting Marine fishing	Possible solution
– **Harsh climatic conditions** have greatly affected fishing. The freezing conditions associated with winter, distress the developmental level of fishing. Oceans freeze, leaving no ice-free fishing grounds. During spring the stormy conditions come along with loss of lives.	– **Processing fish and fish products** during the time when climatic conditions are favourable. That is, fishermen should fish a lot and carry out fish canning in enormous quantities so that in times of unfriendly climatic conditions still they are able to make some exports. – The indoor fish farming practices in large farms should be practiced.
– **The seasonal migration of fish:** This lowers the quantity of fish caught. Fish migrate in given seasons when conditions are not favourable. For example, herrings migrate from north to south from winter and only to come during summer.	– The indoor fish farming practices in large farms should be practiced. This will enable fishing to take place during all seasons.
– **Over fishing** of the fishing grounds associated with marine fisheries. Fishing activity is one of the traditional activities that have stood a test of time for centuries. The increasing demand for fish and fish products has influenced continuous harvesting of fish and fish products resulting in the exhaustion of fish in some parts of the world.	– Restocking the over fished areas with quick maturing fingerings. – Strict measures should be put in place to ensure that recommendable fishing methods are used. – Restricting fishing for sometimes to allow fish to multiply. – **Ban on indiscriminate fishing:** This is done by regulating the size of the fishing nets used during fishing.

– **The presence of the lien fishing vessels:** The marine fishing in some countries such as Norway, China and Japan, face the challenge of foreign illegal fishing vessels encroaching on its waters. These fishermen from other countries use non-recommendable fishing methods that do not ensure sustainable fishing.	– The marine patrol teams or task force should be put in place. The coastal guards should be well facilitated to enable them to protect their territorial and international waters.
– **Water pollution:** There is increasing occurrence of water pollution resulting from industrialization, marine transport, military activities, etc. This affected the life of fish some die while others migrate to other parts of the seas. Even those that survive are found to be having inadequate quality that is below recommendable standards.	– Strict laws against pollutions should be enacted. – Mass education should be provided to the fishermen on how they can control pollution and the causes of it.
– **The poor visibility** on the water due to the presence of fog. This has often made some vessels to collide into each other.	– The radar system should be affixed on the ships so that they detect the in-coming ships and other obstacles such as ice-burgs. – Yellowish strong lights should be used to alert the ships from each other.
– **There is stiff competition:** between the countries engaged in marine fishing. This has left some failing to earn what is in their expectations. There are cheap fish and fish products originating from developing world.	– The quality of fish and fish-products should be improved to capture the interests of the clients. – Trade restrictions under protectionism should be executed in countries that practice marine fishing.

– **Inadequate capital:** Companies involved in marine fishing fail at times to get enough funds to support their fishing operations. Marine fishing is expensive and requires capitals to be used in purchasing equipment and pay workers. The low levels of capital availability limit the modernization of the fishing activity. This is a common experience in less developed countries engaged in marine fishing such as Thailand.	– The companies should secure financial loans from banks. – The companies should save and build a large capital base for future expansion of their operations.
– **Shortage of enough market:** There is a remarkable limited market for fish and fish-products from marine fishing industry. This is because, there other forms of food that substitute fish. There are many countries that have come up for the production and export of fish and fish-products. The inadequate quality of fish and fish-products from the developing world has contributed to this undesired situation.	– Intensive advertisement be put in place. – The companies engaged in fishing should ensure that the quality of their products is competitive and meet the international standards. This will help attract the interests and preferences of the clients.
– **Political upheavals from neighbouring countries and within the country.** The marine fishing is affected by political conflicts and wars. The marine fishing on the Mediterranean Sea has been affected by the political instability in Libya. This chases away the investors, and the infrastructures are destroyed.	– Peace talks between different political parties should be initiated.

– **Conflicts existing between nations:** There are misunderstandings that crop up because of inter territorial and international waters. This is where some countries claim others' fishing grounds. The good example is China and Japan fighting over some Islands.	– The neighbouring countries should endeavour to come to agreement on how to utilize their water resources.
– **Natural hazards such as Tsunamis and tornadoes.** Marine fishing has always been affected by Tsunamis and other associated strong sea waves. Ships are destroyed, nets drifted to unknown parts of the seas.	– Meteorological stations and Tsunami control stations should be distributed near the fishing grounds to provide warnings to the fishermen.

Application Activity 14.5

1. Design and point out the ways that can be put in place to improve the fishing industry in Rwanda.
2. Identify the challenges that are affecting fishing in Rwanda and suggest different ways of addressing them.

14.6: Future prospects and problems of inland fisheries

Learning activity 14.5

Study the photographs shown below and use them to answer the questions that follow:

1. Describe the relationship existing between the two photographs.
2. Analyse the problems affecting the inland fisheries in the world.
3. Suggest the future prospects that would address the challenges faced by the inland fisheries in the world.

14.6.1: Problems affecting inland fisheries of the world

The following are some of the problems influencing inland fisheries of the world:

- Nature of African coasts which are extremely straight and which lack indentations that may provide good shelters for young fish.
- Small continental shelves that do not allow the penetration of in-light water for the multiplication of plankton.
- High temperatures which make water warm, leading to the development of fish species that are too oily and unpalatable.
- Poor methods of fishing and poor fishing vessels that lead to over fishing and reduce the production and investment.
- Lack of capital to invest in fishing activities. This has resulted in the production forsubsistence.
- Low levels of education, some people don't know the importance of fish in their diet. This is further influenced by traditional values and norms that prohibit some groups of people from eating fish.
- Some of the inland water bodies are so deep at the point that sunlight cannot reach the bottom of the lake. This has affected fishing operations and contributed to low quantity of fishes.
- The use of non-discriminative fishing methods results in over fishing, thus causing the exhaustion of fish in the water bodies.
- The inland water bodies are becoming dumping places for wastes from industries and domestic establishments. This has made most of the fish to lose their lives and at the same time making it hard for fishermen to catch high quality fish.
- There are limited commercial fish species in most of the inland water bodies. This has become the hindering block to the supply of specific fish species from inland water bodies.
- There is a challenge of inadequate capital required to facilitate the fishing operations. This has contributed to the absence of integration of advanced technology in fishing and use of skilled labour.
- The inland fisheries are affected by lack of enough modern fish preservation facilities which influenced the inland fisheries to remain subsistence in nature.
- Poor and less developed forms of transport of fish and fish products from remote areas which are naturally endowed with fish in abundant levels have limited the access to the markets.

- There is serious silting of rivers and lakes because of the misuse of the areas surrounding the water bodies. The watersheds poorly farmed with trees cut for charcoal or fire wood haveresulted in serious soil erosion that takes the sediments into water bodies. Then, the fishing nets are buried by the silt and the hatchery, and the breeding places for fish are distorted.
- There is a challenge of water weeds that have covered almost the biggest parts of some water bodies. This has made fishing operations difficult and at the same time suffocating fish.
- There is stiff competition between inland fisheries and marine fisheries. Most of the time, the marine fishing products are bought faster than the inland fishing ones.
- The inland fisheries are more affected by the political instabilities than the marine fisheries. The civil wars and political upheavals have made the inland water bodies unsafe for fishermen.
- There is also competition from other sectors of the economy. There are economic sectors that have attracted more the interests of the masses and investors than fishing. This has limited investment to be injected in fishing industry.

14.6.2: Future prospects of inland fisheries

Below is a detailed explanation of the future prospects of inland fisheries:

- Formation of co-operatives: These may advance loans to the industry for the purchase of fishing gear and other equipment such as refrigerators for preservation. The cooperatives also assist in the marketing of fish.
- Ban on indiscriminate fishing: This is done by regulating the size of the fishing nets used during fishing.
- Restocking overfished waters: Where overfishing has taken place, there is need to restock the fisheries by introducing new fish species which are fast maturing.
- Construction of cold storage facilities: Cold storage facilities should be constructed in the major fishing areas for both fresh water and marine fisheries.
- Establishment of research centers: Research centers should be established to research on fresh water and marine fisheries in the country. Furthermore, it should make possible the creation of new and improved breeds of fish that can multiply faster and mature in abbreviated period.
- The countries engaged in fishing should consider enacting strict laws that aim at protecting fish and their habitants. That is, the laws will at least enable sustainable fishing to prevail.

- New agencies responsible for addressing challenges affecting inland fisheries should be put in place. The governments of the countries with inland fisheries should use such agencies to look for workable solutions that can drive fishing to the desired levels.
- The water bodies whose fish are threatened by depletion should be protected and a specific period should be fixed to allow the fish to multiply. That is, a period of no fishing in such fishing grounds.
- Massive and general infrastructural development should be given a point of attention. This when done, the inland will cease to be subsistence oriented and take the commercial display.
- The countries engaged in fishing, on a general perspective, should establish the fish hatchery centres in various strategic places. This will support the fish farming sector as well as having more young fish to use in restocking the over fished inland water bodies of fishing grounds.
- The master plan should be drawn in favour of the future of the fishing sector. Such will ensure that the fishing sector develops in a sustainable manner.
- Well trained guards should be available to protect the fishing grounds and monitor the implementation of the government policies related to fishing sector.
- The areas near the water bodies where fishing is taking place should be restored and protected against degradation. That requires the reforestation and afforestation programs to take place in the water sheds. This should come along with the establishment of buffer zones around all water bodies. This will address the problem of silting which has left disastrous effects on the life of fish and fishing operations in general.
- The intensive water weed control program should be launched. The concerned governments should ensure that water weeds such as water hyacinth along Nile River and Lake Victoria should be removed completely.
- Commercializing of the inland fisheries should be developed. This will address the challenge of inland fisheries that has for many years remained for subsistence purposes.
- The countries with interest in inland fisheries should encourage fish farming with cage fishing given much emphasis.

Application Activity 14.6

1. Identify the measures to be taken to improve and develop inland fisheries in Rwanda.
2. Suggest the appropriate measures and methods that can be promoted to improve the inland fisheries.

14.7: Fish conservation and preservation

Learning activity 14.7

Read the passage shown below and use it to answer the questions that follow:

In one of the fishing villages around lake Malawi, people are concerned with the quality of fish products the fishermen are selling to them. The fish products have lost their natural flavour, while in some places they decompose before they are taken to the market. This has become a case of great concern to the local authorities. The fishermen and fishing cooperative societies are being trained on how to store their fish products for a reasonable time. However, the number of methods used need to be supported by other methods that can enable fish products to reach market without getting spoilt.

Around Lake Victoria, some measures have been adopted to protect the waters and aquatic animal, more specifically fish.

1. Identify the statement in the passage that represent fish preservation and fish conservation.
2. Using both the passage shown above and the past studies, identify and explain the methods used in fish preservation and conservation.

14.7.1: Fish conservation

The term fish conservation stands for all ways used to protect fish in the fishing grounds to avoid their depletion. This ensures that there is sustainable production of fish and fish-products. There are numerous ways of fish conservation and the following are among them:

- **Use of modern fishing methods:** The modern methods of fishing that are discriminative in nature are used. These only catch the mature fish and leave the young ones to grow. This replaces the traditional and crude methods of fishing such as poisoning and barrier methods that lead to catching of both young and old fish and other aquatic animals.
- **Re-stocking the fishing grounds:** This is the act of seeding the over fished fishing grounds with quick and hybrid fish species. When this is done, fish can grow, and fishing activity during that protection period, is put on halt.
- **Cross-breeding:** This involves the practice of artificial fertilization of fish to attain hybrids. These are of high yielding capacity and mature faster than the local breeds. These hybrid fish are then introduced into the over fished areas or well-selected water bodies.

- **Use of recommendable fishing gear:**The recommended sized nets are used. These are inspected by authorized government officials. This is a conservation measure, because it only allows the fishermen to catch mature fish leaving the young ones to grow. Hence, there is a need to develop and ensure a sustainable fish harvesting system.
- **Artificial hatching of fish:**This involves the creation of special ponds to conduct an artificial fish hatching. In such ponds fish are looked after well until they reach the level of being replanted into the fishing ground or well-selected water bodies.
- **Mass education:** The fishermen and the population living around water bodies should be educated or sensitized on proper ways of fishing. They are given light on the dangers of pollution and proper recommended fishing methods that ensure sustainable fishing practices.
- **Regulated fishing stages:** This involves setting restricted period of non-fishing operations. This aims at allowing fish to grow to maturity and breed without being interrupted. Such specific periods support regeneration of fish.
- **Provision of plankton artificially:** In some water bodies where there are inadequate plankton supplies, it is supplied artificially to allow fish survive and grow in abundance. This is best practiced in fish farms.
- **Enacting strict rules and regulations:**For fish conservation to be implemented, it requires the government's support. The government should put in place the laws that regulate the utilization of water resources and fish. The laws are made to safeguard the wet lands and water bodies from misuse by man.
- **Relocation of predators:** In water bodies where predators dominate and are a threat to fish, they (Predators) are transferred or caged to a given section of the fishing ground.
- **Harsh punishments against pollution:** The fishing grounds should be protected from pollution at all costs at the point that those caught polluting water bodies are fined. This may enable the fishing grounds to be free from the water pollution in order to protect fish from any type of pollution.

