INTERMEDIATE
GEOGRAPHY

CLASS IX

DEPARTMENT OF SCHOOL EDUCATION
MINISTRY OF EDUCATION AND SKILLS DEVELOPMENT
ROYAL GOVERNMENT OF BHUTAN
THIMPHU

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Foreword

The purpose of education is the wholesome development of learners to equip them with relevant knowledge, skills and values crucial for them to deal with realities in life. Learners ought to learn, how to think, understand, integrate and evaluate diverse situations they face in their lives. This pre-empts that education be visionary and future oriented.

We live in an interconnected global world where Geographical perspectives including time and space, physical environment and people influence the world environment. Therefore, it is important for learners to understand and apply the different strands of geography education to help learners in making wise decisions. This is because human activities directly impact our environment.

Understanding of geography and practices of the basic theories of the subject should find link to higher level and transcend to career opportunities for learners. The diverse geography learning experiences and opportunities should stimulate love and care for our natural world to be educated and responsible citizens.

Thus, this book sets the foundation for the learners to understand Geography based on astronomy, physical, human and economic dimensions of Geography education. In addition, it will help them to appreciate the importance of Geography in the conservation of the natural environment for sustainable socio economic development of the country. The textbook presented with clear and simple text enriched with exciting learning activities, informative maps and pictures.

We are grateful to our writers and reviewers from the Royal University of Bhutan, the Ministry of Education, National Land Commission, Bhutan Council of School Examinations and Assessment and colleagues from the Royal Education Council for their valuable contributions. We hope that our teachers and learners enjoy teaching and learning the subject and contribute to the promotion of Geography education as a whole.

Tashi Delek!

Kinga Dakpa
Director General

Table of Content

Chapter One
The Earth – A Unique Planet

Learning Outcome(s):

- State the evidences to prove the sphericity of the Earth
- Explain the size of the Earth in comparison to other planets
- Discuss the uniqueness of the Earth in the solar system

1.1 Introduction

People in the past believed that the Earth was flat but with the advancement in the field of astronomy and geodesy, it is confirmed that the Earth is spherical in shape. The Earth is the third planet from the Sun and the only planet to have an atmosphere with oxygen and water. It is neither too far nor too close to the Sun. This creates favourable conditions to support life on the Earth.

Learning Activity:

Quiz time

1. What is the shape of the Earth?
2. Name the Earth's sister planet.
3. How far is the Earth from the Sun?
4. How many planets are there in the solar system?
5. Which is the farthest planet in the solar system?

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1.2 Shape of the Earth

The Earth appears round like any other planets. However, due to gravity and variation in the speed of rotation from equator towards the pole, it is slightly bulged at the equator and flattened at the poles. This makes the Earth *'oblate spheroid'*. As the Earth rotates, the sphere is distorted by the centrifugal force. This force causes objects to move outward from the centre of gravity. The centrifugal force is greatest at the equator causing the slightly outward bulge. The circumference and diameter of the Earth is larger at the equator than at the poles.

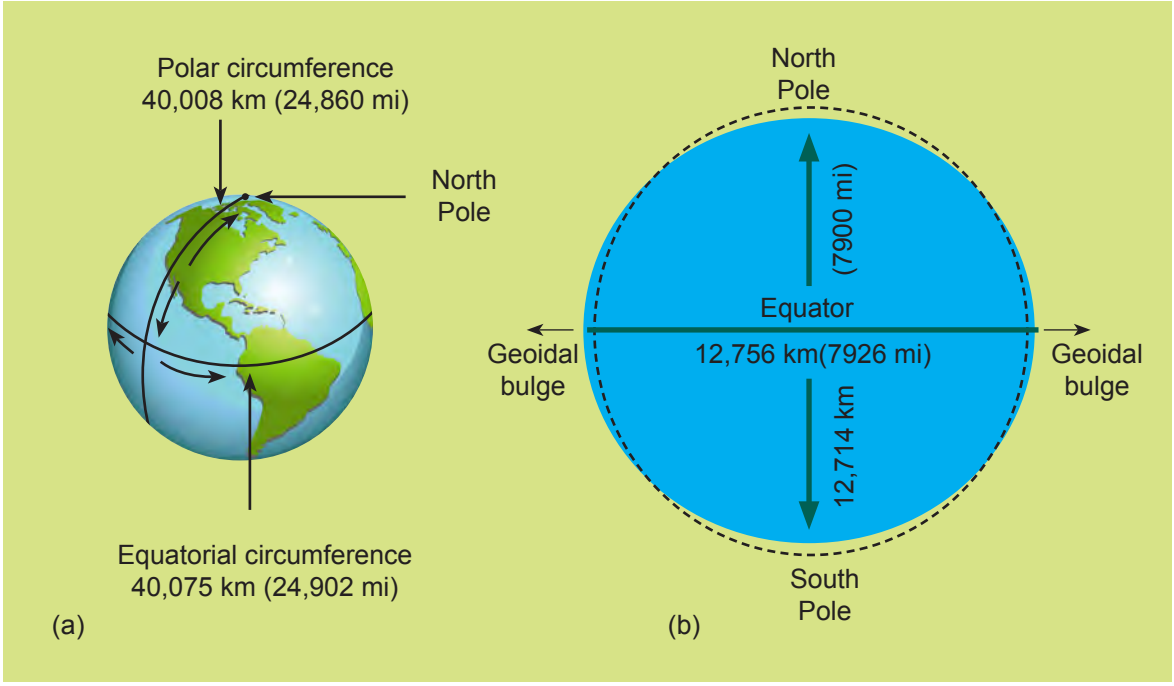
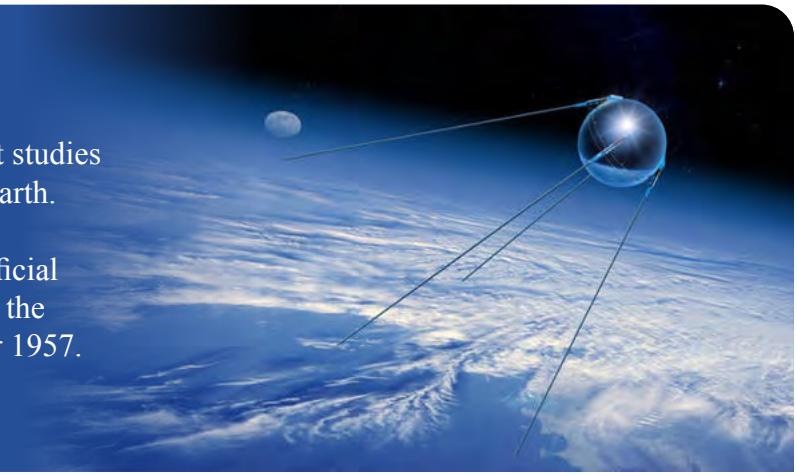


Figure 1.1 Diameter and circumference of the Earth

KNOW MORE

Geodesy is the science that studies the shape and size of the Earth.

Sputnik 1 was the first artificial Earth satellite launched by the Soviet Union on 4 October 1957.



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Learning Activity:

Explore for suitable simulation/videos or pictures and animations from different sources to learn more about shape of the Earth.

- Share the best simulation/videos in the class
- Display the pictures collected in the class

1.3 Sphericity of the Earth

1.3.1 Proofs to show that the Earth is not flat

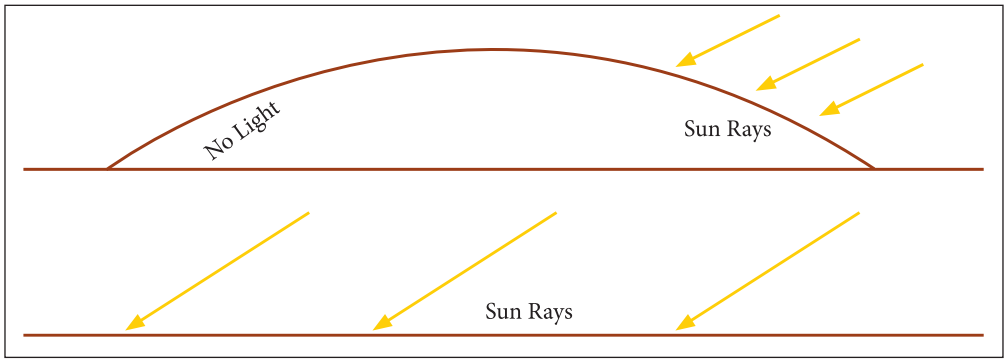

Figure 1.2 Showing Round and Flat Surface

i. Varying time of Sunrise

If the Earth was flat, the rising Sun would be visible at all places on the Earth's surface at the same time but this does not happen. Places located in the east receive Sun rays earlier than the places located in the west.

ii. Ship and the horizon

When a ship approaches land, its funnel or mast is seen first followed by the hull. If the Earth was flat, the whole ship would be seen at the same time.

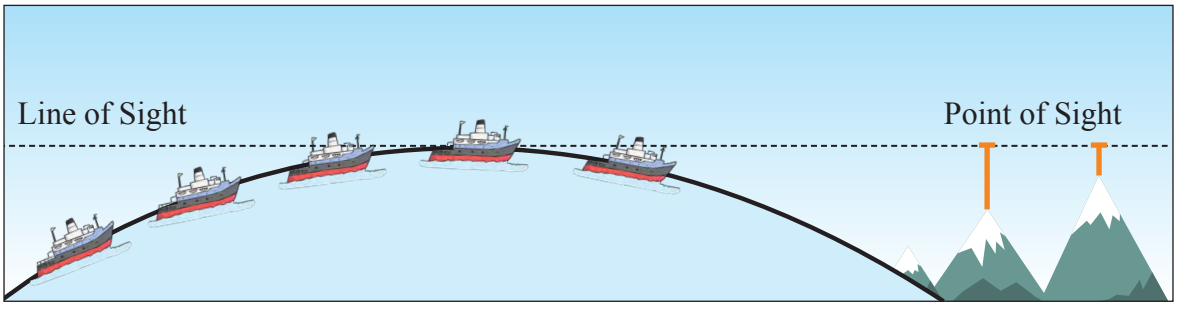

Figure 1.3 Approach of ship

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iii. Bedford level experiment

Bedford level experiment shows the curvature of the Earth. Three poles of equal height were set above the surface of Old Bedford River in England at an interval of 9.7 kilometres. An observer using a telescope, looking from the top of the first pole towards the third, saw that the middle pole was about a metre higher than the other two. When this experiment was carried out in other places, the result was the same. This proved that the Earth is not flat.

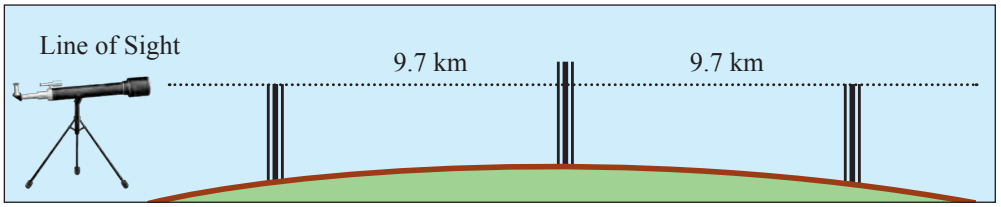

Figure 1.4 Bedford Experiment

Learning Activity:

Explore more on Bedford Level Experiment from library or from internet sources. Share the findings in the class.

Facts to prove the sphericity of the Earth

1. A Lunar eclipse occurs when the Earth comes between the Sun and the Moon. The shadow of the Earth falls on the Moon which appears in as an arc of a circle. A spherical object will always cast a circular shadow.

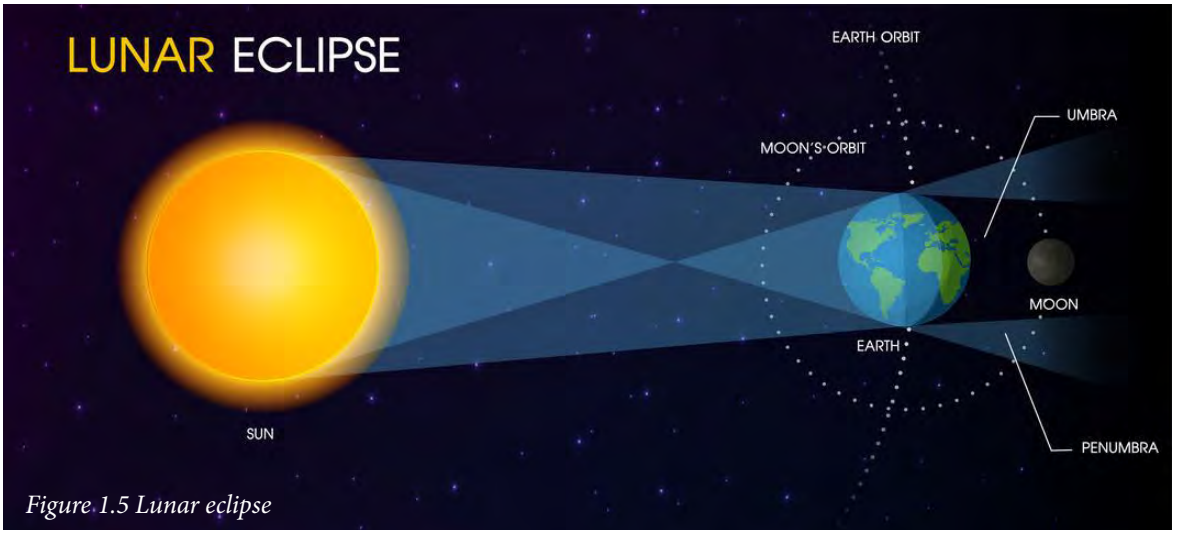

Figure 1.5 Lunar eclipse

There are three eclipses: total, partial and penumbral. A total lunar eclipse occurs only when the Sun, Earth and Moon are in a straight line. During partial lunar eclipse only a portion of the moon passes through the Earth's shadow. Penumbral lunar eclipse occurs when the Moon passes through the penumbral shadow of the Earth. All eclipses cast a circular shadow on the Moon.

2. The Sun, Moon and all the celestial bodies appear to be spherical from different positions. Hence, the Earth cannot be an exception.