14.7.2. Fish preservation

The term fish preservation refers to all ways that enable fish and fish-products to be stored for a prolonged period before being taken to the market or consumed. As fish is perishable, it needs to be preserved as soon as it is caught to increase its storage life. Below there is a detailed explanation of the methods of fish preservation.

Fish preservation method	Description
Salting 	After fish have been cleaned, salt is displayed on them especially between the layers of fishes.
Smoking 	The fish is dried using fire This method involves hanging the cleaned fish above the fire, purposely to remove moisture. This method enables the fish to dry perfectly and thus enabling it to be preserved for a reasonable time.
Deep frying 	This involves the cleaning of fish and dissecting it. Then, the pieces of fish are put in boiling cooking oil. This removes moisture from fish. When it is confirmed that now the fish is dehydrated, it is removed and put in dry packages.
Sun drying 	The fishermen clean the fish, scales and intestines are removed. The cleaned fish or pieces of fish are displayed on a stretcher or stall under the sunshine. The sunshine removes the moisture. After some days of sun drying, they are packed in well-spaced clean place to allow the air to pass through.

Refrigeration 	This is a method that has taken a strong significant place in fish preservation. Fish is cleaned and dissected into filets. Sometimes, scales and intestines are just removed and the whole fish is subjected to low temperatures using deep freezers. The primary purpose of this method is to store fish in its fresh form for a reasonable period. Fish may be put in packages before it is refrigerated.
Fish canning 	Fish is cleaned. It is then subjected to recommendable heat, it is then put in containers and sealed tightly under strictly hygiene conditions. The sealed fish in a container is further heated to destroy the micro-organisms that make the food spoilt. The sealing is primarily done not to allow air entering which may contaminate the packed fish.

Application Activity 14.7

In Umutuzo village, the local population gets their livelihood from fishing. They fail to market their fish and fish-products because the market centres are far away. Wherever they try to transport their products, they get spoiled before reaching the market.

1. Advise the people from Umutuzo village on the ways of conserving and preserving their fish in order to transport them without getting spoiled.
2. Show how some of the fish preservation methods affect negatively the environment.
3. Describe how sustainable fishing can be implemented in the above mentioned village.

14.8: Case studies of fishing in selected countries

Learning activity 14.8

1. To what extent are physical factors responsible for the growth and development of fishing in Norway?
2. Outline and explain the contribution of fishing industry to the economy of Japan, Norway and Peru.
3. Using Text books, internet and other sources of geographical information, research on the state of fishing industry in Morocco and South Africa.

14.8.1: Norway (North East Atlantic)

The country of Norway is known for its leading position in fishing in the whole of Europe. Its total fish catch is estimated to stand at 5% of the total world's catch. Fishing is a dominating economic sector in the country. It employs the greatest percentage of the population and fetches huge sums of foreign exchange for the government. Its fishing ground falls under North East Atlantic. The extent of Norwegian fishing ground extends from Stavanger in the South to around Hammerfest in the North-Eastern. This fishing ground is naturally blessed with a variety of fish species. The dominant ones include the following: Herrings, Pilchards, Sardines, Mackerel, Sprat, Halibut, Dogfish, Haddock, Cod, and Capelin.

The fishing in Norway has been primarily favoured by the presence of an extensive continental shelf that stretches for thousands of miles or kilometers. Norway is a good place for coast and deep-sea fishing.

For freshwater fishing, Norway offers top quality trout fishing in beautiful woodland and mountain areas. Pike fishing is also very good. Freshwater inland lakes and ponds are abundant with trout, pike, grayling, carp and perch.

Figure 14.311: A map of Norway showing fishing grounds

Factors that have led to the development of fishing industry in Norway

Below are the factors that have influenced the development of fishing in Norway:

- The presence of vast and extensive fishing ground that is composed of North Sea, Norwegian Sea and Barents Sea.
- The country has extensive and shallow continental shelf that has supported the growth of enough plankton. This is so, because light can reach the sea beds. Therefore, being able to attract large shoals of fish.
- The Norwegian fishing ground is naturally blessed with cool waters. These provide ideal conditions that favour the growth of plankton and fish metabolism. Such has attracted large shoals of fish.
- The country has a wide range of rivers radiating from the interior to the coastal areas. These have provided better breeding areas for a variety of fish species, at the same time bringing enough food to the sea which supports the existence of fish.

- There are extensive sheltered waters along the coastal regions of Norway. This has contributed to the development of excellent fishing landing sites, ports and at the same time the provision of protected fish breeding points.
- The Norwegian fishing industry has been favoured by the presence of many off-shore Islands. There are almost more than 2000 islands. These have resulted in the creation of several fishing villages.
- The latitudinal location of Norway allows the presence of cool temperate climatic conditions which supports easily the preservation of fish and fish-products. The area is blessed with cool waters that favour fish metabolism. Such has attracted large shoals of fish to prevail in the area.
- The soils of Norway are infertile and less productive. This is worsened by the mountainous nature of the country. These have pushed the country to resort to fishing.
- The fishing grounds of Norway are ice-free most of the year. This is attributed to the warm North Atlantic drift that influences the existence of mild winters. Therefore, fishing operations are conducted throughout the year.
- Norway has several forested areas which support ship building by providing timber and other forest products which lessens the cost of ship building.
- The fishing industry of Norway is supported by the existence of a variety of fish species. These include White fish, Prawns, Herrings, mackerel and Cod among many others.
- There are supportive government policies that have favoured the development of fishing in Norway. These include financing the fishing operations and tax holidays that are provided to the upcoming fishing companies.
- The presence of excellent forms of transport has favoured the development of fishing industry. The fishermen can transport both in-puts and out-puts easily and at a cheaper cost.
- There is availability and accessibility to local and international markets. The Norwegian fishing sector exports fish to countries such as China, German and many others.
- There is well developed marine technology in Norway. The fishermen have been able to develop their fishing operations because all modern equipment needed is available and they know how to use it. Therefore, they can use the detectors of shoals of fish, trawling methods among others.
- The fishermen in Norway are organized in cooperative societies. These have supported the fishermen to have access to the financial support, market and at the same time purchasing fishing gear becomes easy.

- There is availability of adequate capital required by fishing companies. The country of Norway for many years has injected into it huge sums of capital earned from the exportation of oil and natural gas. There is also a collaborative atmosphere between the government and financial institutions whereby banks are encouraged to give loans to the fishing companies.
- There is a steady supply of both skilled and semi-skilled labour force from the large influx of immigrants from the Asian countries and the Arab regions. This labour force supports the development of fishing operations.

14.8.2: Japan (North West Pacific)

Japan is ranked the third in fishing industry in the world and it contributes about 8% of the world's fishing production. Japan is a country with thousands of Islands which favour the country to have several fishing villages. Japan fishing ground stretches from Hokkaido to Kyushu. Japan also has greatly advanced aquaculture or sea farming techniques. In this system, artificial insemination and hatching techniques are used to breed fish and shellfish, which are then released into rivers or seas. These fish and shellfish are caught after they grow bigger. Salmon is raised this way.

Japan has more than 2,000 fishing ports, including Nagasaki, in southwest Kyūshū; Otaru, Kushiro, and Abashiri in Hokkaidō. Major fishing ports on the Pacific coast of Honshū include Hachinohe, Kesennuma, and Ishinomaki along the Sanriku coast, as well as Choshi, Yaizu, Shimizu, and Misaki to the east and south of Tokyo.

Japan is also one of the world's few whaling nations. As a member of the International Whaling Commission, the government pledged that its fleets would restrict their catch to international quotas, but it attracted international opprobrium for its failure to sign an agreement placing a moratorium on catching sperm whales. Currently Japan conducts research whaling" for minke whales in the oceans surrounding Antarctica.

The major fish species caught in Japan include: Sardines, herrings, Pearls, Salma, yellow tail, Tuna, Shellfish, Cuttle fish, Whales, and Crustaceans. It should be noted that japan has a well-developed fishing sector that exercises the highest level of modernization. Her fishing grounds are in North West pacific zone.

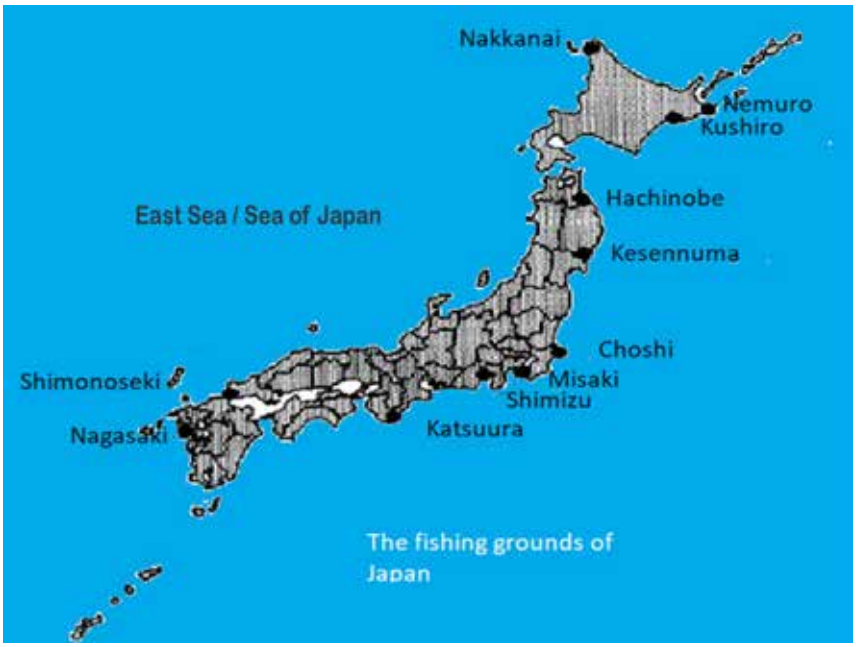


Figure 14.312: Fishing grounds of Japan

Factors influencing the development of fishing industry in Japan

- The existence of extensive irregular coastline that covers almost 29,750 km. This has favoured the development of fishing ports, occurrence of breeding places for fish due to the sheltered waters. The irregular nature of coastline is made up of many bays such as Ise Bay near Nagoya, Southern Honshu, Tokyo Bay around Tokyo and Yokohama, and Osaka Bay near the metropolis of Kobe-Osaka.
- There is an extensive and shallow continental shelf. This allows the light to infiltrate up to the sea bed, thus favouring the growth of enough plankton. It explains why there are large shoals of fish.
- Japan has an indented coastline characterized by bays and lagoons. This has led to the formation of sheltered inlets which have favoured the establishment of fishing ports and villages. Examples: Eastern Honshu and South of Tokyo.
- The huge fishing ground that extends to Pacific Ocean. This has supported the massive fishing operations as far as to the deep parts of the sea, and thus ensuring large production that meets the increased demand for Japanese fish.
- The convergence of the Warm Kuroshio and Cold Oyashio currents has supported the creation of favourable conditions that give a hand to the growth of plankton and fish metabolism. This explains why there are huge shoals of fish of both demersal and pelagic fish in the fishing grounds of Japan.

- The presence of several Islands influences the existence of Sea faring tradition that has played a significant role in the development of the fishing sector. Japanese are known for having a culture that respects the sea life. The major Islands are Hokkaido, Kyushu, Shikoku and Honshu. However, there are other several small Islands and all are known for fishing.
- Japan is naturally endowed with vast forested areas covering almost 50% of the total area. These have provided steadily raw materials to the ship building industry. Therefore, it is easy to get ship, small boats and other related vessels needed in the fishing sector.
- The rugged nature of the country made the land to be less supportive to the agricultural sector. This left fishing as the only alternative for the Japanese Homesteads.
- The warm Ocean currents, especially the Warm Kuroshio, keep the waters of Japan to be Ice free even in times when winter is in existence. This allows the fishing operations to be conducted throughout the year.
- Japan has a relatively smooth sea floor along the East Sea / Sea of Japan. This has supported the use of trawling and Drifters in the catching of both pelagic and demersal fish species.
- Japan experiences the cool temperate climate. This favours both the existence of large shoals of varying fish species and their preservation.
- There is adequate market for the Japanese fish and fish-products. This is provided by its high population that stands at almost above 127,230,107 People as per 7th May 2018. It also exports fish to countries such as China, Korea, Philippine and Singapore among others.
- There is intensive research into marine technology as well as fish breeding, restocking fishing grounds and artificial fertilizing of fish eggs. The research into this area has enabled the Japanese to introduce even other fish species in their waters that never existed before.
- Better methods of fishing are used. These are highly modernized and efficient in nature. They include trawling, drifting and seine nets. These are witnessed on the East / Sea of Japan.
- The country of Japan has been stable for several years. This has built trust in the minds of foreign investors to put their funds in the sector of fishing.
- There is a close cooperation between Japanese fishing companies and foreign fishing groups. This exposure has enabled the Japanese to have access to modern technologies and being allowed to conduct fishing in other international waters.