3. The photographs of the Earth taken from space prove beyond doubt that the Earth is a sphere.

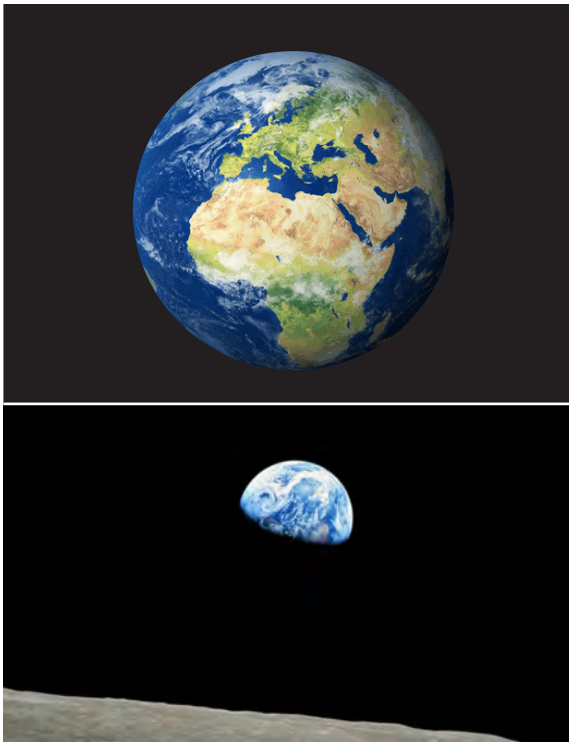

Figure 1.6 Photographs of the Earth taken from space

1.4 Size of the Earth

The Earth is the fifth largest planet in the solar system. It is smaller than the four gas giants - Jupiter, Saturn, Uranus and Neptune but larger than the three rocky planets - Mercury, Mars and Venus. The circumference of the Earth is about 40,075 kilometres at the equator and 40,008 kilometres at the poles. The Earth is the densest planet because of its metallic core and rocky mantle, and crust.

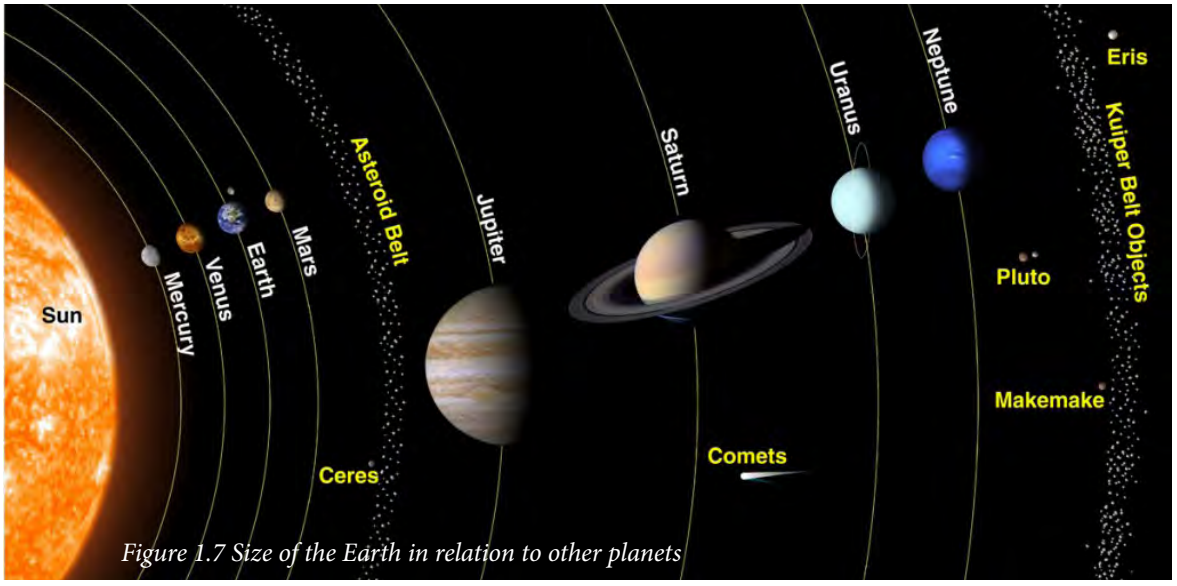

Figure 1.7 Size of the Earth in relation to other planets

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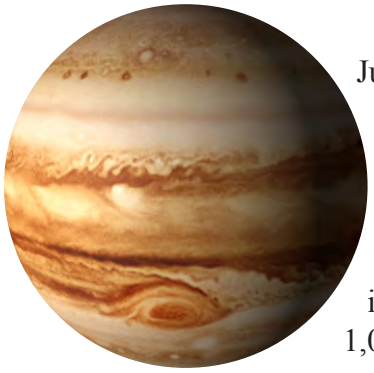
KNOW MORE

Greek philosopher Eratosthenes was the first person to estimate the circumference of the Earth in the 3rd century Before Common Era (BCE).

Sl. No	Planet	Average Radius in km	% to the size of the Earth (approximate)	Average Density (gm/cm3)
1	Jupiter	69,911	1,120	1.3
2	Saturn	58,232	945	0.7
3	Uranus	25,362	400	1.3
4	Neptune	24,622	388	1.6
5	Earth	6,371	100	5.5
6	Venus	6,052	95	5.2
7	Mars	3,390	53	3.9
8	Mercury	2,440	38	5.4



Jupiter is the largest planet in the solar system which is 11 times the size of the Earth. The Earth's average radius is 6371 kilometres. The smallest planet, Mercury has a radius of 2440 kilometres and is smaller than the Earth by 38 percent.

The Earth is a unique planet as it supports life. There are about 1,000,000 species of animals and more than 350,000 species of plants on the Earth.

The Earth is about 150 million kilometres away from the Sun with an average surface temperature of 14^0C making it neither too hot nor too cold.

It is the only planet in the solar system that has water in liquid form covering about 71% of its surface. The heat capacity of the ocean is important to maintain the Earth's temperature relatively stable. The occurrence of the water cycle on the Earth makes water available continuously.

Learning Activity:

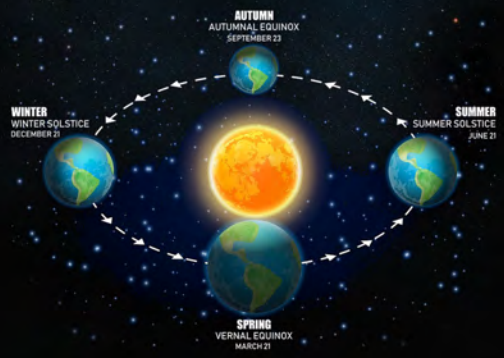
1. The Earth has a lone natural satellite, the moon. Explore the number of natural satellites that exist in other planets and discuss in the class.
2. What would be the situation if the size of the Earth is greater than the Sun? Give reasons.

The Earth is denser than any other planet due to its metallic core. The high density of the Earth has maintained atmosphere in its present form. Thick atmosphere protects it from harmful ultra violet rays from the Sun and the presence of oxygen in un-combined state maintains biological processes. The atmosphere prevents asteroids and meteoroids from reaching the Earth's surface.

These characteristics allow the Earth to be the only planet in the solar system that is known to support life.

Test Yourself:

1. Design a poster to show the condition of the Earth without water.
2. Imagine that you are on a world voyage, would you ever reach the edge of the Earth? Justify your answer.
3. Who is an astronomer?
4. Suppose life exist on Mars, would you prefer to live there? Why?
5. Equatorial diameter of the Earth is not identical to Polar diameter. Which one is greater and why?



Chapter Two
Rotation and Revolution

Learning Outcome(s):

- Discuss the causes of rotation and revolution of the Earth
- Explain the consequences of rotation and revolution

2.1 Introduction

The Earth is constantly in motion, rotating on its axis and revolving around the Sun on its orbit. The rotation of the Earth is a result of inertial force while revolution is caused by the gravitational force of the Sun. These motions result in various phenomena such as day and night, seasons and variation in climatic conditions.

2.2 Rotation

The Earth spins on its tilted axis from West to East (counter-clockwise). It takes 23 hours, 56 minutes, and 4 seconds to complete one rotation. Day and night are caused due to the rotation of the Earth. The speed of rotation varies from the equator towards the poles. The speed at the equator is approximately 1,670 kilometres per hour, gradually decreasing towards the poles.

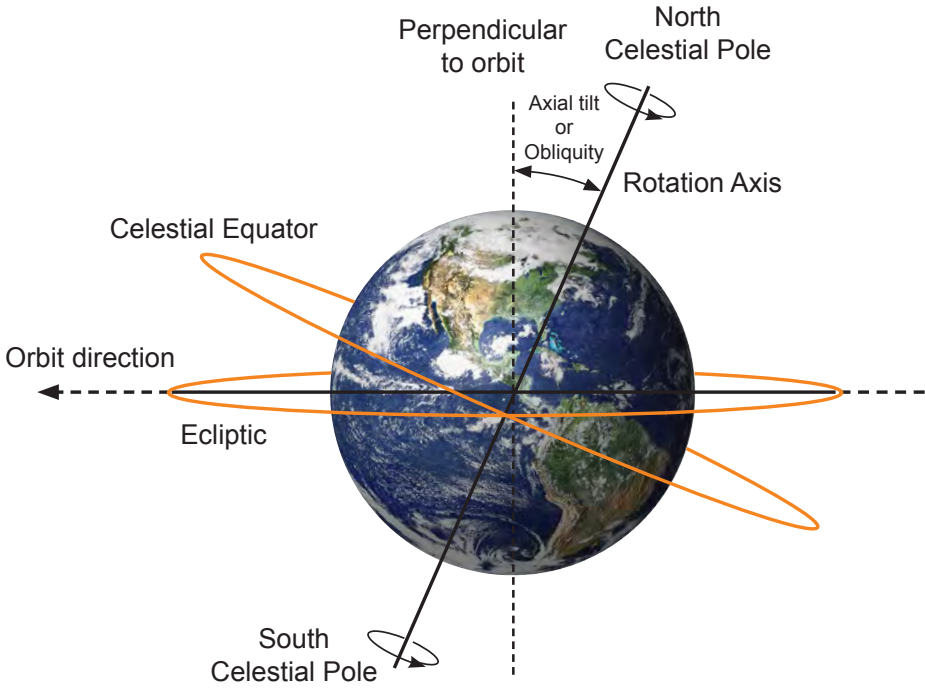


Figure 2.1 Rotation of the Earth

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2.2.1 Causes of Rotation

The planets were formed from clouds of gas and dust. Shock waves from a nearby supernova bounced against this cloud that made it to collapse. Gravitational forces pulled it into a flat spinning disc when it collapsed. Since all the planets were formed from that same disc, its momentum caused all the planets to spin in the same direction. The planets have continued to spin because of inertia. The momentum and direction is maintained in most of the planets because no external force is applied. Thus, the Earth and the planets in the solar system continue to spin.

2.2.2 Consequences of Rotation

The Earth rotates on its axis and takes approximately 24 hours to complete one rotation. The consequences of rotation are:

1. Rotation causes a diurnal cycle of light and darkness, changes in temperature and humidity. The part of the Earth that faces the Sun is illuminated while other part remains in darkness. The illuminated part experiences day and other part experiences night. This causes change in temperature and humidity.

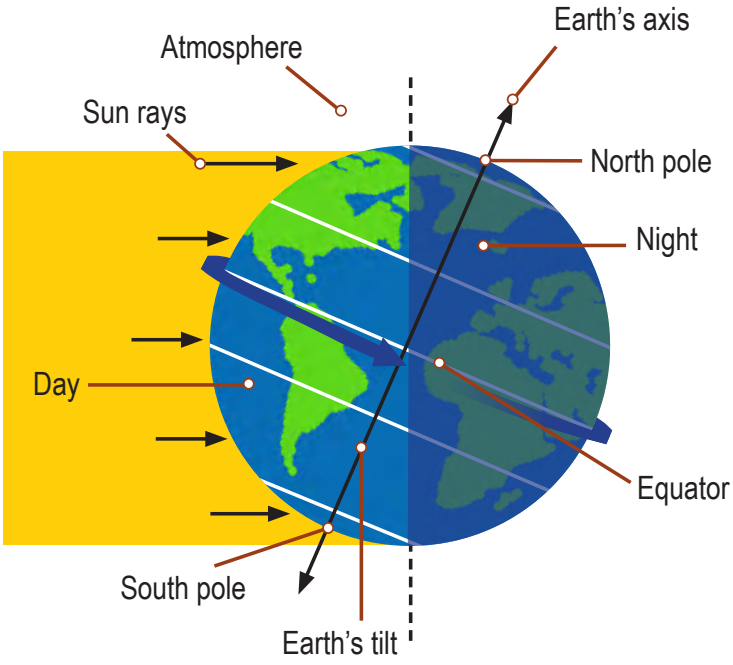

Figure 2.2 Occurrence of day and night

KNOW MORE

Supernova is a massive cosmic explosion of a huge dying star.

On 8th January 1851, Frenchman Leon Foucault demonstrated that Earth rotates on its axis using a device known as Foucault's pendulum.

Venus and Uranus rotate in clock wise direction.

Frenchman Leon Foucault

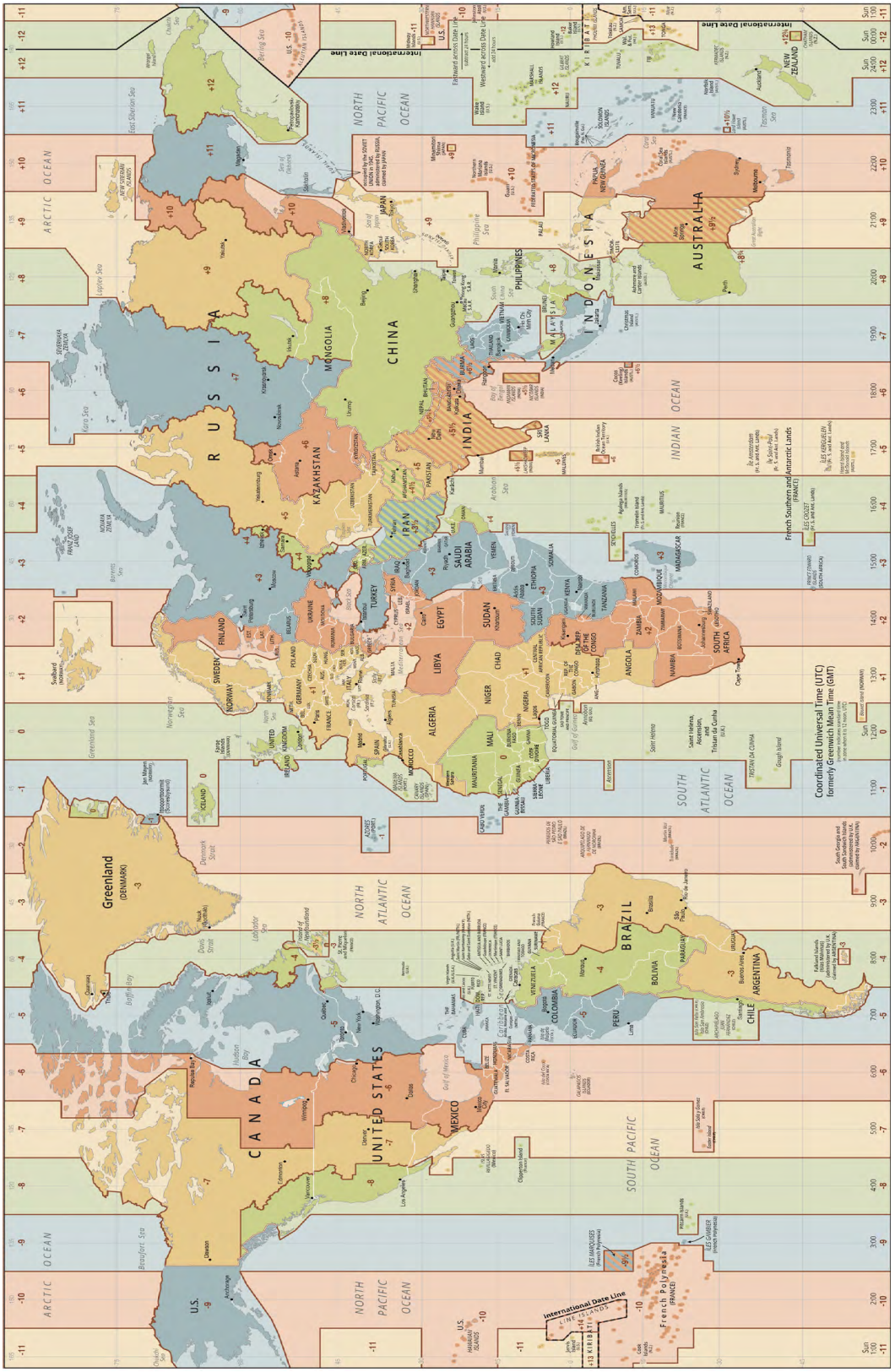

Figure 2.3 Time Zone

2. Standard time zones

Rotation of the Earth results in standard time zones. The Earth rotates 15° every 60 minutes. It completes the full circle of 360° in 24 hours. Therefore, the Earth has 24 time zones and each zone extends over 15° longitudes.

3. Tides

The rotation of the Earth causes tides. Sea level rises and falls twice a day. The tidal range is determined by the combined gravitational pull of the Sun and the Moon. Tides are highest when the Earth, Sun and Moon are in a straight line. The two types of tides are Spring and Neap tides.

Spring tide occurs when the difference between high and low tide is greatest. It occurs twice a month during the Full and New Moon. The position of the Sun, the Earth and the Moon are aligned during the Spring tide.

Neap tide occurs when the difference between high and low tide is the lowest. It occurs twice a month during the quarter Moon. The gravitational force of the Sun and the Moon works against each other during neap tide as the Sun and the Moon are at the right angles to the Earth.

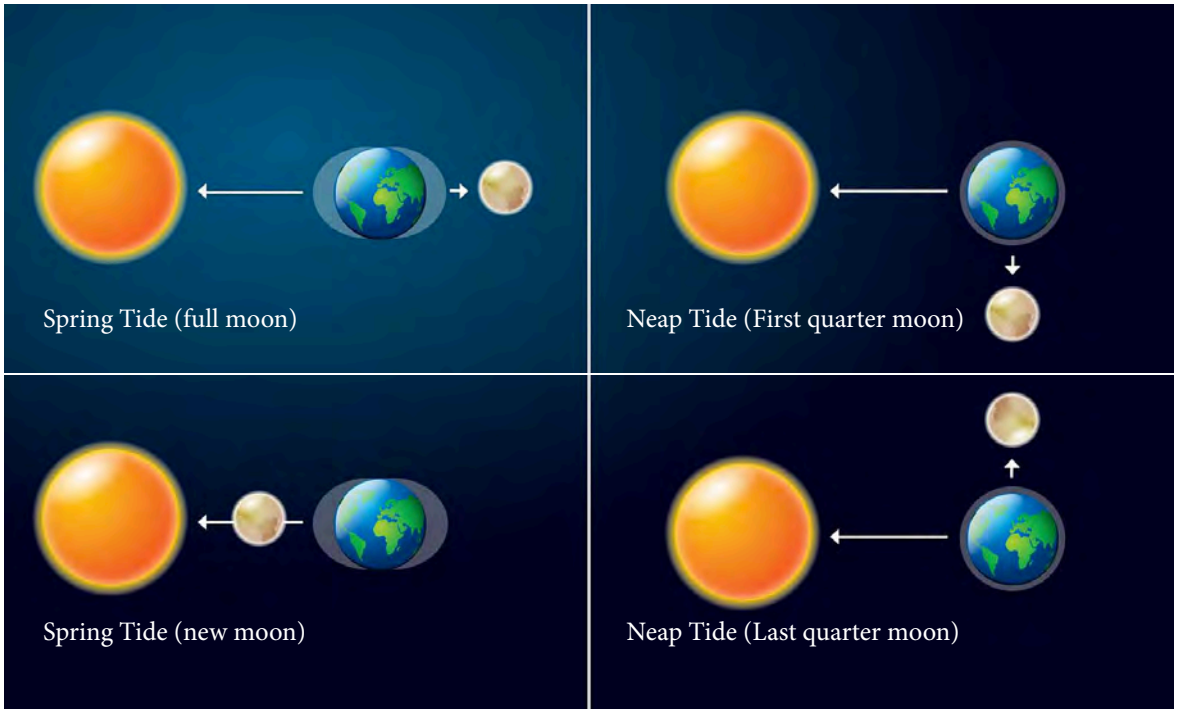

Figure 2.4 Tides

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Learning Activity:

Identify and discuss the benefits of tidal waves by referring to figure 2.5.

Figure 2.5

4. The Coriolis Force

Rotation of the Earth causes Coriolis force. Coriolis force is an inertial force that acts on an object and it deflects moving objects to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The extent of deflection of the air is directly related to the speed at which the air moves and its latitudes. Coriolis force is minimum at the Equator and maximum at the Poles.

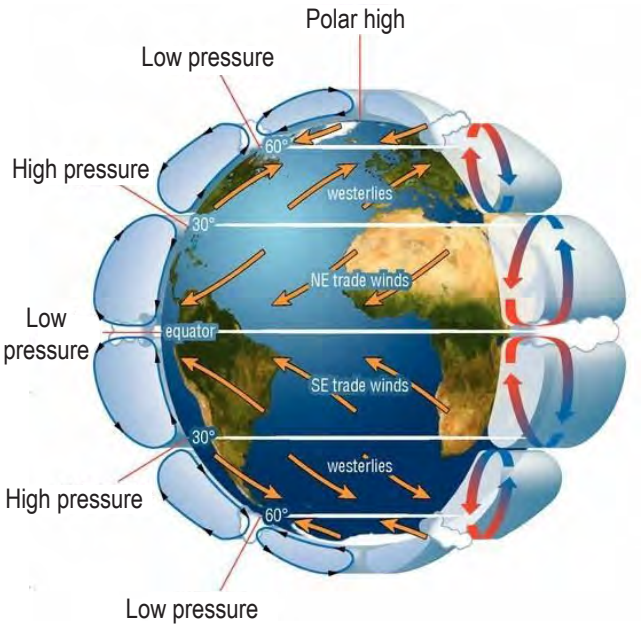

Figure 2.6 Effects of Coriolis Force

2.3 Revolution

The Earth revolves around the Sun in a counter-clockwise direction. It takes 365 ¼ days to complete one revolution. It revolves at a speed of 30 kilometres per second. The path of revolution is known as the Earth's orbit. The average distance of the Earth from the Sun is about 150 million kilometres. However, due to an elliptical orbit, the distance varies by 5 million kilometres at perihelion and aphelion.

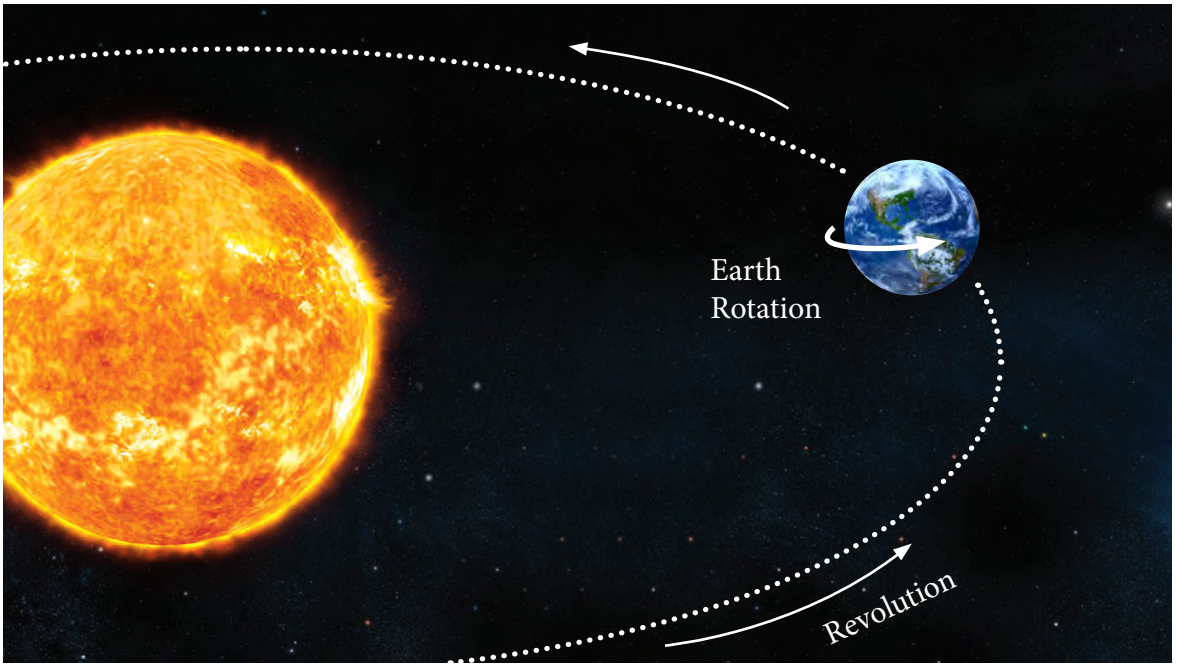

Figure 2.7 Revolution of the Earth

2.3.1 Causes of Revolution

The gravitational pull of the Sun keeps planets in their orbit. The Moon revolves around the Earth because of the Earth's gravity. Similarly, the Earth revolves around the Sun due to the Sun's gravity. The orbit of the Earth is elliptical because of its velocity which is perpendicular to the Sun's gravity.

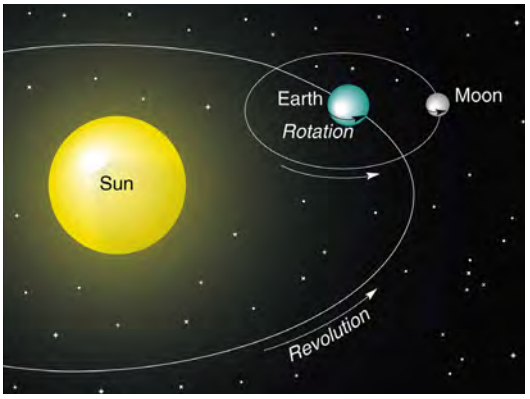

Figure 2.8 Revolution of the Earth

2.3.2 Consequences of Revolution

The Earth revolving around the Sun with its inclined axis has various consequences. It determines the distribution of solar energy over the Earth surface. It also causes change in elevation and location of stars at different times of the year.

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i. Varying length of day and night

The length of the day and night varies seasonally with varying latitudes. This variation is caused as the Earth's axis is tilted at 23½^0 from the plane of orbit. However, at the equator, the length of the day and night is almost same throughout the year.

Daylight is longer in summer than in winter. For instance, the northern hemisphere faces the Sun during summer increasing the daylight hours making daylight hours longer than night. The North Pole experiences six months of continuous daylight during summer.

In winter, the Earth tilts away from the Sun in the northern hemisphere and night becomes longer. Therefore, the North Pole experiences six months of continuous darkness. This varying length of day and night causes seasons on the Earth.