- There are supportive government policies. These include making agreements with other countries that share international waters with Japan. Providing tax holidays to the investors and the implementation of fish conservation programs.
- There is a steady supply of labour force of all kinds. This is provided by the local population and immigrants from Asian and African countries. These have provided a helping hand to the development of the fishing industry of Japan.
- The excellent and well-developed forms of transport, especially the network of electrified railways system that connects fishing ports to market centres. This has assisted the fishing companies to have the capacity and means of taking the fish and fish-products on time. The good example is the railway line in Ise Bay town, Osaka Bay and other inlets of commercial significance.
- Japan has one of the modern and highly facilitated storage facilities for fish. These have modern refrigerators that enable fishermen to prolong the shelve life of the fish and fish-products. These are in hundreds and strategically located. Some are found at Hokkaido, Nagaya and Osaka.

14.8.3: Peru (South East Pacific)

The country of Peru is found in South America. This is done all along Peru's vast Pacific coastline; The economy in this country is supported by fishing industry. Peru was once a world's leading country of fish and fish-products production in 1950s. Even though there were some changes in the trend, still it earns a reasonable position in the tropical America and the world at large.

Peru is naturally endowed with a variety of fish species. These include Rainbow trout, Sardines, Mackerel, Bonito, Anchovy, Tuna and many others. It should be noted that much of her fish caught are used in the making of fertilizers and fish oil.

The fishing industry of Peru has developed because of several factors as developed below:

Factors influencing the development of fishing industry in Peru

- There is an extensive coastline. Peru's long coastline covers almost 3000 km in length. It stretches from Tumbes in the North to Taona in the south. This facilitated the fishing industry to have a vast fishing ground.
- The sea bed along the coastline of Peru is smooth. This has favoured fishing of both the pelagic and demersal fish using the appropriate methods such as Trawling, and purse seining that ensure a large catch of fish
- There are good conditions that favour the growth of Plankton. These conditions are created by the cool Peruvian current known as Humboldt. Such has attracted varying fish species to the area

- The country is blessed with indented coastline. This has led to the creation of well-sheltered inlets that provide excellent sites for Port establishment. The major fishing Ports include Callao, Trujillo and Chimbote among others. The indented nature provides fish breeding and nurseries for fish.
- The presences of coastal birds in millions make the coastal areas unique. Their droppings naturally fertilize the sea bed and therefore, supporting the growth of plankton. The more plankton, the more fish are attracted to the area and the result is enabling the fishing companies to register a big catch.
- . The rugged nature of the western region of Peru, because of Andes mountain ranges, left the land to be of less agricultural importance. Therefore, for the economic survival, Peru resorted to fishing as the best viable substitute.
- There are various rivers radiating from the middle part of the country to the coastal waters of Peru. These come along with the required salt minerals that support the growth of plankton. These rivers bring a wide range of fish feeds as well as providing breeding places for some kinds of fish. The most notable rivers are Maranon River and Ucayali.
- Peruvian fishing grounds are known for having a wide variety of fish species. These include Mackerel, Anchovies, Bonito, Skipjack. They enable the fishing companies to always meet the market demand. The sector of fishing in Peru has resorted to the use of fish to manufacture fish meal for animal fodder, fertilizers and fish oil. These are practiced at Chimbote and Callao fishing Ports.
- The country of Peru has several off-shore Islands. These are dominantly used for the collection of Guano and giving support to the fishing vessels that sail far away from the coast.
- There are huge forested areas especially along the slopes of the Andes mountain ranges. These have supported fishing in several ways especially in ship, boat and vessel building. The timber collected is also used in making packaging products/materials in the form of boxes. The fuelwood is used to make fire that is needed in the smoking of fish as a form of fish preservation technique.
- There are a wide number of fresh water bodies that have supported unreservedly the development of inland fresh water fisheries. These include Lake Titica, River Amazon, River Maranon.
- The Peruvian coastal areas experience the cool temperate type of climate. This has favoured the growth of plankton and supported the fish metabolism. This cool temperate climate again increases the dependability of fish preservation methods basing on natural conditions.
- There is availability of adequate capital. The fishing companies in Peru have adequate capital to use in the purchasing of in-puts such as fishing nets, packaging products and hiring the needed labour force.

- The Peruvian government has designed and implemented policies that favour the growth and development of fishing. These include the conservation of water bodies, strict laws against water pollution and tax holidays of the newly established companies.
- There is intensive research being carried out in Peruvian fishing circles. This is related to restocking the over fished areas, Nourishing the fish species and artificial fertilization of fish. This has enabled continuous availability of large shoals of fish. This research is more pronounced at Callao and Chimbote research centers.
- The country is connected by a network of well-developed transport facilities. There are modern railways, better roads, and water transport in place. The fishermen are therefore, able to transport both inputs and outputs easily and very fast.
- The Peruvian population is settled in large numbers along the coastal regions. This has therefore, created a class of people with the sea experiences and who find their livelihood in fishing.
- There is a steady supply of labour force of all kinds. This is provided by both the local population as well as the immigrant population. Many people from the neighbouring countries move to Peru to work in the fishing sector at a cheap and affordable cost.
- There are several fish processing factories throughout the coastal areas. These have enabled the fishing industry to add value to the out-put and therefore, improvising quality. This explains why their products are highly demanded. They process fish and fish products into a variety of other products such as cosmetics, medicine, fish oil and fertilizers as well as fertilizers for agricultural purposes.
- There are modern and well-facilitated storage centers that assist the fishermen to preserve their fish and fish products for a reasonable period as they wait for export or buyers. These centers are refrigerated and well air conditioned in line with the international standards.
- Peru is one of the South American countries that at least have relatively ideal political stability. This has made the country the hub of investment in the sector of fishing for both local and international companies.
- The Peruvian fishing sector uses modern technology. This has enabled the fishing companies to save time and increase the production. The fishermen use the GPS units, Spotter air crafts, under water cameras, fish attractants and baits, modern fishing vessels with radars among others. All these account for the prosperous prevalence of the fishing industry in Peru.

14.8.4: Morocco (West Africa)

Morocco is one of the African countries known for having relatively a well-developed fishing sector. This fishing ground is situated in the North East Atlantic fishing zone. The ocean off Morocco's Atlantic coast is one of the richest fishing grounds in the world. (1) All together, Morocco's coastline covers 2,141 miles along the Mediterranean Sea and Atlantic Ocean. The Moroccan fishing sector is supported by almost 15 fishing centers. The Moroccan fishing ground extends from Mediterranean Sea to downward direction along the coastal areas of the country. In actual sense, there are three major fishing zones in morocco. These include;

(i) Along the shores of the Mediterranean Sea: The major fishing ports found in this zone include: Martial, Lao, Madiq, Wadir, AliHoema as the most important ones.

(ii) The northern Moroccan coastal areas: The zone has the following fishing Ports: Kenitra, El Jadid, Rabat, Casablanca, Tangier and Laranhe.

(iii) The Southern Moroccan coastal waters: The major fishing ports in this area are: Safi, Essaquira and Agadir.

However, there are other small fishing ports and villages in this fishing zone. The Moroccan fishing is more commercial oriented and carried out on a very wide scale. This has therefore necessitated the use of modern fishing methods such as Trawling, Drifting, and Pursue seining. The fishing grounds of Morocco are naturally endowed with a variety of fish species especially Anchouvy, Tuna, Sardines and Mackerel.

Figure 14.313: Morocco fishing ground

Factors influencing development of fishing industry in Morocco

The following are the major factors influencing fishing in Morocco:

- The Moroccan coastline is characterized by an indented structure. This has supported the establishment of several fishing ports such as Tan-Tan, Tangier and Agadir. Such a nature of coastline has enabled the existence of excellent fish breeding places and the protection of young fish against strong sea waves.
- The Sea floor associated with the Moroccan Atlantic coastal areas is relatively smooth. This has helped the fishermen to use trawling and other suitable commercial fishing methods.
- The country of Morocco has off shore Islands such as Canary Island. This help the fishermen to have off-shore landing points especially in times of emergency. These Islands also influence the creation of fishing villages.

- There is a vast fishing ground associated with Morocco. This includes the Moroccan territorial waters of Atlantic Ocean and part of the Mediterranean Sea. Having a wider fishing ground means having chances of conducting larger fishing operations.
- The aridity conditions existing in Morocco have made the soils to be less supportive to agriculture. This favours fishing since it becomes the only source of economic survival and a chief source of food.
- The availability of enough plankton. This is attributed to the presence of the Cold canary ocean current that creates ideal conditions that support the growth of plankton. The cool conditions support also the fish metabolism. Therefore, influencing large shoals of fish to live within the region.
- The Moroccan fishing ground is naturally blessed with a wide variety of fish species that are of commercial significance. These include Pilchards, Tuna, Sea cucumbers, Anchovies, Mussels, Shellfish, sardines, mackerel and Oysters among several others.
- There is a long tradition of sea faring cherished by the Moroccan population. This is so because most people are settled along the coastline.
- The government of Morocco entered into international fishing agreements that gave the country a chance of having its fishing ground being extended for 320 km.
- There are better methods of fishing used in Morocco. These are recommendable and they meet the international standards. They include trawling, drifting, purse seining, long lining among others.
- The country is endowed with Mediterranean forested areas. These have provided timber required in making of fishing gear such as boats, packaging boxes, and fish net floaters.
- There is availability of required technology related to fishing and marine operations. The fishermen use ships with radars, have GPS units, light searchers, sonars, fish finders, under water cameras and many others. This technology has also enabled the canning and processing of fish products to recommendable quality and standards.
- There is availability of adequate market for the Moroccan fish and fish-products. This is provided by both the local population (that stands at 31.5 million people) and abroad, as the Moroccan fish and fish-products are liked. The country exports in enormous quantities fish and fish-products to Spain, USA, Japan and Italy.
- The country has several fish processing plants. These purchase massive quantities of fish from the fishing sector. They process the fish into fish oil, fertilizers, animal feeds, glue and many others. For example, there are fish processing companies at Agadir and Casablanca.

- Morocco is one of the Arab countries that have been stable for a long time. This has built trust in the eyes of foreign fishing companies. The latter have invested huge sums of capital in the fishing sector of Morocco. These companies come from Norway, Italy, and Spain.
- The fishing sector of Morocco has engaged in intensive research that aims at improving all the circles of fishing operations. They have set up a Moroccan fish research center, which has played a key role in fish breeding and restocking techniques.
- The government of Morocco has developed and designed policies that have favoured development of fishing. These include tax holidays, fish conservation, protection of fishing grounds against pollution, and easy registration of companies.
- The fishing sector of Morocco is characterized of well-developed fishing organizations and cooperatives. These have benefitted the fishermen, since they are taught better methods of fishing, fishing company management techniques, marketing the fish and fish-products and at the same time enabling the fishermen to access modern fishing in-puts.

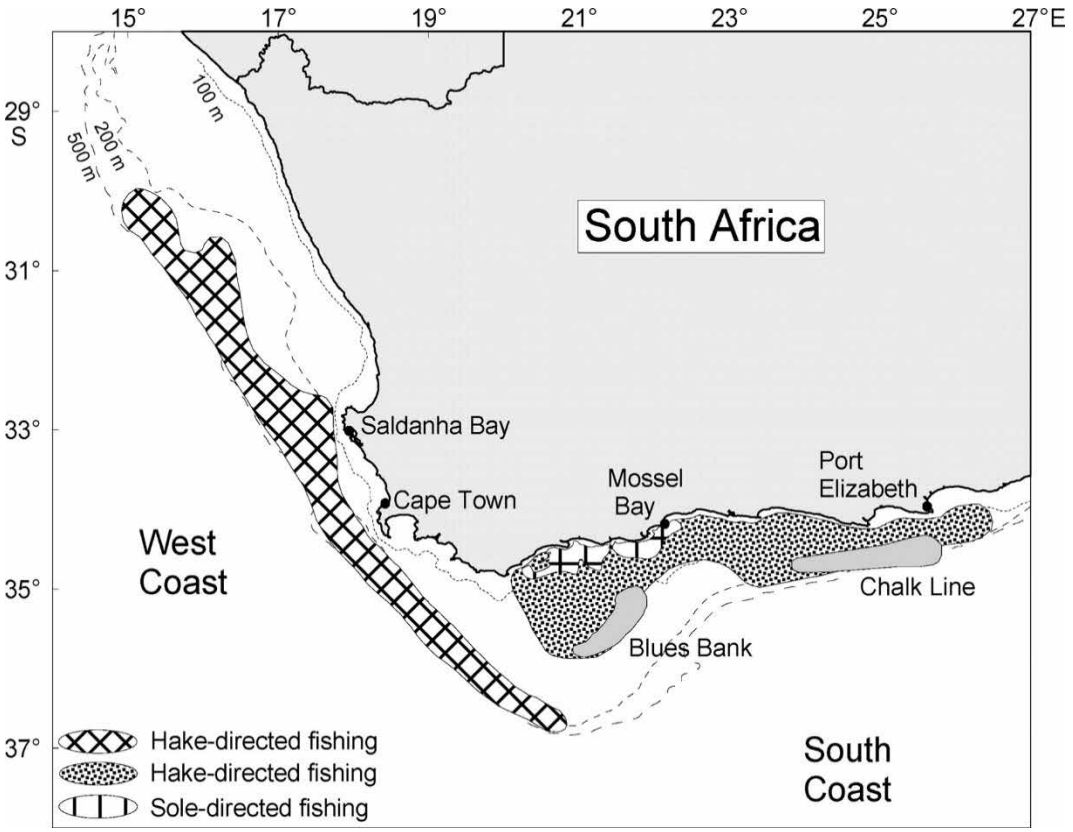


Figure 14.314: Major fishing grounds of South Africa

14.8.5: South Africa (South East Atlantic)

The fishing grounds of the Republic of South Africa are both in the South East Atlantic Zone and South East Indian region. These form three major fishing grounds, namely West coast fishing ground, South coast fishing ground and East coast fishing ground. The East coast fishing ground is characterized by little prosperous fishing operations. This is because of the presence of the warm Mozambique current which has influenced the existence of conditions that do not support fish metabolism. The few that thrive there become oily and the majority migrate to other parts of the sea. In the whole of Africa, the South African fishing sector takes the leading position. The country is known for the in-shore and deep-sea fishing operations. There is also a well-developed aqua-culture. There are major fish species such as Sardines, sole, pilchards, mackerel, Shellfish, Anchovies, Shrimps, crabs and crustaceans. This sector is also engaged in fishing whales that are used in the production whale oil.

The South African fishing sector is also involved in harvesting sea weeds, used for human consumption as well as making the animal fodder. There are several companies that process the products from the fishing sector to make cosmetics, glue, iodine, and gelatin. Fishing has also become a sporting activity in South Africa.

The sector is supported by the existence of several fishing ports such as East London, Somerset, Cape Town, port Noloth and Saldanha. The fishing sector of South Africa operates the entire year-round. South African's waters are kept open and ice free. The chief fishing zone is located around the Agulhas Cape. This is the part of the Atlantic where the warm Mozambique (Agulhas Ocean current) mixes up with the cold Benguela current. Such creates the most ideal conditions that support the growth of plankton in abundance. These conditions have attracted large shoals of varying fish species to dwell in the area.

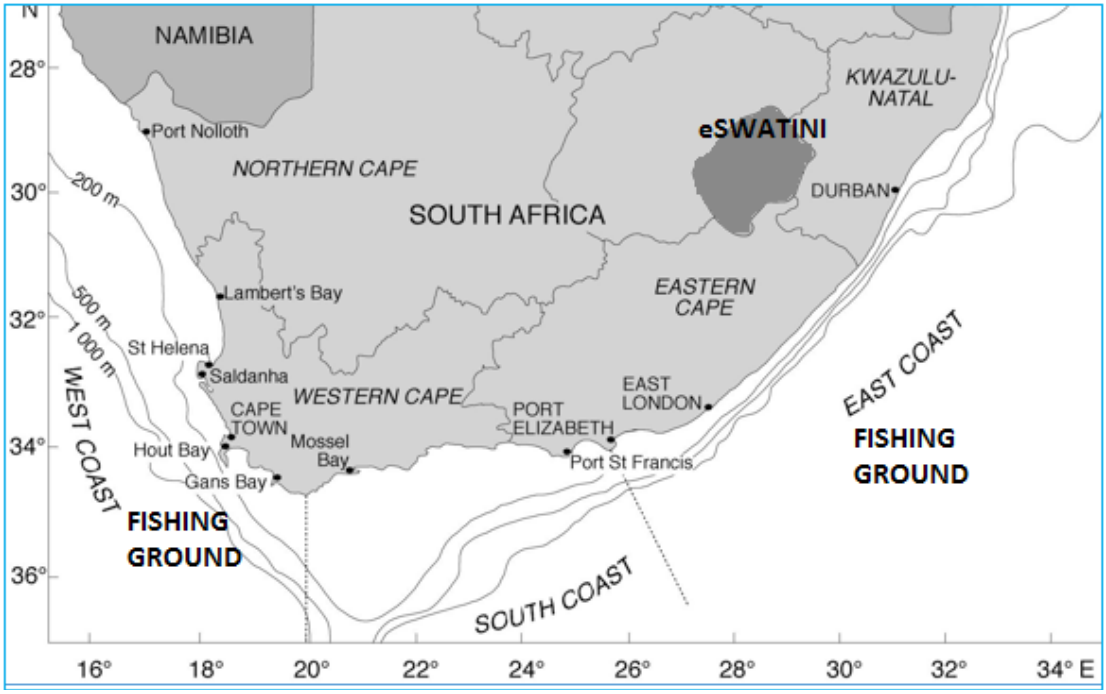


Figure 14.315: A map of South Africa showing its fishing grounds

Factors influencing the development of fishing industry in South Africa

Below are factors that have supported the development of the South African fishing sector:

- Presence of long and extensive continental shelves which are shallow. It is estimated to cover almost beyond 2000 km.
- The country has an indented coastline which has given a chance of port development and occurrence of naturally sheltered fish breeding areas and nurseries for the young fish. This can be seen at Table Bay, Cape Peninsula and Picketberg.
- There is availability of enough plankton which supports the lives of fish. This also keeps attracting more fish to the area.
- South African fishing grounds are blessed naturally with a wide range of fish species. These include, Sardines, sole, pilchards, mackerel, Shellfish, Anchovies, Shrimps, crabs and crustaceans.
- The influence of the cold Benguela ocean current. This has led to the occurrence of cool conditions that support fish metabolism as well as the growth of plankton.
- There is availability of the needed technology. This has enabled the fishermen in South Africa to use modern fishing methods and to add value to the fish and fish-products.

- Availability of enough capital. The fishing companies have invested huge capitals in the sector of fishing. The government still is injecting a lot of funds in the programs related to fishing.
- The government of South Africa has designed policies that support the development of fishing activities. These include fish the conservation and protection of fishing grounds against pollution and foreign or illegal foreign fishing vessels.
- The western regions of South Africa are affected by arid conditions and dry winds. This has made the area not to be of great agricultural significance. This therefore has influenced the South Africans to seek for an economic survival from the fishing sector.
- There is availability of local, regional and international market for the South African fish and fish-products. The urban centres with high population numbers depend on fish for food, and much of the fish and fish-products are exported to the DRC, Angola and some European countries such as Spain.

Application activity 14.8

1. With specific examples, explain why fishing in Norway is different from that of Rwanda.
2. Explain the major fishing operations that the government of Rwanda can adopt from any developed country studied under case studies (Norway, Japan, Peru, Morocco and South Africa).

End unit assessment

1. Examine the impact of fishing on the sustainable development of any country of your choice.
2. For either Norway or South African, assess the influence of physical factors to the development of the fishing sector.
3. Discuss the economic implication of the fishing sector in the developing world.

UNIT 15

MINING IN THE WORLD

UNIT 15: MINING IN THE WORLD

Key unit competence:

By the end of this unit, I should be able to explain the impact of mining in the sustainable development of different countries in the world

Introductory activity

The underground is very rich in natural resources, but they have to be utilized in a sustainable manner in order to support the socio-economic development of different countries owning those natural resources. However, if they are not exploited well, the physical environment can be degraded.

1. Identify the economic activity taking place in the areas shownin the photographs above.
2. Name the major minerals of the world and mention the countries which are exploiting them.
3. Examine the factors that have favoured mining activities in USA or South Africa,
4. Analyse the effects of exploitation of minerals to the economic development of any country like Rwanda.

15.1: World distribution of major minerals

Learning activity 15.1

1. Identify the major world minerals and state where they are found using the above map.
2. Using the legend presented in map above, state the countries where the following minerals are exploited: Gold, copper, oil and natural gas, lead.
3. Explain how the natural resources in specific minerals can be exploited without affecting the environment.

Mining refers to all the processes by which minerals are obtained from the earth. Minerals may be in gaseous, liquid or solid form. The processes involved depend upon the mode of occurrence of the mineral.

Three major mining areas may be distinguished based on the variety of mineral resources, amount of exploited minerals, and their production. These are:

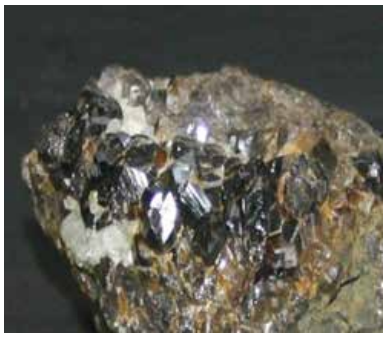
- **North America**: From central Alaska and north-central Canada to southern Mexico. The central plains from the Gulf of Mexico to the Laurentian shield contribute more than half of the total value of minerals mined in the USA and about one-fourth that of Canada. Petroleum, natural gas, coal, Sulphur, potash, lead, zinc, and gold are found here.

- **Eurasia:** From the United Kingdom and the Iberian Peninsula to east central Siberia. West Europe is rich in coal, iron ore, bauxite, salt, potash etc., but it lacks in copper, lead, zinc, tin and alloys etc.
- **South-east Asia:** It includes India, China, Japan, Malaysia, and Indonesia. This region has sufficient output of earth material to cater to the domestic needs of a large population. India and China have sufficient coal, iron ore and a variety of alloys. Malaysia and Indonesia have surplus tin.

The table below shows the minerals, their uses and where they are found. The countries shown are just some among the many other ones. below there is a table showing major world minerals and their locations along with their major uses.

Mineral	Location	Major uses
Petroleum 	Russia, USA, Iran, Iraq, Venezuela, Nigeria, China, Libya, Kuwait, UAE, Indonesia, Algeria, Mexico and UK.	It provides fuel for heat and light, lubricants for machinery and raw materials for a number of manufacturing industries.
Coal 	USA is the world leading producer of coal (25%) Russia follows with (20%), China (19%), Poland (8%), U.K. (5%), India (4%), West Germany (4%), South Africa (3.5%) and Australia (3%)	Used in generation of electricity Steel production Used in cement manufacturing Used as a liquid fuel

Iron ore  **Accordingly, iron content can be divided into:** **Magnetite-Iron content is up to 72.4%** **Hematite: Iron content is up 70%.** **Limonite: Iron content is up 60%.** **Siderite: Iron content is up 48%.**	This is produced in many countries, but the most important ones are Brazil, Russia, Australia, U.S.A, China, India, South Africa, Canada, Ukraine, Sweden, Liberia, and France.	The uses of Iron ore include the following: Iron ore is mainly used in the manufacturing of steel, used in the making of automobiles, locomotives, ships and beams (used in buildings, furniture among others).
Copper 	USA,Russia, Chile, Democratic Republic of Congo (DRC),South Africa, Canada, Indonesia, Canada,Poland, China,Mexico, Zambia.	It is used in the engineering industry; in manufacturing ornaments; weapons and coins.
Aluminium 	Jamaica,USA, Australia, Brazil.	It is used in the making of cooking utensils. It forms part of the raw materials used in the manufacturing of ships and wagon. It is used in industries especially food processing equipment.

Tin 	China,Malaysia, Indonesia, Thailand	It is used in making plates; food cans (non-rust quality); an alloy with other metals /Roofing/ utensils, /ornaments and petrol tanks; making the packaging materials/ products.
Lead 	Peru,Russia, Australia, Mexico.	It is used in the production of metals; solder bearings and castings; roofing materials; chemicals; construction materials.
 **Zinc**	Canada,USA, Australia,Russia, Peru, Japan.	It is used in Galvanizing iron and steel, Manufacturing cars and Machine parts.
Manganese 	Congo(DRC), India, Ghana,South Africa, Russia.	It is used: As a cleaning agent in steel works. In making railway lines, In making rock crushers In the construction of steel.