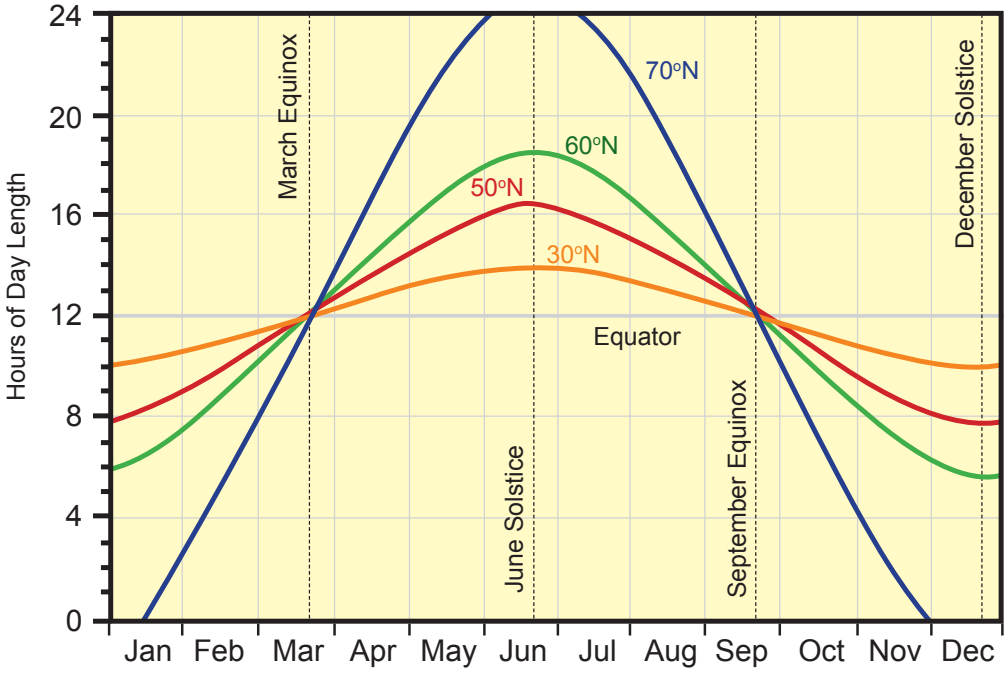
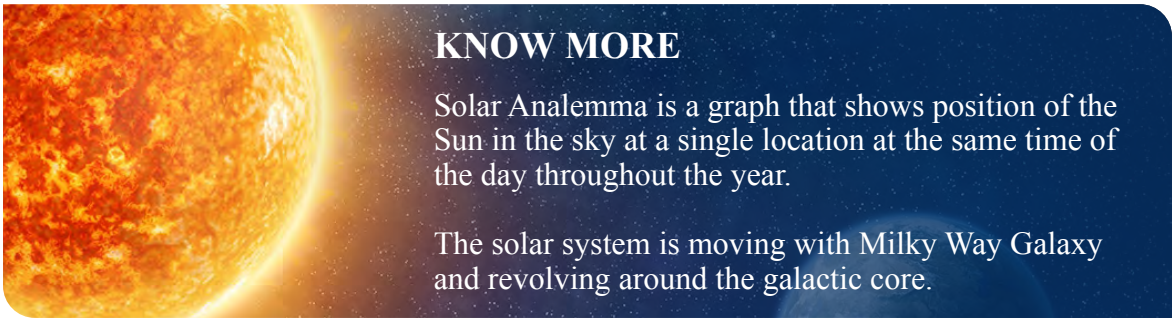


Figure 2.9 Annual variations in day length



ii. Seasons

Seasons are the division of the year according to changes in the character of weather in the course of the annual cycle. The timing and characteristics of the seasons depend upon the location of the Earth. Each season lasts about three months.

The astronomical and the meteorological methods are used to define the duration of the seasons. The astronomical method uses dates of equinoxes and solstices to mark the beginning and end of the seasons.

According to the meteorological method, seasons begin on the first day of the month that include the equinoxes and solstices. The four seasons are Spring, Summer, Autumn and Winter.

In spring, the Earth begins to tilt towards the Sun. The weather is warm and often wet. While in summer, temperature increases as the Earth receives direct rays of the Sun. Summer is the hottest season.

During autumn, temperature decreases as the Earth tilts away from the Sun and the weather becomes cold. Winter is the coldest season with shorter days as the Earth is away from the direct rays of the Sun.

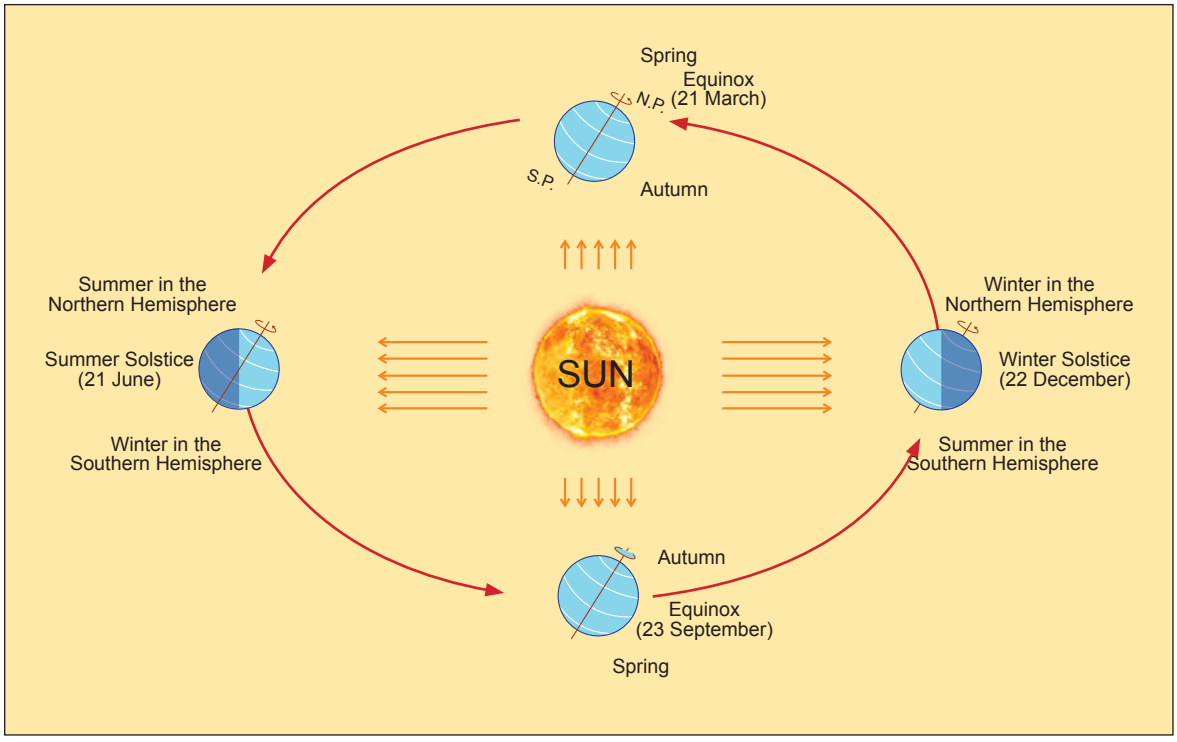


Figure 2.10 Revolution of the Earth and Seasons

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iii. Equinox

Equinox is the time when the Earth experiences equal length of day and night. It occurs twice in a year on March 21st and September 23rd. During equinox the Earth's axis is exactly at right angle to the direction of solar illumination. The circle of illumination passes through North and South poles.

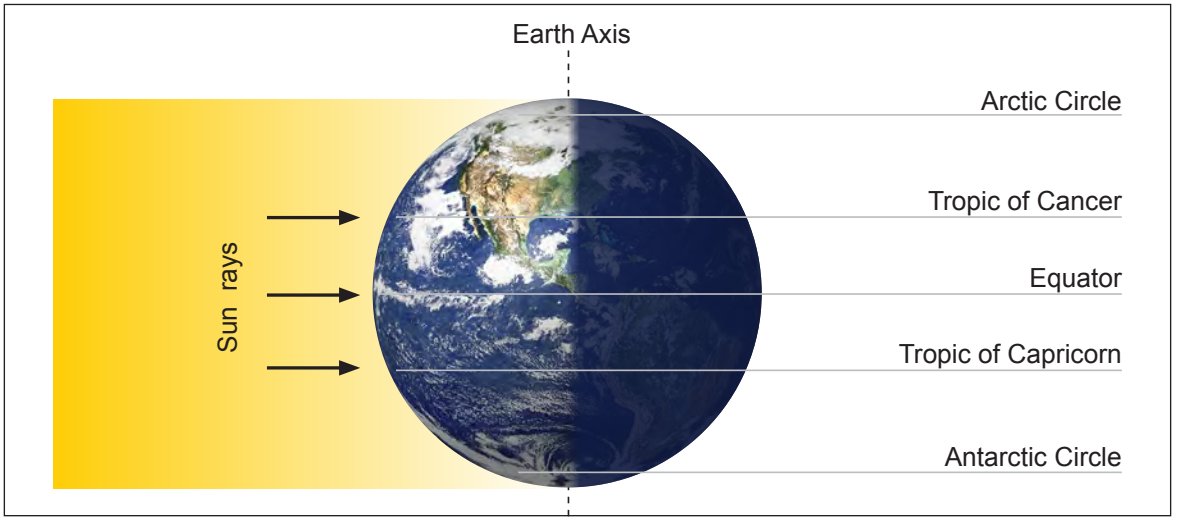

Figure 2.11 Equinox

iv. Solstice

Solstice occurs when the Sun rays fall vertically over the tropics. Summer solstice occurs on June 21st when the Sun's rays are vertical over the Tropic of Cancer. Winter solstice occurs on December 22nd when the Sun's rays are vertical over the Tropic of Capricorn.

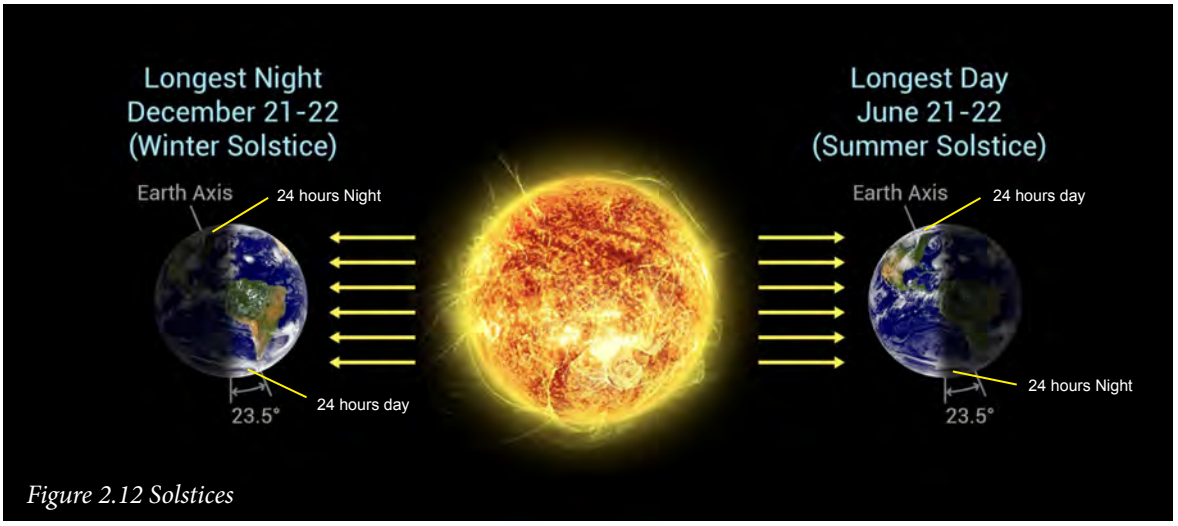

Figure 2.12 Solstices

v. Midnight Sun

Figure 2.13 Midnight Sun at the North Pole (https://www.youtube.com/watch?v=5Cvk3N6LBd8)

The Midnight Sun also known as polar day is a phenomenon when the Sun does not set for 24 hours. It is experienced in the region north of the Arctic Circle and south of the Antarctic Circle. The Midnight Sun occurs because the Earth's axis tilts towards the Sun in summer.

During Spring Equinox, the Sun rays are vertical over the equator. The daylight hours gradually increases in the Northern hemisphere with 12 hours at the equator on March 21st to 24 hours in the Arctic Circle during Summer Solstice. The places beyond the Arctic Circle experiences daylight up to six months at the North Pole. Places such as Alaska, Canada, Norway, Finland and Northern Russia experience Midnight Sun in summer.

Learning Activity:

Label figure 2.14 based on your understanding about revolution. Include:

i. the Earth's axis, showing the tilt
ii. arrows showing the movement of the Earth around the Sun
iii. seasons, and
iv. astronomical date of each season

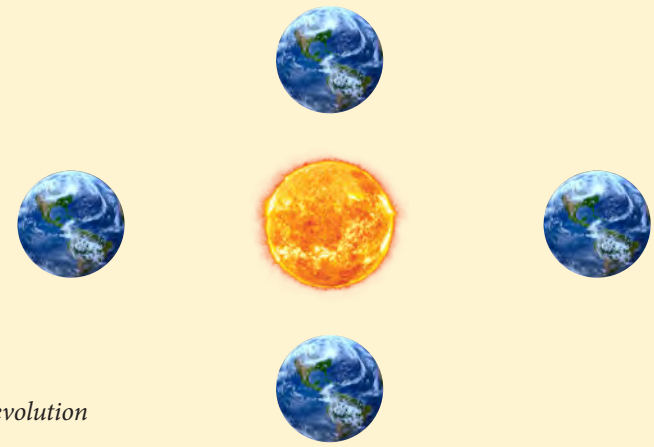

Figure 2.14 Revolution

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Test Yourself:

1. The Earth's axis is tilted at $23\frac{1}{2}^0$. What are the effects of this tilt?
2. The Sun appears at different positions in the sky at different times of the day. Explain.
3. Distinguish rotation from revolution of the Earth.
4. Imagine that you are studying in Norway, how would you adjust your daily activities in contrast to your daily activities in Bhutan?
5. When the Tropic of Cancer receives vertical rays of the Sun, what would be the season in southern hemisphere? Explain it with the help of a diagram.
6. In which season would tourist prefer to visit Bhutan and why?
7. What would happen if the Earth rotates in an opposite direction?

Chapter Three
Latitude and Longitude

Learning Outcome(s):

- Discuss the importance of latitude and longitude
- Calculate Time and Longitude

3.1 Introduction

The spinning of the Earth on its axis provides two natural points of reference, North and South Poles that form the basis of the geographical grid. The grid consists of horizontal and vertical lines which are called parallels of latitudes and meridians of longitudes. Latitude and longitude are also referred to as geographical coordinates as they provide a systematic network of lines.

Coordinate system is an arrangement of reference lines to identify the location of place and represent the angular distance from the centre of the Earth. These coordinates are measured in degrees and also shows direction.

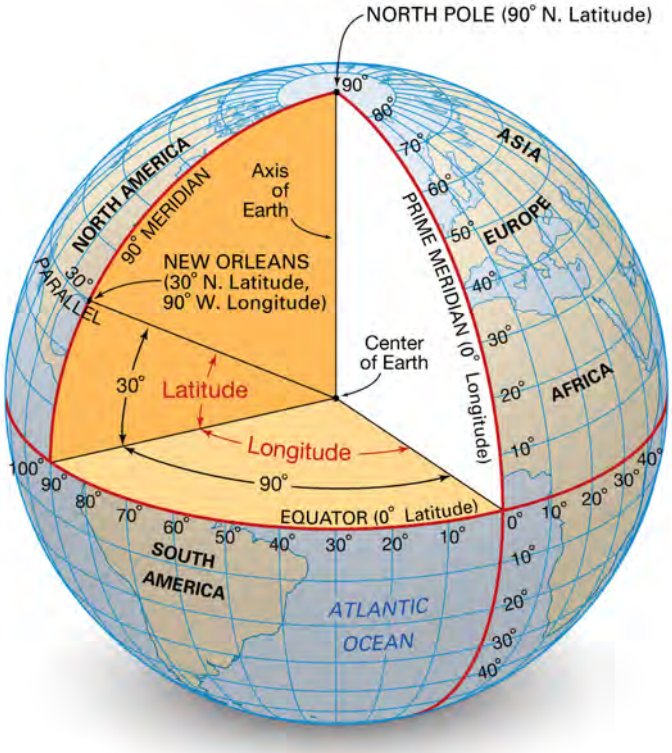

Figure 3.1 Coordinates showing angular distance

3.2 Parallels of Latitude

The latitude of a place on the Earth's surface is an angular distance north or south of the equator. It is measured along the meridian of a place as an angle from the centre of the Earth. Latitudes are also called parallels. Latitude of a place can also be determined with the help of the altitude of the Sun and the Pole Star.

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Learning Activity:

Draw a circle and divide it into two equal halves horizontally. This horizontal line represents the equator. Place a protractor on this horizontal line and mark $23\frac{1}{2}^0$ to the left and right from the centre towards the north. Now join the points by drawing a line. This is $23\frac{1}{2}^0$ N latitude.

Carry out similar exercise for $23\frac{1}{2}^0$ S, $66\frac{1}{2}^0$ N and S latitudes.

Major parallels of latitudes

The Equator is zero degree latitude that divides the Earth into Northern and Southern hemisphere. It is the largest latitude that forms the only Great Circle among the latitudes. The northern most limit where the Sun's rays fall vertically during Summer Solstice is Tropic of Cancer ($23\frac{1}{2}^0$ N). During Winter Solstice the vertical rays of the Sun fall on the Tropic of Capricorn ($23\frac{1}{2}^0$ S).

The Arctic Circle is $66\frac{1}{2}^0$ North and the Antarctic Circle is $66\frac{1}{2}^0$ South. Places lying beyond these latitudes receive more slanting rays of the Sun throughout the year.

Importance of latitudes

The parallels of latitudes serve a useful purpose. Parallels are used to find the distance of a place from the equator. Latitude along with longitude is used to find the exact location of a place on the Earth. Latitudes are also important to understand the various climatic patterns. High latitudes experience different climatic conditions compared to low latitudes. Thus, the Arctic is colder and drier than the Tropics.

3.3 Longitudes

Longitudes are the angular distance of a point east or west of the Prime Meridian. Longitudes are also called meridians. All meridians are half circles which converge at the North and South Poles. Lines of Longitudes measure how far a location is east or west of a universal vertical line called the Prime Meridian.

There are 360 degrees of longitudes with 180 degrees each in the east and west of the Prime Meridian. International Dateline is 180^0 longitude and the Prime meridian is 0^0 longitude.

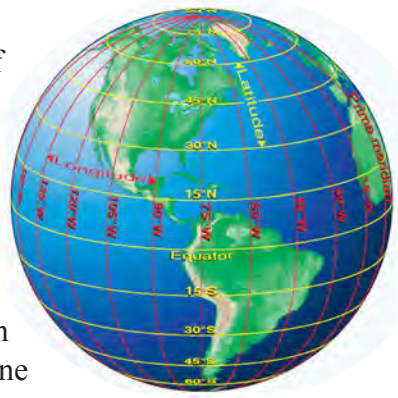

Figure 3.2 Coordinates of the Earth

Lines of longitude are used to determine time zones.

Longitude and Time

Longitude helps to determine the time of a particular place. The time of a place east of Greenwich is ahead and the west of Greenwich is behind. A traveller crossing the International dateline from east to west loses a day and gains a day while crossing from west to east.

The Earth rotates 360^0 in 24 hours which means 15^0 per hour or 1^0 in 4 minutes. The rate at which the Earth rotates over certain degrees of longitudes is used to determine the local time of an area in relation to Greenwich Mean Time.

Local Time

Local time is the time of a particular place which is expressed in relation to the line of longitude passing through it. It is also referred to as Noon Time. It is the time of the day when the Sun is overhead of that particular longitude and the shadow cast by an object is the shortest. Noon occurs at different times in different meridians. Hence, local time varies from place to place.

Standard Time

The Earth is divided into 24 time zones and the time established in each zone is the Standard Time. The time in each zone differs by one hour. It is the reference time for a country. It is the local time of standard meridian passing through the country or a region. All places within one time zone follow same time irrespective of their longitude. For example, in figure 3.3 places located between 68^0 East and 97^0 East longitude follow one standard time zone based on the standard longitude $82½^0$ East.

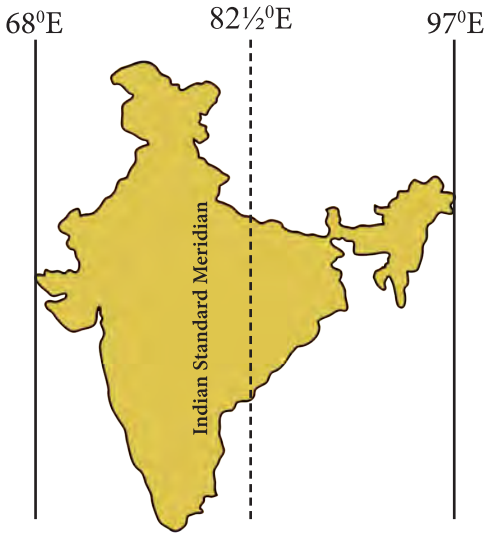

Figure 3.3 Indian Standard Meridian

Universal time

Greenwich Mean Time or GMT is the mean solar time at the Royal Observatory in Greenwich, London. It is the same all year round and is not affected by Summer Time or Daylight Saving Time. All the time zones in the world refer GMT as standard time. However, Coordinated Universal Time (UTC) replaced GMT. GMT is the time zone and UTC is the time standard which is the basis for time and time zone followed throughout the world.

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KNOW MORE

- Amerigo Vespucci was the first person to offer the method of measuring longitude.
- The term Meridian is derived from Latin, meri, denoting "middle", and diem, meaning "day".
- Abbreviations a.m. means Ante meridiem, and p.m. means Post meridiem
- Daylight saving time is a common system in which time is advanced by one hour from standard time during summer.

Amerigo Vespucci

Time and longitude calculation

Solved Example:

24 hours = 360^0 Longitude
1 hour = $360 \div 24 = 15^0$
60 minutes = 1^{50} (or)
$60 \div 15$ = 4 minute
Therefore, 1^0 = 4 minutes

1. Finding Time and day

What will be the time and day at 120^0E when it is 10 PM at 120^0W on Monday?

Solution:

No. of longitude between 120^0 E and 120^0 West = 240^0 [120^0E – (- 120^0W)]

- ➞ 1^0 = 4 minutes (Fact)
- ➞ 240^0 = 24^0 X 4 = 960 minutes (minutes should be always converted to hours)
- ➞ 960 minutes 960/60 = 16 hours
- ➞ The time at 120° E longitude is 22 hrs + 16 hrs =38 hrs (Convert to AM/PM)
- ➞ = 1 Day and 14 hours (convert to AM/PM).
- ➞ **Therefore, it is 2 PM on Tuesday.**

2. Finding Longitude

The local time of place X is 10:00 AM when it is 4:00 PM at 80^0E. Calculate the longitude of place X.

Solution:

- ➞ Time difference = 6 hrs (16 hrs – 10 hrs)
- ➞ 1 hour = 15^0 (Fact)
- ➞ 6 hours = 15 X 6 = 90^0 longitude difference
- ➞ Therefore, longitude of place X = 80 – 90 = -10 [- (minus) is west longitude)]
- ➞ **Since, the time of place X is behind, the longitude of the place X is 10^0W**

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Learning Activity:

1. Calculate time at New York (74^0 W) when it is 12 AM at 82 ½^0 E.
2. Place A located at 40^0 E is 4 hours ahead of place B. Find the longitude of place B.

Test Yourself:

1. Explain, why the lines of longitudes are called the meridians of longitudes?

2. The distance between all parallels of latitudes is 111 kilometres while the distance between meridians of longitudes is 111 kilometres only at the equator, why?

3. Find the coordinates of the following cities using available resources
   a. Tokyo
   b. Paris
   c. Sydney
   d. Buenos Aries
   e. Nairobi
   f. Los Angeles

4. Calculate local time of the places located on the following longitudes, when it is noon at Greenwich.
   a. 70^0W
   b. 50^0E
   c. 120^0E

5. Calculate the location of a place where the local time is noon when it is 7.30 PM at Greenwich.

6. Calculate the local time at Singapore (104^0E) when it is 6.00 PM at Greenwich.

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Chapter Four
Map Reading and Interpretation

Learning Outcome(s):

- Discuss types of maps
- Interpret topographical maps

4.1 Introduction

Map reading is an art of understanding and interpreting geographical features represented on a map. Maps represent various themes such as political boundaries, physical features, roads, topography, population, climates, natural resources and economic activities. Five important elements of a map are: title, legend or key, direction, scale and grid system. The physical and cultural features are represented by conventional signs and symbols.

4.2 Types of maps

Maps are categorised based on scale, purpose, and content. Large and small maps are categorised based on the scale. A large scale map shows small area in greater details. Cadastral and topographical maps are the examples of large scale maps. A map with the scale of 1: 50,000 is an example of large scale map. A small scale map shows large geographical area with lesser details. A Wall map and an Atlas are examples of small scale maps with R.F. of 1: 250,000.

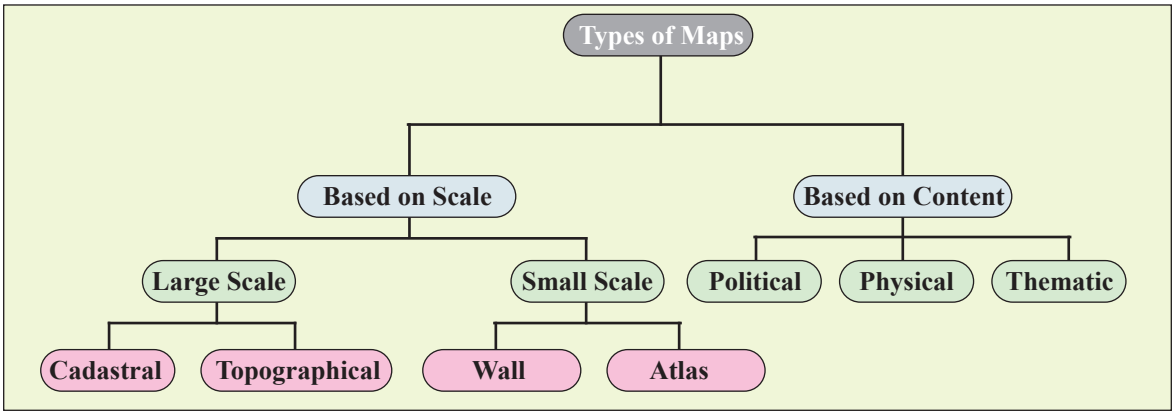

Figure 4.1 Type of Maps

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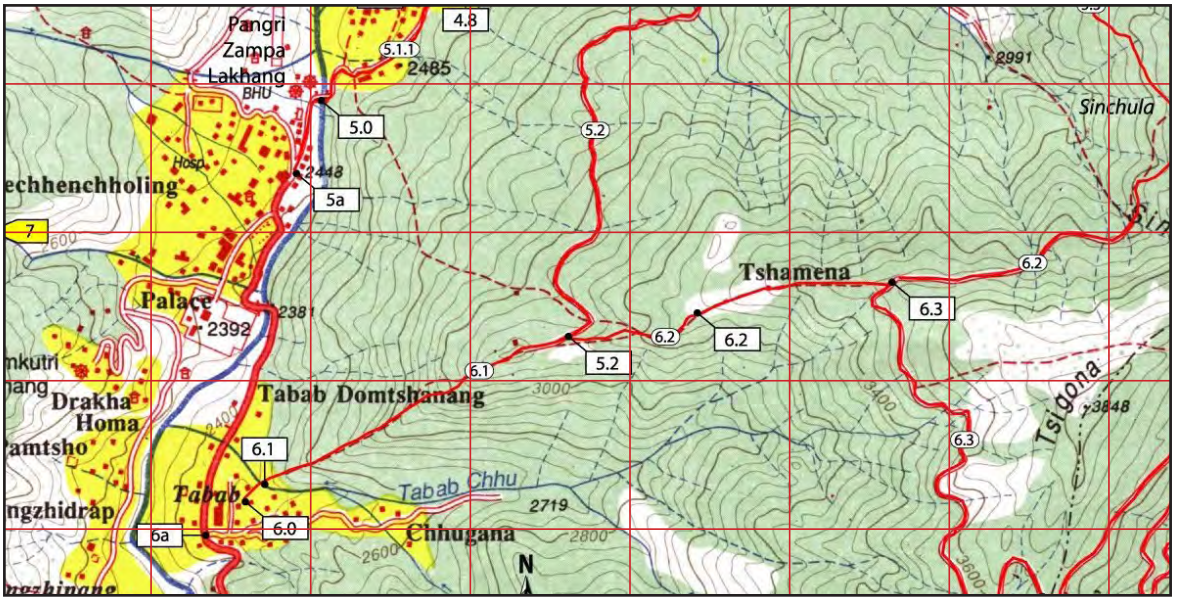

Figure 4.2 a: A Large scale map

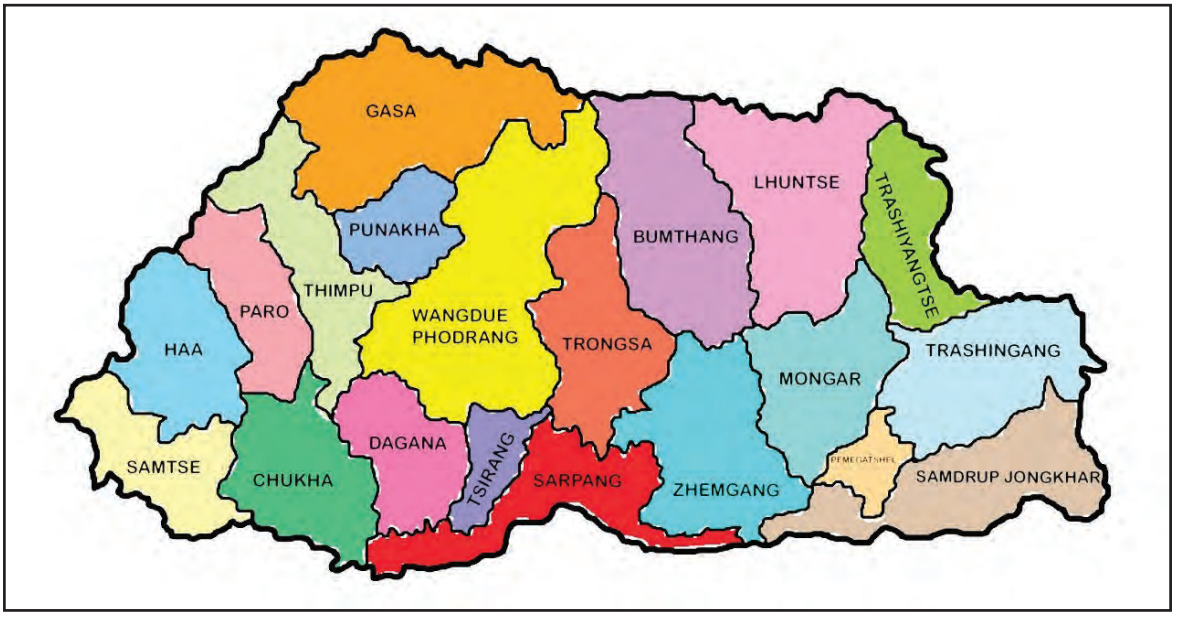

Figure 4.2 b: A Small scale map

Maps are also categorised based on content. Political maps display territorial features such as cities, states, countries and their boundaries. Major water features such as seas and oceans are also represented on this type of map.