Nickel 	Canada,Cuba, USA, Australia.	It is used in manufacturing machine spare parts, coins.
Diamond 	DRC, South Africa, Ghana,Namibia, Brazil.	It is used in making cutting tools and pyramidal gems.
Uranium 	Australia,South Africa,Canada, Gabon, France	It is used in: Energy producing factories.
Gold 	SouthAfrica, USA,Canada, Ghana,Mexico, Philippines	It is used in the making of precious jewellery It is used as a medium of exchange in trade in many countries, store of wealth.

Here below there is a map showing the distribution of major minerals in the world:

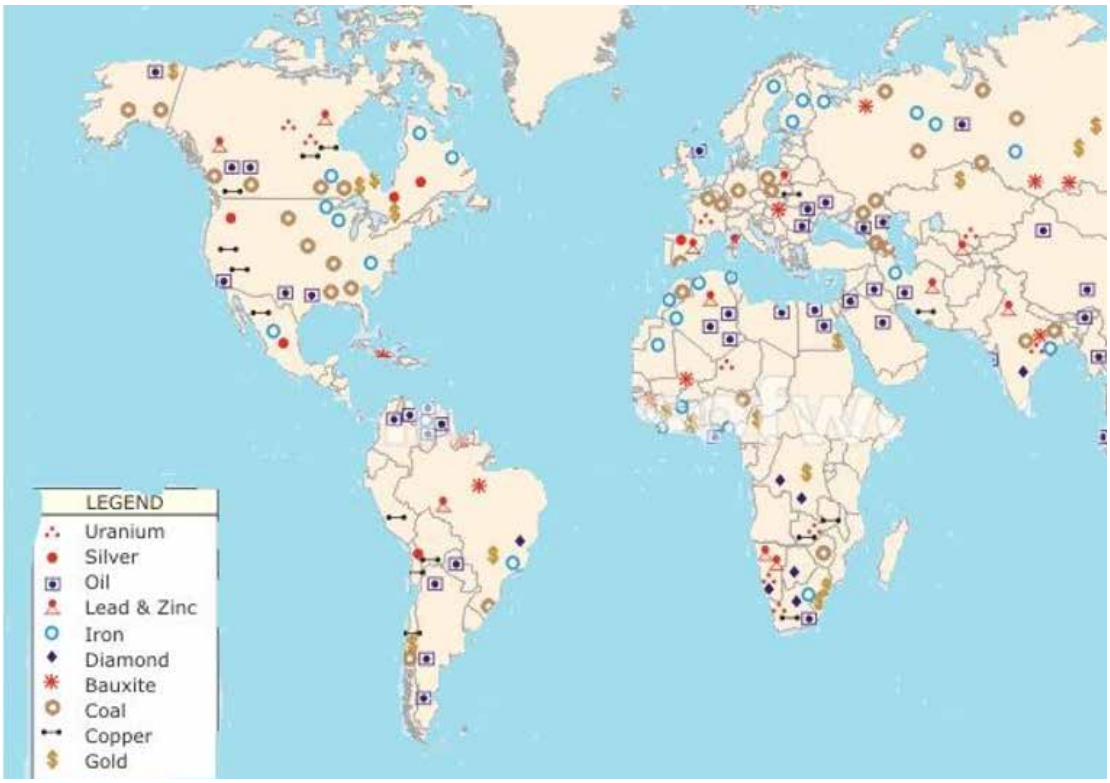


Figure 15.316: Distribution of major minerals in the world

Application Activity 15.1

1. Identify two areas outside Rwanda where tin and coltan are extracted in large quantities.

2. Apart from Tin and Coltan, state other major world minerals.

3. Draw a sketch of Rwanda and show the major areas where minerals are exploited or extracted.

4. Using the world map locate the major mining areas of the world.

15.2: Methods of mining

Learning Activity 15.2

Read the passage provided below and answer the question that follow:

Mahoro is one of the prosperous investors who is interested in mining. She recently visited the DRC and the research findings included the following: (i) Some mineral ores are near the surface; (ii) Some minerals are deeply located below the surface area.

1. Using the past studies, describe the mining method that can be used by Miss Mahoro in the exploitation of the mineral ores near the surface and mineral ores occurring deep into the crust.
2. Identify and explain the effects of different mining methods on the physical environment and suggest the appropriate ways to deal with the negative effects of those mining methods.

When extracting mineral ores from underground/ground deposits, there are various methods that can be used. These methods depend greatly on the mode of occurrence of the mineral ore, of the value of the mineral, and the size of deposit. The most common mining methods include the following:

15.2.1. Opencast or open pit mining

This is the easiest and the cheapest way of mining minerals that occur close to the surface. It simply involves the removal of the overburden that is the earth or other rock bands lying above the mineral-bearing strata. Then, the extraction of the ore in successive layers is done until the mineral content becomes exhausted or inaccessible/ too small for economic mining.

Equipment like caterpillars and excavators are used to create exposure of the mineral ore bearing rocks. In most case when the overlying burden (soils and rocks covering the mineral bearing rocks) is soft, then digging is used. When the overlying burden is hard, explosives are used. The purpose of using explosives is to loosen the rocks for easy removal. Open cast method can be carried out in two ways: Stripping and hill slope boring.

(i) Stripping method: This is the simplest and cheapest method of mining. It is used where minerals are very close to the surface of the earth.

Figure 15.317: Stripping method

Hill slope boring: This is used in the extraction of minerals such as coal which may outcrop from the hill side. A gently sloping shaft is dug into the hillside to reach the mineral. The augers are used to drill out large pieces of coal and haul them to the surface from where they are taken to the processing plants by trucks.

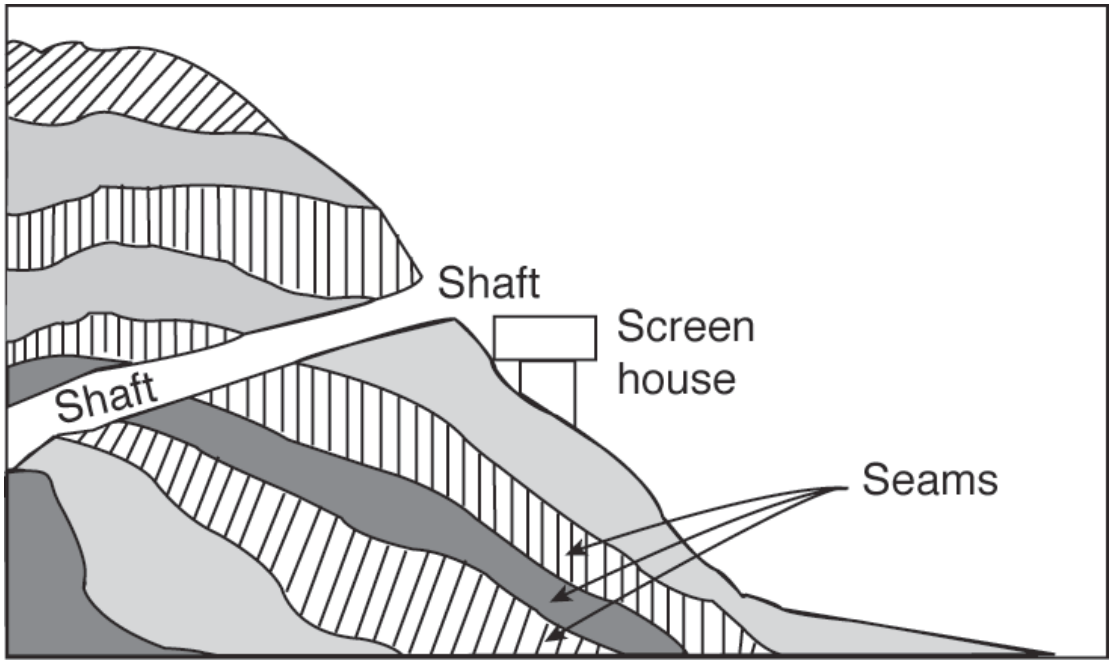


Figure 15.318: Hill slope boring method

15.2.2. Underground mining

When the ore lie deep below the surface, the overburden is too thick to be removed by mechanical shovels and underground mining methods have to be used. This mining method involves the creation of network of both vertical and horizontal tunnels. These follow the mineral bearing rocks. The vertical tunnels are called shafts. The mined ores are transported along the shafts using conveyor belts on which lifts, or cages are affixed. The cages move up and down the shaft. The cages also assist the miners to move along the vertical tunnels.

There are circumstances where the mineral ore bearing rocks occur in a horizontal manner. In this case horizontal tunnels are created to have access to the mineral ore extraction. Such tunnels are called Adit or crosscut opening. There must be proper ventilation to allow the miners have clean and safe air, the roofs of the tunnels must be supported with strong pillars and strong wire mesh. This method is used in extraction of mineral ores in countries such as gold mining in South Africa, copper and cobalt in DRC and Zambia.

The following are the different underground mining methods:

(i) Drift or Adit method: This is whereby the minerals are extracted from the sides of a hill or a valley. The mineral bearing veins or seams are found protruding on the side of the valley or hills.

(ii) Shaft method: this is used to extract minerals found in deep or very steep inclined seams. Vertical shafts are sunk underground. From these, horizontal tunnels or galleries are dug to reach the mineral bearing rock.

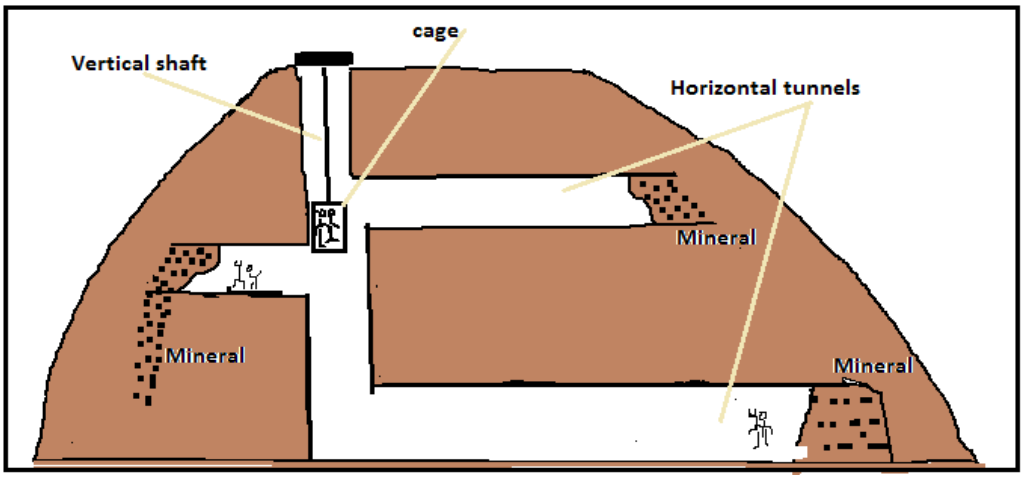


Figure 15.319: Shaft method of mining

(iii) Solution method: This is done from the surface of the earth. Shafts are sunk down into the mineral deposits. Pipes are installed to link the deposits.

(iv) Drilling method: This method is used in the extraction of non-sold minerals such as oil and natural gas from the ground. It involves the use of equipment known as the derrick. This is used purposely to create deep holes into the ground up to the depth of where the mineral to be extracted is situated. This equipment holds a drill stem on which drilling pumps are attached. After the drill reaches the mineral, pumps are inserted to transport the oil or gas to the collecting and refinery centers.

Figure 15.320 (a): On land oil drilling equipment. (b): Off-shore oil/gas drilling derrick

Source: http://www.nogtec.com/bp-shelves-onshore-exploration-in-libya

15.2.3. Alluvial mining

When minerals occur in alluvial deposits, they are usually recovered by placer mining methods. This is done by mixing the alluvium with great deal of water and tilting or rotating the gravels until the lighter particles (sand, mud, dust, stones) are washed off, leaving behind the heavier ores, e.g. gold, tin, chromium, platinum, which have a higher specific gravity. The following are the main alluvial mining methods:

(i) Placer mining: This method is used in cases, where the original bearing rock is broken down by natural processes and it is transported and redeposited by running water. Placer mining involves excavating alluvial deposits such as sand, gravel, silt and clay. Screens and sluices are used to separate the minerals from alluvial materials. This method is used by gold and diamond miners in Ghana, the Democratic Republic of Congo and Namibia. The gravel bank is loosened by a high-pressure stream of water distributed through a large nozzle called a hydraulic giant.