Physical maps are designed to show the natural landscape of the Earth. Thematic maps highlight specific themes or topics of interest. Population distribution, mineral and road maps are some examples of thematic maps.

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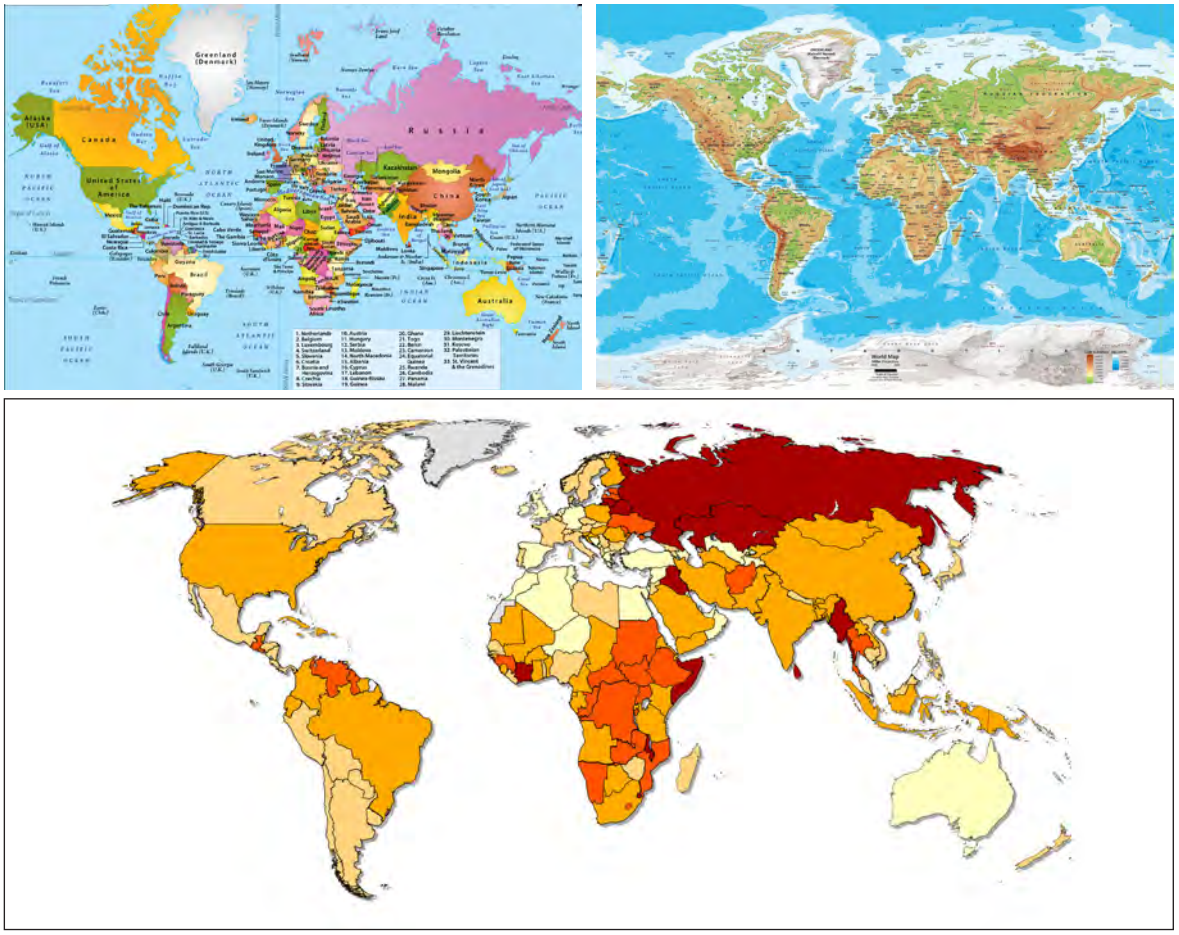

Figure 4.3 Political, physical and thematic maps

Learning Activity:

1. Explore more examples of thematic maps of Bhutan.
2. What features are depicted by physical maps? List and discuss in your team. Present your findings to the class.

4.3 Topographical Map

A topographical map is a two dimensional representation of relief features. This map helps the user to visualise three dimensional terrain depicted by the contour lines. It is a large scale map drawn based on surveys. Natural and human-made features are shown by different colours and symbols known as conventional signs and symbols. Relief, vegetation and drainage are some of the natural features while roads, settlements and land use are cultural features.

Toposheet tips:

- Follow the blue arrow and the spot height to find the flow direction of a river.
- To find the distance of any two places on a map, take conventional symbol of particular feature of the place.

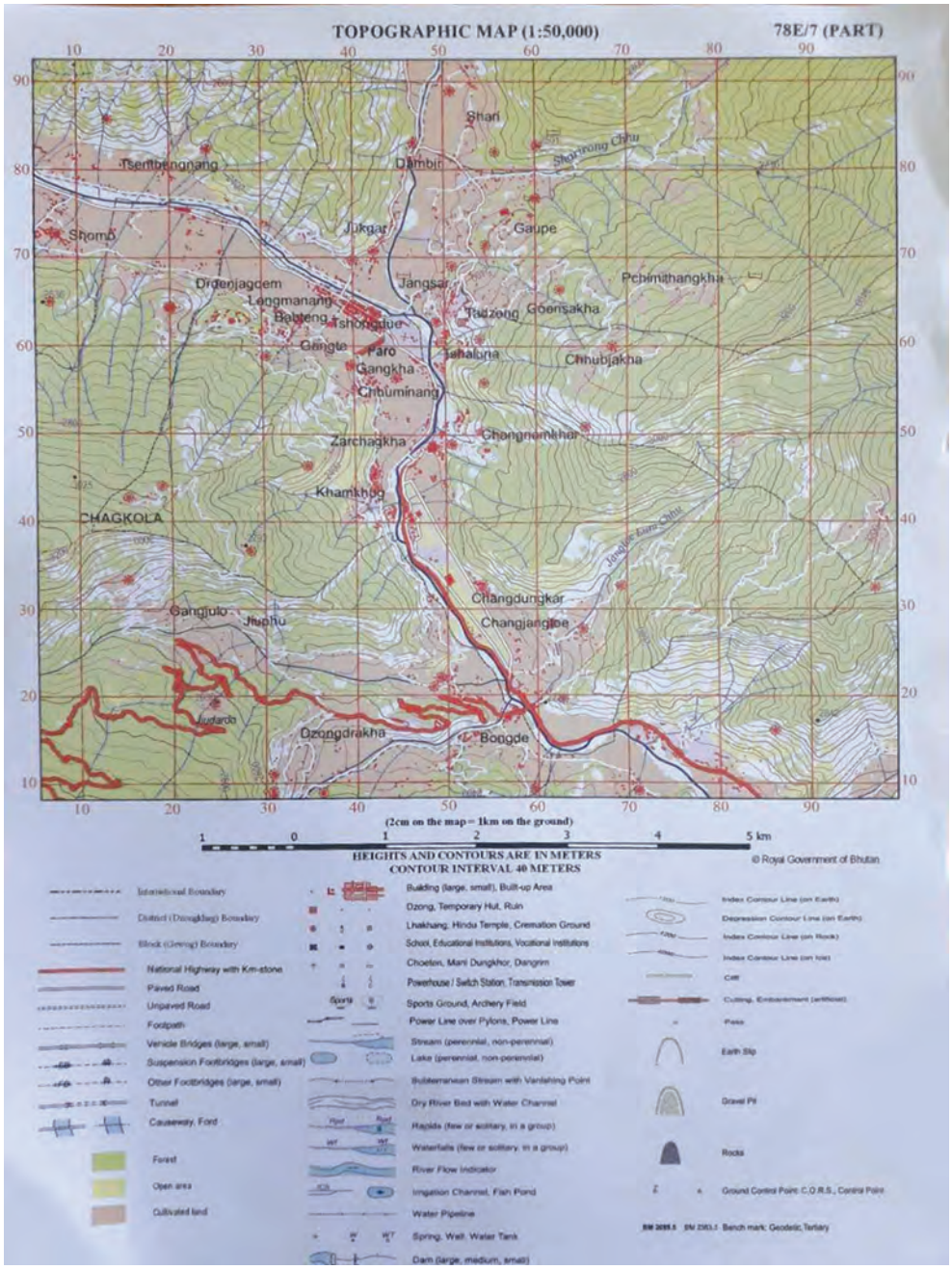

Figure 4.4 A topographic map

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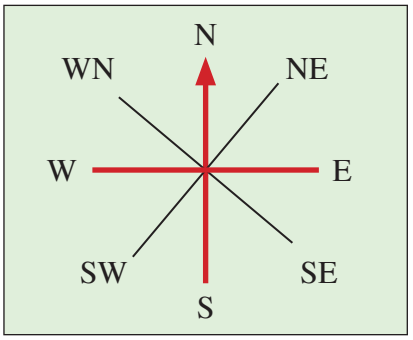
KNOW MORE

- France was the first country to produce topographical maps in late 17th Century.
- Dynamic maps are interactive representation of the Earth that can be accessed online.

4.4 Grid Reference



Grid is a network of lines drawn on a map in red colour. The lines running from north to south are called eastings and the lines running east to west are called northings. Grid references are given on a survey map to enable the reader to find the exact location of features. Four and six figure grid references are two methods of referencing on toposheet.

Learning Activity:

Refer figure 4.4 and complete the activities.

1. Find the four figure grid reference of spot height 2842, 3425 and 2792.
2. Find the six figure grid reference of Lhakhang near Goensakha, Chhubjakha and Dambji.

4.5 Distance and directions

The distance between the two places on a topographical map can be calculated with reference to the scale of a map. Direct and non-direct are methods of finding distance. The direct distance on a topographical map indicates a straight distance as the crow flies. To measure direct distance, place the straight edge of a paper strip or a ruler and note the map distance. Then use the graphical scale or the statement scale to convert it into the actual ground distance.

Non-direct method is used in measuring the distance of roads, rivers and footpaths. To calculate the non-direct distance, use a string/thread placing along the line of roads, rivers and footpaths and note the map distance. Then use the graphical scale or the statement scale to convert it into the ground distance.

The direction of a place or an object is expressed in relation to a given point. Direction is an important element of a map and used to find the direction of any place. There are four cardinal directions – East, West, North and South and four secondary directions- Northeast, Southeast, Southwest and Northwest.

Learning Activity:

1. Referring figure 4.4 calculate the crow fly distance between Lhakhang at Dambji and Goensakha.
2. Calculate the length of Jangtoe lum Chhu from its source till confluence at Pa Chhu.

4.6 Contours and Profile

Contour lines are used to determine three-dimensional images on a flat surface. Relief features can be identified based on the nature of the contour lines. Horizontal Cross section and Longitudinal profile methods are used to identify the landforms represented by contours. Contour lines are also used to find the height of a place.

Characteristics of contour lines

The following characteristics of contour lines help interpretation of features represented on topographical map:

- Contour lines are imaginary lines connecting places having same height above the mean sea level.
- The difference between two consecutive contour lines is called the Contour Interval or Vertical Interval.
- A thick contour line with a number at regular interval is the Index contour.
- Contour lines never cross one another. However, the contours may appear to overlap if the lines pass through a cliff or waterfall.
- Evenly spaced contours indicate a uniform slope while closely spaced contours indicate a steep slope.
- Widely spaced contours indicate a gentle slope and unevenly spaced contours indicate irregular slope.
- Contours bend inward in valleys and outward in a spur.
- Contours do not pass through permanent structures such as buildings.

4.7 Conventional Signs and Symbols

Conventional signs and symbols are symbolic representations of the Earth's features that are not drawn to the scale of a map. The symbols used to represent features are of three

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types: points, lines, and polygons. Points are used to depict features such as spot height and bench mark. Lines are used to illustrate linear features such as roads, railways, and rivers. Polygons represent shapes, sizes and areas of various features.

Different colours are used in topographical maps to show various features.

Sl.	Colours	Features
1	Black	All names, river banks, broken grounds, dry streams, surveyed trees.
2	Yellow	Cultivated areas.
3	Green	Wooded and forested areas, scattered trees.
4	Brown	Contour lines, their numbering, stony waste.
5	Blue	Water bodies.
6	Red	Grid lines and their numberings, roads, footpath, settlements, huts and other buildings.

Contours and heights

Spot height – It is the height of a particular point on the ground indicated with a black dot in front of a number. For example.156.

Triangulated height – It is the height in meters above sea level of a trigonometric or triangulated station represented with a black triangle. For example △560.

Bench Mark – This height is marked on rocks, stones and walls, marked along the railway lines and on the hill stations. For example, B.M 1080.

The height of any features on a topographical map can be calculated by referring the contour index value and the nearest spot height. To find the height of a place, the nearest index contour value and contour interval are referred. For example, place C is at 720 meters (700 + 20 or 750 - 30) in figure 4.5.

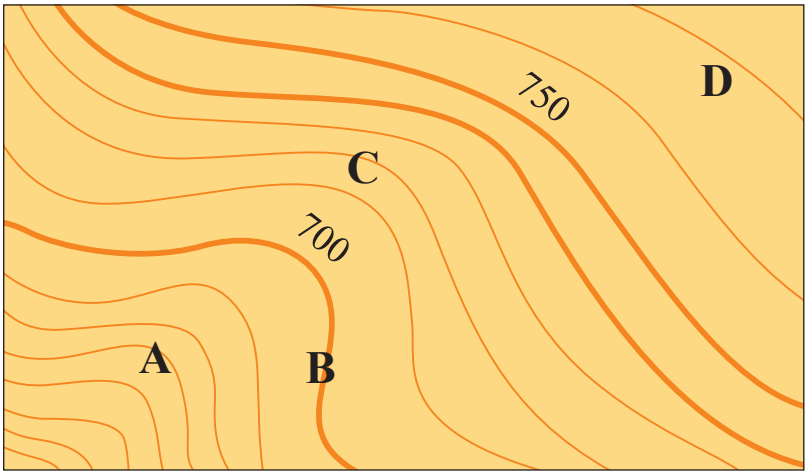

Figure 4.5 A contour map

Learning Activity:

1. Refer figure 4.5 to find the height of places A and D.
2. Identify the landform depicted by contours in figure 4.5.

Drainage Pattern

Drainage pattern is the pattern formed by streams and rivers in a particular drainage basin. Dendritic or tree-shaped drainage pattern is the most common and widespread pattern found on the Earth's surface. Trellised pattern is a rectangular pattern where the tributaries join the main river at right angle. The radial drainage pattern appears circular in shape with tributaries radiating from the source.

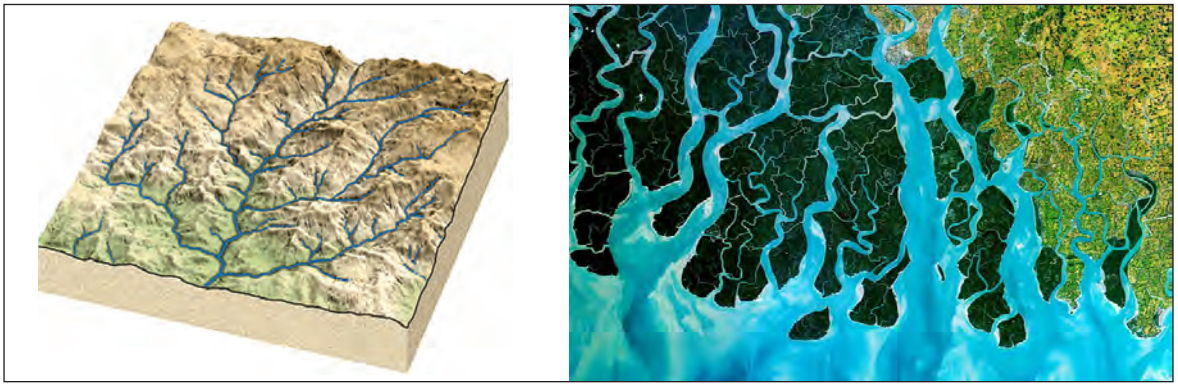

Figure 4.6 Drainage Patterns

Settlement Pattern

Settlements are represented by red rectangular and square boxes. Some of the common settlement patterns formed are: nucleated, scattered and linear.

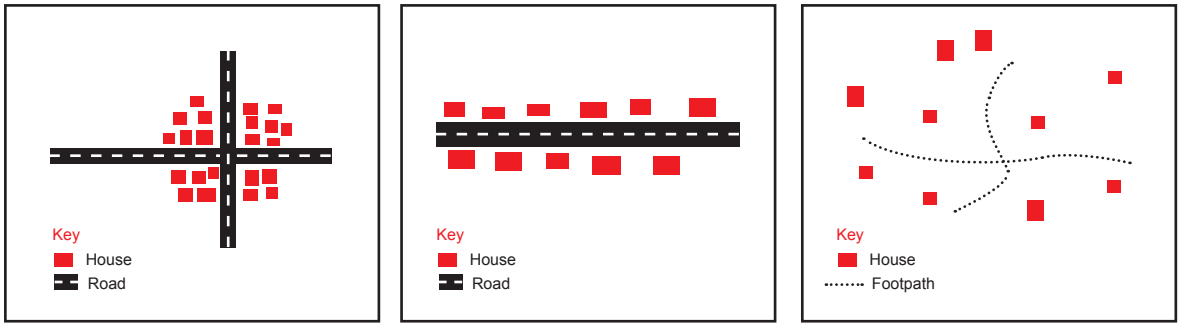

Figure 4.7 Settlement Patterns

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Land use and Occupation

The land use type and occupation of an area is interrelated. The occupation can be understood from the land use pattern of an area. The agricultural land on a topographical map is represented with yellow colour. Natural vegetation is represented with green colour. Some occupations can also be derived from cultural features.

Test Yourself:

1. Refer toposheet 78E/11 and answer the questions:
   i. Contour interval of the map is 40 meters; find the index contour interval of the map.
   ii. Calculate the ground distance between Lhakhang in Rama and Yangchenphu.
   iii. Identify four landforms from the topographical map and draw contour lines for the same.
   iv. Pema and Tashi are friends living at Barbesa and Dechenchholing. Which direction would Pema travel to meet Tashi?
   v. Dorji is a fresh graduate and wants to establish a dairy farm. Which area is suitable for the purpose? Why?
   vi. What is the flow direction of Wang Chhu?
2. Refer toposheet 78E/7 and complete the activities.
   i. Find one physical and one human made features in the grid square 5050.
   ii. Identify the lowest and highest spot height on the given map.
   iii. What is the general slope of the land in the area? Give two reasons to support your answer.
3. Explain the importance of topographical map.
4. How is settlement pattern related to occupation of the people?
5. Identify the landform depicted in figure 4.8.

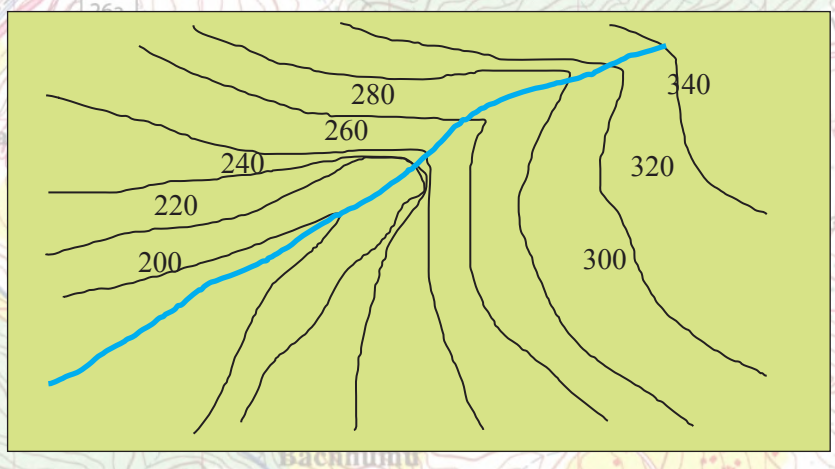

Figure 4.8 A land feature

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Chapter Five

Soils

Learning Outcome(s):

- Explain the factors affecting soil formation
- Explain the properties of soil
- Describe types of soil found in Bhutan
- Discuss the importance of soil and suggest ways to conserve it

5.1 Introduction

Soil is a thin layer of the Earth's crust composed of weathered rock particles, decayed organic matter, living organisms, mineral salts, water and air. There are different types of soil with varying properties depending on climate, topography, parent material and time. Soil is the bases of all life. Soil fertility has determined human settlements around the world. Thus, conservation of soil is necessary.

Figure 5.1 Soil

5.2 Factors affecting soil formation

Soil is formed by the interaction of parent material, climate, living organisms, topography and time. Soil forming factors are broadly classified as active and passive.

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5.2 .1 Active factors

Climate and living organisms are considered active factors. These factors are responsible for breaking down parent material and their influence over soil formation can be directly observed.

i) Climate

Temperature and precipitation are active soil forming factors. A hot and wet climatic region has deep and fertile soil as high temperature and humidity accelerate the rate of weathering and decomposition of organic matter. A cold and dry region has thin and poor soil due to slow weathering and decomposition.

Figure 5.2 Influence of climate on soil

ii) Living Organisms

Living organisms actively help in soil formation. Plant roots help in weathering and creating passages for the water and air. Animals also help in soil formation by loosening and mixing the soil. Micro-organisms like bacteria and fungi help in decaying the dead plants and animals producing humus.

Figure 5.3 Living organism as factor of soil formation

5.2.2 Passive factors

Parent material, topography and time are passive factors for soil formation. The impacts of these factors are not observable over a short period of time. Passive factors are not directly responsible but have some influence over climate and organisms.

i) Parent material

Parent materials for soil are either solid bedrock or loose sediments that have been transported and deposited by the action of wind, running water and glaciers. The type of parent material determines the type of soil. If the parent rock is limestone, the soil will be rich in calcium. Sandstone will form coarse sandy soil, while basalt will result in fine textured soil.

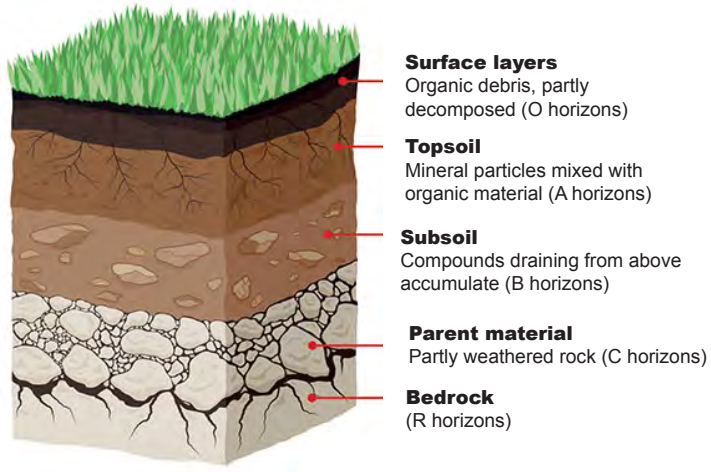

Figure 5.4 Soil formation from parent material

ii) Time

Soil formation is a continuous process that takes many years. The influence of time will depend on the nature of parent material. Soil formation takes a very long time if the parent material is solid hard rock. It is fast if the parent material is of loose sediment or soft rock.

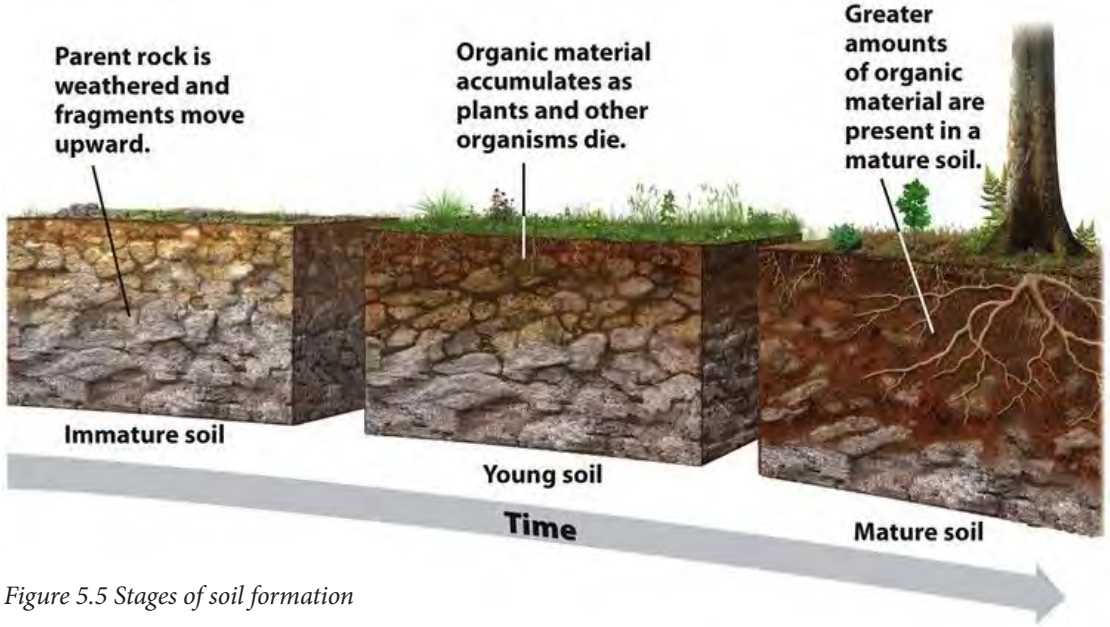

Figure 5.5 Stages of soil formation

iii) Topography

The nature of slope determines the depth and nature of soil. Steeper slopes have thin and less fertile soil as the surface erosion is faster than the soil formation. A soil in a plain area is deep and fertile due to deposition and less surface erosion.

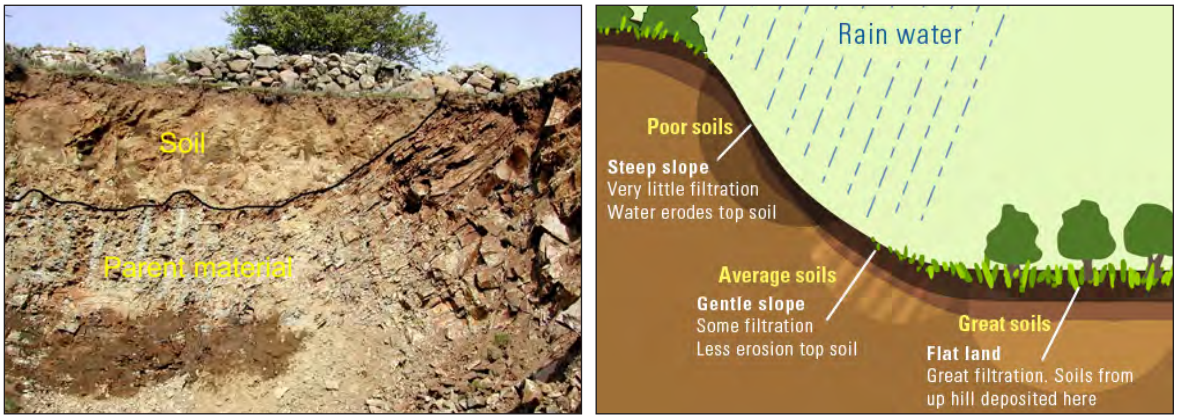

Figure 5.6 Soil and Topography

Learning Activity:

1. Discuss how human beings contribute to soil formation.
2. Study the soil in your school garden and make a list of organisms responsible for soil formation.