Figure 15.321: Placer mining method

(ii) Panning: This method is used by small scale miners. It involves mixing water with mineral bearing deposits scooped from riverbeds. The mixture is then lifted into a pan. The pan then is rotated vigorously and later tilted to incline on one side. While lighter material of sand, mud, dust and stone debris are left behind stuck on the wet drier side of the heavier material consisting of the mineral is found at the bottom of the water.

Figure 15.322: Panning mining method

(iii) Dredging: In this method expensive equipment referred to as a dredger is used to dig out the alluvium. The dredger floats on water and it has a series of traps through which the alluvial deposit is channelled. The traps usually intercept the heavier alluvial materials that bear the minerals.

(iv) Hydraulic mining: This is the use of water sprayed from powerful pumps on the sides of valleys or slopes to bring down the alluvial deposits once the alluvial deposits, have landed on the floor of the valleys, they are collected.

Application Activity 15.2

Analyse the photographs below and use them to answer the questions that follow:

Figure. A

Figure B

(1) Name the economic activities that are taking places in the areas represented by figure A and Figure B.

(2) Describe other methods of mining used in the world.

(3) Analyse the impact of the two methods mentioned represented by figure A and B on the physical environment.

15.3: Factors affecting mineral exploitation.

Learning Activity: 15.3

Read the passage shown below, and use it to answer the questions that follow:

There are several countries in the world that are known for having a variety of minerals. The mineral ores are eather near the surface or deep underground. In spite of having these resources, the mining sector is still challenged with poor economy. On the other hand, the mining sector in other parts of the world has developed and registered success.

A

B

1. Explain the factors that have contributed to the differences associated with mining represented in the passage above.
2. Evaluate the effects of the activity being carried out in Figure A on the physical environment.

The factors that influence or affect the mineral exploitation include the following:

- The value of the mineral: Minerals of high value such as diamond are exploited at any cost. They can be mined without incurring losses.
- Size of deposits: This factor influences the nature and type of equipment to be used. The bigger the mineral deposit, the wiser and economically rewarding to invest in its exploitation. Small deposits are uneconomic to exploit because mining involves huge investments and to reach payback period requires some years of fully operational mining.
- Grade of the ore: When a given mineral has more ore is worth mining. The lower the ore, the less the mineral ore is economically viable for exploitation. This implies that only the minerals with high content of ore are exploited.
- Transport costs: This is a factor that determines whether the mineral is worth mining. The less bulky mineral ores are, the more it becomes suitable to exploit it and smelt or process it at hand's reach.

- Mode of occurrence of minerals: Minerals that are near the surface of the earth are more profitable to exploit since less expensive mining methods and equipment are involved. This means that, if the mineral is deep underground, it becomes costlier to exploit it.
- Labour: Mining requires both skilled and semi-skilled labour. In developed countries, it is easy to get the required labour unlike in developing countries.
- Capital: The presence of adequate capital will encourage the exploitation of minerals. This because mining requires heavy equipment that is expensive to purchase. When the capital is not enough, it means that the mineral deposits can hardly be mined.
- Markets: Mining is majorly conducted for commercial reasons. Therefore, its success depends entirely on the presence or availability of enough market. If there is a high demand for a given mineral, such mineral will be exploited. It would even influence many investors to put a lot of funds in its exploitation.
- Technology: Mining requires appropriate technology. Countries with advanced levels of technology exploit their deposits better than developing countries with low levels of technological advancements.
- Political climate: When the country is secure in terms of security and political stability, minerals will be exploited. This is so because both foreign and local investors will be interested in making business ventures in the sector of mining.
- Government policy: Minerals can only be exploited when there are favourable and friendly governmental policies such as tax holidays, quick and on-line registration of companies and affordable licensing procedures.
- Power: Mining requires adequate supply of power and energy because of the heavy equipment used in the exploitation of minerals. Therefore, in areas where power is unreliable, it is very hard to exploit minerals that are deep underground.

Application Activity 15.3

1. Account for the low levels of mineral exploitation in the developing world.
2. To what extent is the mode of occurrence of mineral ore responsible for its exploitation in DRC.

15.4: The effects of mining to the economies of the world

Learning Activity 15.4

Use the Internet, Geography textbooks, previous knowledge acquired in Geography to;

1. Evaluate the effects of mining to the socio-economic development of the world countries.
2. Analyse the effects of mining operations on the physical environment in Rwanda.

The mining sector contributes a lot to the socio-economic development of countries. Some of the contributions are positive while others are negative. Below is a detailed explanation of the effects of mining to the economies of the world:

15.4.1: Positive effects of mining to the economies of the world

The mining industry has had an influence on the economy in a number of ways, which may be summarized as follows:

- **Employment opportunities:** There are thousands of people employed by the sector of mining either directly or indirectly. These have had their lives improved because of the salaries they receive. For example, in 2014, 611,000 and 495,568 people were employed directly by the mining sector in USA. And South Africa respectively.
- **Development of transport and communication facilities:** Mining has influenced the establishment of varying forms of transport and communication infrastructures. There are feeder roads radiating from mining centers to ports and urban centers. These are also used by other economic sectors such as trading, fishing, agriculture and Industrialization. For example, the Tazara railway line was constructed because of copper mining in Zambian copper, St. Lawrence sea way was developed because of supporting the mining of salt, iron ore, limestone, lead, Zinc e.tc.
- **Source of revenue:** The companies involved in the mining sector pay taxes to the government. They must attain license and such calls for payment of a given fee. The revenue collected is thereafter used to develop the country.
- **Source of foreign exchange:** Mining sector contributes a lot to the earning of foreign currencies of countries. Minerals are exported to other countries and such enables them to have huge sums of foreign currencies. Such money is used to purchase what is not locally produced and at the same time fill the gaps within the national budget. Thus supporting the development and growth of the countries' economies.

- **Urbanization of many areas:**The mining operations have encouraged the growth and development of the urban centers. That is, many people flock to mining areas, increasing population numbers and attracting other infrastructural development to the area which eventually, helps develop towns and cities. The good examples are: Lubumbashi, Belfast, Johannesburg, and Lagos.
- **Growth and development of industries:** Mining has led to the development of large manufacturing industries. There are industries engaged in the smelting of mineral ores, others in the processing of minerals to both semi-finished and finished goods. On the other hand, there are other industries that are dealing with the manufacturing of mining equipment.
- **Diversification of the economy:** Mining has assisted the countries to have another alternative economic activity. This implies that the countries are able not to depend on few economic activities.means that, on top of other economic sectors such as agriculture, fishing, industrialization and tourism, the country can utilize the mining sector too. This is helpful to the economic growth because when one economic sector fails, at least mining or any other sector can support the economy.
- **Improved international relations:** Exporting and importing countries always tend to have a friendly relationship. It means that as one provides mineral ores the other provides market. This interdependence results in having political allies that can support one another in times of crisis.
- **Improved standards of living**: People earn income in the form of wages and salaries which is used to better and improve their way of living, such as sleeping well, dressing, good shelter, acquisition of education for their children and meeting the domestic demands such as food, medical treatment among others.
- **Acquisition of skills:** The people employed by the mining sector learn a lot of skills through the staff development training. These skills acquired can be later utilized by individuals to start up their own business projects.
- **Exploitation of other resources such as generation of HEP:** Mining has influenced the tapping of other resources such as the use of water falls in power generation like Hydro-electric power. This is so because of the high need for power in running of the heavy machines. The examples of hydroelectric power stations set up as a result of mining include Ntaruka, Inga Dam (on Inga falls in the DRC), Kainji dam on River Niger in Nigeria(which was primary set up to support oil refinery industries).
- **Tourist attraction:** The mining operations and installations entice many people from various parts of the world. These people pay a fee to the concerned countries and companies in concern. it therefore develops tourism which is one of the sources of foreign exchange.

15.4.2: Negative effects of mining on the economic development of the countries of the world

The mining industry has played a positive role in the economic development of the world. However, it may contribute negatively to the economic development in several ways. The following are some of the negative effects of mining on the country's economic development:

- Mining has become the main cause of pollution in many countries of the world. This is because of the impurities, fumes from the equipment used and by the products associated with mining operations. Both air, water, land and noise pollution are evident. It has lead to serious global warming as a result of environmental degradation.
- The mining sector has caused the depletion of the resourcest in the areas where it has taken place for many years. The exhaustion of minerals leaves a handful of workers unemployed. Such bring a challenge to the government and increases an overdependence ratio.
- There are sometimes great losses incurred by the mining companies. This is because some minerals are of low demand. Such reduces the investment base of the people.
- The prices of minerals are determined by the forces of demand and supply. Therefore, the fluctuation of prices makes it hard for the economic planners to have a reliable policy designing system that is workable and functional. Such leaves a great gap within the economic development. To worsen the situation, some companies fail because of registering losses.
- Mining has become one of the attractive sectors that employ thousands of people. This has however, left other economic sectors with reduced productivity, leaving mining as a chief supporter of the economic development.
- The land suitable for agriculture is wasted or removed when mining is taking place using Open cast. This has left some areas faced with shortage of food. Since only depleted scars of land characterized by deep pits and hanging walls are left behind, such a land can hardly support the growth of crops.
- There is increased environmental degradation caused by the high demand for timber which is used in the mining sector. At the same time, large chucks of forested areas are cleared as minerals are being searched. Yet, deforestation has many ill-effects.
- There is increased government expenditure as it tries to address the challenges caused by the mining sector, Such as rehabilitating depleted areas and filling up the deep pits left behind by the mining companies. The money spent would otherwise be used to develop other sectors that directly benefit the citizens.

- Many homesteads are involuntarily displaced when mining operations are to take place from a specific area. This breaks the social ties that families share. Resettling them in other parts of the country too is costly.
- Most of the mining sectors are owned and managed by foreign companies. These have always repatriated the profits and leaving little for reinvestment in the country. This implies that, their mother countries' economies are developed at the expenses of the countries habiting their companies.
- Urbanization has partly come into existence because of mining operations in some areas. This has come along with slum developed, organized crime, and other ill-effects. All these put together affect the development of the economy.

Application Activity 15.4

1. Assess the contribution of mining on the economic development of Rwanda.
2. Discuss the negative effects of mining to the physical environment of Rwanda.

15.5. Case studies of mining in selected countries

Learning Activity 15.5

Using the geographical documents, text books and internet research on the following:

1. Describe the mining activities taking place in USA, RUSSIA and Middle East.
2. Examine the factors that have favoured the development and growth of mining sector in China and Nigeria.
3. Assess the contribution of mining sector to the socio-economic development of South Africa and Zambia

15.5.1: Mining in the United States of America

The USA has for many years been the world's leading mining nation. Its growth and development trace its beginning even before the colonial era. The country is naturally gifted with almost all types of minerals. These natural resources are fully utilized in a sustainable manner; such has enabled the USA to develop her economy. This explains why it has managed to have a leading highly developed economy in the world. The major minerals exploited in USA include Coal, Lead, Uranium, Mica, Sulphur, Copper, Silver, Gold, Iron ore, Zinc, Bauxite, among others. However, America has the world's largest coal reserve (25%).

It should be noted that, not all the minerals are in abundance in USA, some are also imported to add on what is locally exploited; these include the following: tungsten, oil, diamond, zinc, bauxite, copper, Aluminium and uranium. These imported minerals are a result of high demand for thembecause of its increased industrial growth and development.

The major mining centres of the USA include Mesabi Mountain Ranges of the Great Lakes Region (the chief mining centre of the USA), New Mexico, Montana, Arkansas, Wyoming, Utah, Appalachian Mountain Ranges of the Great Lakes region, Colorado, Louisiana, Mississippi, California, Texas and Oklahoma.

Factors influencing the development of mining in the USA

- The presence of a wide variety of minerals such as zinc, lead, iron ore make the region ideal for mining. These have enabled the mining companies to have what to exploit in large quantities and at the same time meeting the international demand for a variety of minerals.
- Adequate power supply from large sources of coal, natural gas and hydroelectric power stations also facilitate the mining industry. This is a favourable factor because mining is in most cases dependent on power. Power is used in the running of machines in extraction and smelting of the ore.
- The presence of adequate capital from foreign earnings (exports and other financial institutions) favour the mining industry. This has contributed abundantly to the mining sector in terms of being enabled to hire the required labour as well as the purchasing of the modern equipment.
- The presence of skilled labour since the region has immigrants from France, Germany and other regions where mining was practiced before. The human labour is required in mining operations. Having a steady supply of workers assists the mining companies to carry out their operations at a cheaper cost.
- The availability of well-developed transport networks like roads and railways, especially the St. Lawrence and the Great Lakes waterways. The mineral ore are heavy and need to be transported to the market centres. This has also helped in having access to the required mining in-puts from overseas.
- The presence of a ready market for the minerals both in the country and outside. This is due to the prominent level of industrialization associated with the country. Most of the industries are engaged in manufacturing. Therefore, whatever is extracted is sold hence providing reinvestment opportunities to the mining companies.
- The region is technologically advanced, making the mining operations easy to handle. This has assisted the mining companies to have the ability of exploiting the minerals whose mode of occurrence is deep. The technology available eases the exploration of minerals and the processing operations.

– The political stability of the region plays a crucial role in the development of the mining industry in the region. This is a factor that has earned international investors who have had a convincing interest in mining operations.

15.5.2: Mining in Russia

The mining industry in Russia is among the highly developed sectors in the country and the world at large. Russia is known for having almost all known minerals resources in the world. Russia has the world's largest proven iron ore reserves and the world's second largest coal reserves (20%). The mining industry of Russia is one of the leading mining industries in the world. Russia having been naturally endowed with a wide range of mineral resources, the country put them to better use and became the world's leading mineral resources producer. It contributes up 14% of the world's total mineral extraction. Russia possesses the following minerals reserve: Iron ore, Manganese, Chromium, Nickel, Platinum, Titanium, Copper, Tin, Lead, Tungsten, Diamonds, Gold, Oil, Natural gas, Coal.

The production of metals in Russia form 14% of its total exports. This is the second foreign exchange earner, after Oil and natural gas industry. The country's metal exports are dominated by raw metals and aluminum. Even though Russia uses metals in her industries, most of the metal production is exported. The chief metal producing company is Bellwether private company.

Russia is known for being the largest world producer of Iron Ore, the second leading producer of recoverable coal reserves. The country takes the third position of the world's producer of black coal.

There are four major mining regions in Russia:

– South European region which is known for coal mining and oil drilling.
– West Siberia also known for coal and oil
– Urals region which is important in copper, manganese, platinum and tungsten mining.
– Murmansk region which is known for the exploitation of copper and lead.

Factors that favour mining in Russia

– The presence of a wide variety of mineral reserves in the country. The country is blessed naturally with a variety of minerals that have enabled a steady supply of minerals on the international market. These minerals include among others Oil, coal, copper, iron ore, to mention but a few.
– The availability of capital from the state and from the international mining companies that exploit minerals in the area. The mining companies involved in the Russian mining sector have all the necessary and require capital. This explains why they are able to use modern equipment as well as hiring experts.

- Supportive government policies that help stimulate the sector. These have favoured the establishment of mining companies since they are offered tax holidays and subsidization in times of economic hardships.
- The availability of both skilled and unskilled labour from the locals and immigrants in the country. The mining sector requires labour force. Having it at a hand's reach provides the opportune moments of prosperity.
- Important levels of technology that is required in the mining sector. The Russian mining companies have managed to exploit the deeply concealed minerals and drilling of oil from off-shore oil deposits. This is all attributed to the availability of technology.
- Adequate power supply that is required to power the sector. The nuclear power production as well as other forms of power and energy in large levels, have enabled the mining companies to operate at all time. This makes them meet the high demands for the needed minerals.
- The presence of a well-developed transport and communications system needed for the transportation of minerals and their products. Russia is one of the countries of the world with well-developed means of transport. The mining sector has benefitted from this, by transporting both the in-puts and out-puts at a cheap cost hence assuring high economic returns.

The challenges faced by the mining sector in Russia

- Depletion of mineral reserves. The prolonged period of exploiting minerals in Russia has left most of the mineral ore deposits exhausted. The exposed coalfields are now depleted, and the country is forced to engage in the under-ground mining. This has come along with increased costs of mining.
- There is a low discovery rate of new reserves. This has put the mining sector of Russia at a significant risk of having some minerals being expensive to get.
- The mining sector of Russia is still devoted to the traditional machinery used in the reasonable years gone by. This has made it hard for some of the companies not to access the concealed mineral ore deposits.
- The death toll in the mining sites of Russia is very high. This is because the soils of Russia in places where mining is conducted are less consolidated such as in coalfields. The underground tunnels collapse easily.
- There is stiff competition from other countries engaged in mining sector. These have to some extent out competed Russia in its selling in the international market.

- The mining sector is challenged with prominent levels of pollution of all kinds. The dusty nature of coal mining areas proves how environmentally the country is challenged. The piles of metals leach and chemicals are transported by rain water (Run-off), thus polluting both land and water resources.
- In many places Mining has led to the displacement of people from their homes. In areas where mineral resources are found, in most cases people are displaced and resettled in other places. This is costly and socially challenging.
- Mining has left scars of exhausted areas that are completely of less or no importance in terms of production. Such depleted areas are usually characterized by deep pits, open lands, piles of soils among many others.

15.5.3: Mining in China

China is one the countries blessed with a variety of mineral resources. In terms of scale and magnitude, China's mining industry ranks third in the world. Chinese mining sector is greatly supported by high levels of technology and supportive government policies. The country has several minerals such as: gold, cobalt, iron and steel, nickel, vanadium, molybdenum and manganese. China is the second largest world producer of Gold after South Africa and the second in copper production after Chile. It also takes the firth world's position as a producer of Iron ore. There are several mining centers in china, but the most dominant and major ones are the following:

Mining centers	Mineral ores exploited
Xikuangshana	Antimony
Jinfeng	Gold
Zhalanzhangzhi mines	Iron ore

Other mining centers include Tayeh, Bayan Obo, Anshan, Shantung, Kiuchuan, Xinjiang and Guangzhou. The increasing demand for mineral resources has made the Chinese industries to supplement the locally mined minerals with the imported ones. The country has oil fields in Beijing, Lanzhou and Chongqing.

The factors that influence the development of mining sector in China are similar to the ones discussed in general earlier.

15.5.4: Mining in the Middle East

The Middle East countries are dominantly involved in the exploitation of oil and natural gas for their economic survival. The region produces a third of the world's petroleum. The greatest oil reserves in the world are found in the Middle East. This means that these countries will continue to serve the world with oil.

The oil producing countries in this region include Saudi Arabia, Iran, Iraq, Kuwait and the United Arab Emirates . They are the major oil producing countries. Jordan has established itself as a world leader in phosphates and potash mining, holding four per cent of the global reserves.

Factors which have favoured oil production in the middle East

There are several factors that have supported mining in the middle East. These include:

- The presence of massive quantities of oil and natural gas. The middle East countries such as Saudi Arabia have contributed a lot to the oil exports because of the vastness nature of her oil deposits.
- The region has managed to develop her mining because there is availability of capital. This is provided by the companies that are associated with mining especially Shell, Total, Agip among the others. Such has supported the use of hired labour and modern technology.
- The availability of advanced technology. The oil drilling companies have come along with the modern technology that has made it possible to tap the oil and natural gas from the deepest level underground. The major equipment includes the remote sensing (Sensors) that are used to determine the location and the mode of occurrence of the oil deposits.
- The existence of generally flat landscape. This has favoured the establishment of the required infrastructure such as roads and pipelines that are used in the transportation of oil and the in-puts that are needed.
- Availability of large market for oil and petroleum products. There is a wide range of market from outside the middle East region. This has enabled the companies to sell what they produce.
- The Middle East region is associated with harsh climatic conditions that hardly support other forms of economic activities such as agriculture. This influences the governments to resort entirely to the drilling of oil.

Problems facing the oil industry in the Middle East

- Shortage of labour due to low population in countries such as Kuwait. This has resulted in the costs of operations being high, hence registering relatively low economic returns that it would be.
- The presence of alternative sources of energy like solar and nuclear energy that compete with petroleum. This therefore has reduced the market for the oil and oil products. This explains why some companies are now operating at a low rate.

- The fluctuation of oil prices in the international market. There is too much crude oil that is legally exported to other countries of the world. This influences the forces of demand and supplies which results in unstable prices. It makes the investors lose a lot.
- Conflicts between countries that often result in wars. This has become a common characteristic associated with countries that produce Oil or petroleum.It has made most of the foreign companies to relocated elsewhere not in the middle East. Also, most of the infrastructures are destroyed by the wars.
- Profit repatriation by international companies. The oil drilling is in the hands of foreign companies. These reinvest the profits gained from mining in their mother countries, thus leaving the local countries less developed and benefiting relatively at lower levels.
- Lack of domestic markets in the region due to limited population. This leads to overdependence on the foreign markets. This is because most of the middle East countries are located in desert regions that discourage the settlement.
- Prominent levels of air, water and noise pollution. The drilling of petroleum or oil is associated with both air, land and water pollution. This has made the areas where it is carried out to have problems of environmental degradation.
- Stiff competition between the Middle East and other oil producing countries like Nigeria, Algeria, and Russia. This has made the oil and oil products from the Middle East lose their market. Such a situation also makes the engaged companies get out of mining business.

15.5.5: Mining in Nigeria

Nigeria is a country in West Africa which has various deposits of minerals and large oil deposits. It is the biggest producer of oil in Africa. The country is also endowed with other minerals in addition to oil which is its major foreign exchange earner. These minerals include tin, coal, iron ore and columbite. There are also other minerals that occur in small quantities. Nigeria's economy is greatly supported by the economic returns from the exports of oil. There are several oilfields both in the interior and along the coastal areas of the country. The mining industry of Nigeria has become a centre of interest for both local and foreign companies. These companies include Shell-BP, Mobil, Agip, SAFRAP, Texaco and Gulf.

Factors favouring the development of the mining industry in Nigeria

- There are several factors that have played a key role in the development of the mining industry of Nigeria. They include the following:
- The mineral resources of Nigeria are of high quality. The presence of large oil deposits and reserves in areas such as the Niger delta and iron ore in the Jos Plateau.

- The availability of both skilled and unskilled labour which is provided by the Nigerians and immigrants from other neighbouring countries.
- The availability of adequate capital provided by the rich foreign companies such as Shell-Bp and Agip. The government of Nigeria has also invested a lot of capitals in the sector and supports investors through the various national agencies.
- The high population of Nigeria has created a large market for the products of the mining industry.
- The high level of Industrialisation that helps in the value addition of the mining products.
- Nigeria is strategically positioned at a point that enables the country to easily access the Western and European markets.
- The presence of well-developed forms of transport such as railways, road and pipe lines.
- The presence of cheap and affordable power that supports the mining operations.
- The presence of foreign companies with advanced technology that is important in the extraction of minerals.

15.5.6: Mining in South Africa

Mining in South Africa has been the main driving force behind the history and development of Africa's most advanced and richest economy, after Nigeria. Large scale and profitable mining started with the discovery of a diamond on the banks of the Orange River in 1867 by Erasmus Jacobs and the subsequent discovery and exploitation of the Kimberley pipes a few years later. This was followed by the discovery of Gold especially in the Witwatersrand Gold in 1886 and the subsequent rapid development of the gold field there.

Diamond and gold production may now be well down from their peaks, though South Africa is still number 5 in gold, it remains a cornucopia of mineral riches. It is the world's largest producer of chrome, manganese, platinum, vanadium, vermiculite. It is the second largest producer of ilmenite, palladium, rutile, and zirconium. It is also the world's third largest coal exporter. South Africa is also a huge producer of iron ore; in 2012, it overtook India to become the world third biggest iron ore supplier to China, who are the world's largest consumers of iron ore.

The country is endowed with a variety of natural resources. It has large mineral reserves.

It is the world's largest producer of manganese ore, platinum group metals and gold.

Other minerals found in South Africa include; diamond, coal, copper, uranium, iron ore, asbestos and silver.

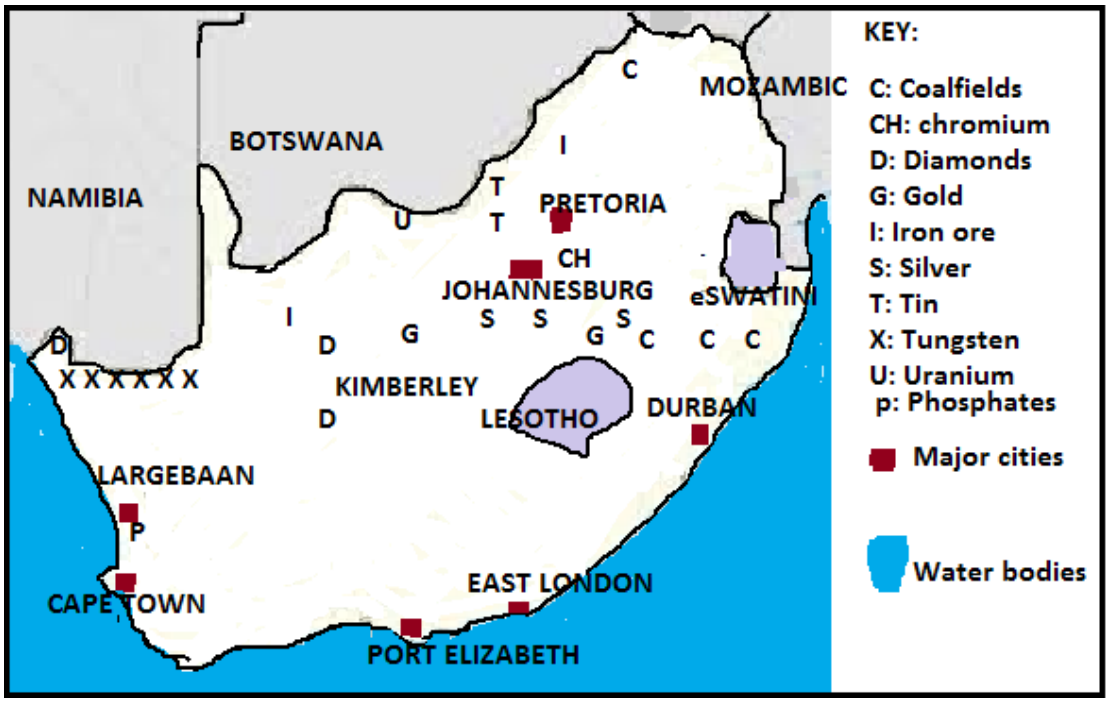


Figure 15.323: Location of major minerals of South Africa

15.4.7. Mining in Zambia

The production of copper in Zambia is a dominant economic activity that is associated with the mining industry. Zambia is the 7th world's largest producer of copper. Copper is mined in the Zambian copper belt that is made up of various mining centres that include; Bwana Mkubwa, Chibuluma, Chililabombwe, Nchanga, Baluba, Ndola, Chambishi, Mufulira and Chingola.

Factors that favour the development of mining in Zambia

There are several factors that have favoured the development of the mining industry in Zambia. They include the following.

– Zambia is endowed with large deposits of copper. This is supplemented by other mineral ores. This gives the allowance to the mining companies to serve the international market in relation to copper and other minerals. This again makes mining to operate throughout the year.

- There is a steady supply of labour that is provided by the immigrants from the neighbouring countries. The Zambian mining sector is supported by immigrates from southern Tanzania, Malawi, Zimbabwe and South Africa. These come with all the needed skills that have enabled the sector to flourish.
- The presence of hydro-electric power from the Kariba dam and other power stations that support the various operations of mining sector. The mining sector depends on power for smelting copper and extracting it. Therefore, having it in enormous quantities is an advantage.
- The high demand of copper in the international market. The mining sector of Zambia has in recent years benefitted from the increasing usage of copper in manufacturing various products. This has enlarged the market hence enabling the investors to gain more and more. Such has given them the capacity of modernizing the mining sector.
- The presence of foreign investors who put in huge sums of capital and provided skilled labour. They have developed the mining sector since they know what is needed to be done. This again has supported the transformation of the mining sector into a highly mechanized one.
- There is a wide network of roads and railway lines in Zambia. The most notable one is the Tanzara railway that transports both the mineral ore and the mining equipment needed in the mining operations.
- Favourable government policies such as the privatization policy that has attracted local, regional and international investors in the sector. This has supported the mining sector because of the advantages associated with the policy. Furthermore, the investors are given tax holidays and where need be, given soft loans by the government.

Application Activity 15.5

1. For either USA or China, account for the successful mining sector.
2. Note down the lessons you have learnt from the study on mining in USA and show how you can use them to improve the mining sector in your country.

End of Unit Assessment

Study the photograph provided below and use it to answer the questions that follow:

The above photograph shows the pollution of water as a result of mining. This polluted water flows to the bigger water bodies and their outlets further redistribute the water to other parts.

1. Assess the impact of mining on the environment.
2. Suppose you were living in the area where this photograph was taken, explain the challenges you are more likely to face.
3. Create a program which aims at addressing the negative impact of mining on the physical environment.
4. Identify and explain the environmental concerns associated with mining.

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Glossary

Acid lava: a molten material flowing from a volcanic vent. Acid lava is high in silicates, viscous, and doesn't flow far. It creates a steep sided dome

Adit: horizontal tunnels that have access to the mineral extraction.

Agglomeration: when we talk about a large city, there are various aspects to consider. For example, there is a city center, and there is the region that borders the city. The suburbs and the urban areas coexist, and that's where the term agglomeration comes from. Located as part of the city center as well as right outside the city center, an agglomeration is a built-up area of a city region.

Agricultural inputs: it refers to the products permitted for use in organic farming such as feedstuffs, fertilizers and permitted plant protection products as well as cleaning agents and additives used in food production.

Aquaculture: it refers to breeding, rearing and harvesting of plants and animals in all types of water environments.

Ashes are the solid remains of fires. Specifically, it refers to all non- aqueous, non-gaseous residues that remain after something is burned

Atmospheric pressure: it is the force exerted by the weight of the atmosphere on the surface of the earth.

Basalt: it is a common extrusive igneous (volcanic) rock formed from the rapid cooling of basaltic lava exposed at or very near the surface of a planet or moon
Batholiths: A large body of igneous rock formed beneath the Earth's surface by the intrusion and solidification of magma.

Bearing is the direction of a point from another expressed in degrees and measured clockwise from the north.

Bedding: an arrangement of rock strata in bonds of various thickness and characters.

Brine: it is water that contains salt.

Buffer zone: it is an area of land designated for environmental protection.

Cast iron: A hard type of iron that do not bend easily and is shaped by pouring the hot liquid metal into a mould (= a specially shaped container).

Cataclysm: it is a hypothetical doomsday event; any catastrophic geologic phenomenon, a catastrophe or a large-scale and often violent event that causes change or upheaval.

Chemical properties: are characteristics of a material that become evident when the material undergoes a chemical reaction or chemical change.

Cinder cones: these are the simplest type of volcano. They are built from particles and blobs of congealed lava ejected from a single vent.

Circumnavigation originally meant going around something, by ship. Usually it means people going around the world.

Climate: it is defined as the average of weather conditions of a particular area in terms of temperature, atmospheric pressure, wind direction and wind speed, moisture, cloudiness, precipitation, and sunshine for at least 30 years.

Colluvial complex: this is the lower concave slope where there is gradual deposition of eroded material

Commercial farming involves farming for profit. The farmer intends to grow crops or rearing animals in order to sell for as much money as possible.

Condensation: this refers to the process by which water vapour in the air is changed into liquid water. Condensation is crucial to the water cycle because it is responsible for the formation of clouds. These clouds may produce precipitation, which is the primary route for water to return to the Earth's surface within the water cycle.

Continental shelf: the submerged, gently sloping margins of a continent.

Contour: it is a line drawn on a map joining all the places with the same altitude above sea level.

Crater: the round hole at the top of a volcano, or a hole in the ground similar to this

Deciduous forests: forests or shrubs which shade all their leaves at certain season of the year as opposed to evergreen forests.

Demography: the study of statistics such as births, deaths, income, or the incidence of disease, which illustrate the changing structure of human populations.

Dispersion: the act or process of distributing things or people over a huge area.

Divergence: this means moving apart from a common center.

Drill: it is a hydraulic method of mining and conveying coal in substantially vertical seams.

Earthquakes: A sudden ground motion or vibration produced by a rapid release of stored-up energy.

Ecosystem: a biological community of interacting organisms and their physical environment.

Epicenter: the point on the Earth's surface located directly above the focus of an earthquake

Escarpment: fault scarp or the wall of a rift valley

Eutrophication is the process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the growth of aquatic plant life usually resulting in the depletion of dissolved oxygen.

Extensive farming/ agriculture is an agricultural production system that uses limited inputs of labour, fertilizers, and capital, in comparison to the land under cultivation.

Family planning: the practice of controlling the number of children one has and the intervals between their births, particularly by means of contraception or voluntary sterilization.

Fault: A fracture/crack where displacement of rocks occurs. It is also known as line of weakness

Focus (hypocenter of earthquake): The location (point inside the earth) where the earthquake begins.

Foot: It is an a measure of length used in some systems, 1 foot = 0,3048 metres.

Fossil is any preserved remains, impression, or trace of any once-living thing from a past geological age.

Gem: a precious stone that has been cut and polished and is used in jewellery.

Gravity: the force which attracts objects towards one another, especially the force that makes things falls to the ground.

Inch: It is a measure of length used in some systems, 1 inch = 0,0254 metres; there are 12 inches in one foot.

Independent variable: these are variables being tested. Whereby its change directly results into a change in dependent variables.

Inertia: the physical force that keeps something in the same position or moving in the same direction.

Inland water bodies: sources of water that are found within a country. They include rivers, lakes, and swamps.

Insolation: the amount of solar radiation reaching a given area.

Intensive farming is an agricultural intensification and mechanization system that aims to maximize yields from available land through various means, input such as heavy use of pesticides and chemical fertilizers.

Jewellery: decorative objects worm on your clothes or body which are usually made from valuable metals such as gold and silver and precious metal.

Landform is a natural geographical feature or shape that appears on the Earth

surface.

Landscape: the visible features of an area of land, its landforms and how they integrate with natural or man-made features

Leap year: a year that happens every four years and has an extra day on 29 February.

Light year: the distance that light travels in one year (about 9 500 000 000 000 km).

Lumbering is the business or trade of cutting, transporting, preparing, or selling timber.

Map symbols: they are the conventional widely recognized signs or sign systems which are used to represent on a map natural and human features or any other geographical concept/idea/information. These come in the form of points, lines, or areas and they may have different size, form, and color.

Master plan: is a dynamic long-term planning document that provides a conceptual layout to guide future growth and development. Master planning is about making -the connection between buildings, social settings, and their surrounding environments.

Metropolitan: it refers to a large city, its surrounding suburbs, and other neighbouring communities.

Mile: It is an English unit of length, 1 mile = 1609 metres.

Mineral deposit is an aggregate of a mineral in an unusually high concentration. About half of the known chemical elements possess some metallic properties.

Mineral ore: a naturally occurring solid material, from which a metal or valuable mineral can be extracted profitably.

Nomad: is a member of a community of people who have no fixed residence but moving from one place to another in search of grasslands for their animals.

Open-pit, open-cast or open cut mining is a surface mining technique of extracting rock or minerals from the earth by their removal from an open pit or borrow.

Plankton: the food for fish either in form of tiny sea organisms or plants that grow in water bodies.

Population explosion: refers to the rapid and dramatic rise in world population that has occurred over the last few hundred years.

Population policy: a population policy is a set of measures taken by a State to modify the way its population is changing, either by promoting large families or immigration to increase its size, or by encouraging limitation of births to decrease it.

Population pyramid: also called an "age pyramid", is a graphical illustration that

shows the distribution of various age groups in a population.

Rainforest: rainforest is a forest near the equator (the invisible line that runs around the fattest part of the planet) that gets a lot of rain.

Sewage: used water and waste substances that are produced by human bodies, that are carried away from houses and factories through special pipes (= sewers).

Shaft: a long narrow, usually vertical passage in an underground mining, used especially for a lift/elevator or as a way of allowing air in our out.

Sluice: a sliding gate or other device for controlling the flow of water out or into a canal to wash something with stream of water.

Soil: it is the upper thin layer of the loose and unconsolidated material that is derived through the disintegration of rocks that form the uppermost layer of the earth's crust.

Strata: (stratum, plural strata): one of the part or layers into which something is separated.

Subduction: A geological process that takes place at convergent boundaries of tectonic plates where one plate moves under another and is forced or sinks due to gravity into the mantle. Regions where this process occurs are known as subduction zones.

Subsistence farming is a farming whose products are intended to provide for basic needs of the farmer, with little surplus for marketing

Taiga is also known as boreal forest or snow forest, is a biome characterized by coniferous forests consisting mostly of pines, spruces and larches

Tectonic movement: differential movement of the earth's crust: elevation or subsidence of the land including folding, faulting, warping, vulcanicity and earthquakes.

Tsunami: the waves caused by sudden movement of the ocean due to earthquakes, landslides, large volcanic eruptions or meteorite impact in the ocean.

Vegetation: is a term, which is given to a community of plants which grow in area and which give it distinct character.

Vulcanicity: the process through which gases and molten rock are either extruded on the earth's surface or intruded into the earth's crust.

Wood fuel pellets: Pellet fuels (or pellets) are biofuels made from compressed organic matter or biomass. Pellets can be made from any one of five general **categories of biomass:** industrial waste and co-products, food waste, agricultural residues, energy crops, and virgin lumber.

Xerophyte: this is a species of plant that has adaptations to survive on an environment with little liquid water such as a desert or an ice or snow covered region.