5.3. Types of Soil

Generally there are four major types of soil, namely; sandy, clay, silt and loamy. However, the types of soil found in different regions will have mixture of these. A variety of soils have been identified by Pedologists. Some of the important properties of different types of soil found around the world are:

i) Podsolic soil

Podsol is ash-grey coloured soil found in coniferous forests and in temperate regions with short warm summers. It has a moderate leaching rate due to moderate rainfall. Micro-organisms do not thrive in such areas, resulting in a slow decomposition of organic matter. This type of soil is acidic, infertile and has limited agricultural value.

Figure 5.7 Podsolic soil

ii) Brown Soil

Brown soil is found in dense deciduous forests. It is rich in humus as a result of sufficient plant litter and other organisms. It is composed of sand and loam which makes it look reddish yellow and is suitable for agriculture.

Figure 5.8 Brown soil

iii) Chestnut soil

Chestnut soil is deep brown in colour, found in semi-arid regions. Although the soil is poor in organic matter and nitrogen, it can generally be used for agriculture with irrigation.

Figure 5.9 Chestnut soil

iv) Alluvial Soil

Alluvial soil has a high content of humus, making it one of the most fertile soils. It is formed by depositional work of rivers in valleys, flood plains and deltas. It is a mixture of fine grained silts and alluvium with rich mineral content.

Figure 5.10 Alluvial soil

v) Laterite soil

Laterite soil is found in hot and humid regions of equatorial rain forests and Savannah climate. It lacks humus due to heavy leaching caused by heavy rainfall which makes the soil unfit for agriculture. The soil is rich in iron and aluminium but the soil appears rusty-red due to iron oxide.

Figure 5.11 Laterite soil

vi) Desert soil

Desert soil is found in arid regions and areas with scanty rainfall. It does not contain any humus due to thin vegetation. It is alkaline in nature due to high rates of evaporation. Such soils can be used for agriculture only when texture is fine and irrigation is available.

Figure 5.12 Desert soil

vii) Tropical black soil

Tropical black soil is formed as a result of volcanism. It is sticky when it is wet but develops cracks when dry. It has great moisture holding capacity and contains a large variety of minerals. It is useful for cultivation of cotton.

Figure 5.13 Tropical Black soil

viii) Chernozom

Chernozom is also known as black soil that are found in semi-arid lands. It is one of the most fertile soils of the world due to high humus and calcium content. It has great moisture holding capacity and requires little irrigation. It can be used for agriculture without adding fertilizers.

Figure 5.14 Chernozom soil

Learning Activity:

1. Which type of soil is most common in your locality? Write additional properties that you have observed.
2. Collect two different soil samples from your school campus.
   a. Discuss differences and similarities. Share in the class.
   b. Which soil do you think is better for cultivation? Justify.

5.4 Soils of Bhutan

There are different types of soil due to varied topography and climatic zones. Some of the major soil types are:

i) Podsolic soil

Podsolic soil is found in high mountain slopes of Haa, Paro, Thimphu, Bumthang, parts of Puna Tsang Chhu and the upper basins of Drangme Chhu. This soil usually has another

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layer above the top soil called O Horizon which is composed of plant litter. It is suitable for growing crops like maize, millet, wheat and vegetables.

ii) Brown Soil

Brown soil is found mostly in central Bhutan. It has brown or yellow-brown sub soil below a dark grey-brown top soil. Crops like wheat, maize, pulses and barley are best grown in this type of soil.

Figure 5.15 Brown soil

iii) Mountain soil

Mountain soil is mixed with pebbles, gravels and shingles with little organic matter. It is found usually in thin layers on steep gradients of high mountains. The texture varies from loam to sandy loam due to harsh climatic conditions. Mountain soil is not well developed for agriculture.

Figure 5.16 Mountain soil of Bhutan

iv) Red and Black Soil

Red and Black soil is found in few pockets of Bhutan like Thimphu, Wangdue Phodrang, Trongsa and Trashigang. Red soil usually lacks phosphate, nitrogen and lime. A thin layer of black soil which contains humus lies above the red soil. Such soil supports growth of conifers, oak and scrub. This soil is suitable for growing maize, groundnut, chili and oilseeds.

v) Alluvial Soil

Broad and fertile valleys of Paro, Punakha, Thimphu, and the southern foothills have alluvial soil formed by deposition of materials. Most crops grow well in this soil.

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vi) High Altitude Meadow Soil

This soil is found in alpine zones of high altitude regions of Merak, Sakteng, Laya and Lingzhi. It is basically sandy and contains partially decomposed materials. Snow often covers the ground for long period of time and makes the soil water-logged. The soil is prone to landslide and soil creep as it is usually thin, fragile and coarse. The soil is suitable for growing wheat, buckwheat and barley.

Figure 5.17 Lunana

KNOW MORE

- Classification of soil is also done on the basis of amount of annual rainfall as Pedalfers (over 63.5 cm) developed in humid areas and pedocals (less than 63.5 cm) developed under arid conditions respectively.
- National Soil Survey Centre (NSSC) located at Simtokha in Thimphu is a soil research centre.

Learning Activity:

Study the soil types found in your area and record the information provided in the table. Attach your findings to your friends of same level studying in different schools through internet asking them to send information about soil found in his/her area. Collect the information and share it to the class.

Soil Types	Properties	Crops	Vegetation	Dzongkhag

5.5 Importance of Soil

Soil is the reservoir on which most life on earth depends. The importance of soil are:

i) Medium for the growth of plants

Soil provides plants with essential minerals and nutrients. It supports plant roots keeping them upright and also protects from erosion and other destructions. Soil holds water and air which is also necessary for plants.

Figure 5.19 Insects and microbes in soil

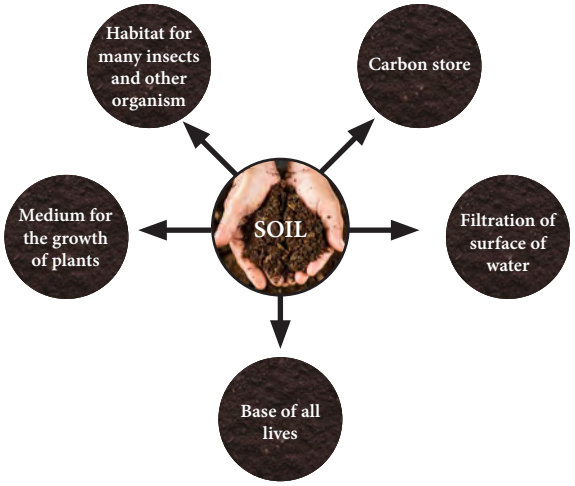

Figure 5.18 Importance of soil

ii) Habitat for insects and other organisms

Soil provides home for a wide range of insects and microbes. Some live on the surface while others live below. They depend on soil for food, air and moisture for their survival.

iii) Filtration of surface water

Water from rainfall and snowmelt flow over the Earth's surface and join water bodies. Some of it percolates into the ground, filtering dust, chemicals and other contaminants. It also stores underground water and serves as a source to springs.

Figure 5.20 Surface water

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iv) Carbon store

Soil minerals act as a huge carbon sink to help balance the dangerous levels of carbon dioxide in the atmosphere. Increasing the total organic carbon in soil can decrease atmospheric carbon dioxide. Proper management of the soil is needed to reduce the levels of carbon dioxide.

v) Support life

Soil plays a vital role in sustaining human welfare and assuring future agricultural productivity and environmental stability. It has food growing capacity and also provides building materials and other bases for survival of all other living beings on earth.

Figure 5.21 Agriculture farming

Learning Activity:

1. Civilisations are believed to have started along the river valleys of Indus and Nile. Give reasons.
2. Debate on the topic, "Soil is a non-renewable natural resource."

5.6 Soil conservation

Soil is a valuable natural resource and most of the world's population still practice cultivation despite industrialization. Soil is under constant threat from excessive farming, use of chemicals, erosion and pollution. Hence, soil conservation is very important. Soil

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conservation is the process of preventing soil degradation. Some of the methods that can be adopted to conserve soil are:

i) Planting trees

The root systems of plants hold soils in place and prevent soil erosion. One of the serious causes of soil erosion is excessive cutting of trees. Planting new trees in eroded areas is known as afforestation while replanting of trees in an area is termed as reforestation. Trees act as barriers to the passage of winds and water which erode the soil.

Figure 5.22 Afforestation

ii) Control overgrazing

Animals move freely in the fields for grazing and spoil the soil with their hooves which leads to soil erosion. Separate grazing land should be identified and quality fodder crops should be grown to control overgrazing. Encourage farmers to raise high quality livestock to reduce pressure on land.

Figure 5.23 Exotic livestock

KNOW MORE

Bhutan set Guinness's world record for planting trees in 2015. A team of 100 volunteers planted 49,672 trees in one hour.

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iii) Improved farming practices

Crop rotation, terraced cultivation, construction of bunds and contour ploughing are some ways to conserve soil. Shifting cultivation should be discouraged as it causes soil erosion and depletion. Channel irrigation should be replaced by sprinkler and drip irrigation.

Figure 5.24 Terraced cultivation

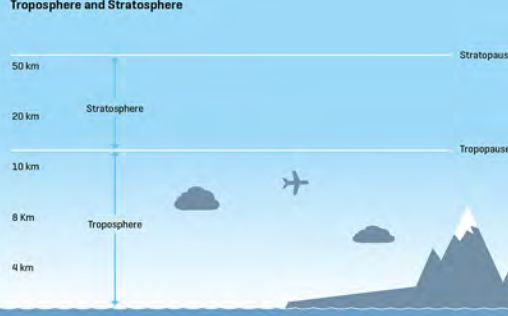
Learning Activity:

1. Samdrup, a farmer faces low yields from his field continuously over the years. After consultation with the soil experts it was found that the cause was leaching. Suggest measures to address this problem.
2. What are the consequences of soil mismanagement? Prepare a power point presentation and present it to the class.

Test Yourself:

1. Why do you think it is important for the farmers to know the properties of soil?
2. Discuss soil as a base of all lives.
3. Explain the impact of human activities on soil and suggest measures to conserve it.
4. Discuss the importance of soil in the development of rural settlements.
5. Explore the main cause of soil degradation in your locality and suggest measures to reduce these problems.

Chapter Six
Atmosphere



Learning Outcome(s):

- Describe the composition of atmosphere
- Analyse the characteristics of different layers of atmosphere
- Draw and explain the basic working principle of weather instruments

6.1 Introduction

The atmosphere is an integral part of the Earth. It is a layer of gases, water vapour and aerosols surrounding the Earth's surface. The presence of atmosphere is felt only when the air blows as wind. Distribution of the atmosphere varies with altitude, time and space. It has weight and exerts pressure. Atmosphere can be divided into layers based on its characteristics.

6.2 Composition of the atmosphere

The Earth's atmosphere is a mixture of nitrogen, oxygen, carbon dioxide, ozone and inert gases. There are also solid and liquid particles called aerosols suspended in the atmosphere.

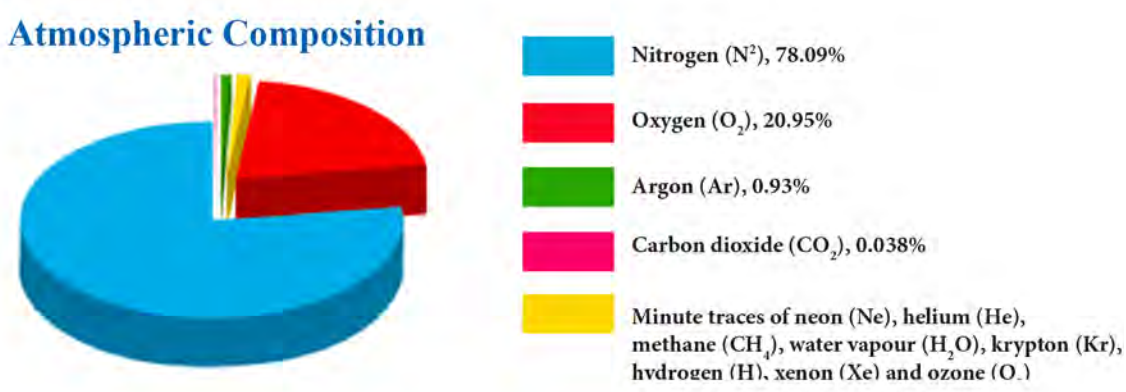


Figure 6.1 Composition of Atmosphere

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i) Nitrogen

Nitrogen in the atmosphere extends upto 128 kilometres. It constitutes 78% of the atmosphere and is chemically inactive. Nitrogen in the atmosphere is converted into nitrates by lightning and by nitrogen-fixing bacteria. It helps to control the fire by neutralizing oxygen. During precipitation, a certain form of nitrogen is removed as nitric acid.

ii) Oxygen

Oxygen is one of the most chemically active gases in the atmosphere. It constitutes about 21% of the atmosphere and is highly combustible. Maximum amount of oxygen is found in the lower layers of the atmosphere. Oxygen is used by living organisms for respiration. It is also used for treating wastewater to accelerate decomposition.

iii) Carbon dioxide

Carbon dioxide is one of the heaviest gases mainly found in the lower layers of the atmosphere. The atmosphere comprises of about 0.04% of carbon dioxide. The carbon dioxide released by fuel combustion, respiration and oceanic evaporation is used for photosynthesis. It is responsible for trapping outgoing terrestrial radiation. The increasing level of carbon dioxide in the atmosphere is responsible for climate change.

iv) Ozone

Ozone is a thin layer of gas in the atmosphere. It is concentrated in the stratosphere. The Ozone plays an important role in the atmosphere by absorbing ultraviolet rays emitted by the Sun.

v) Hydrogen

The composition of hydrogen in the atmosphere is negligible. Hydrogen has the lowest density and is the lightest gas in the atmosphere. It is produced from the splitting of water (H_2O) into hydrogen and oxygen.

vi) Other Gases

The atmosphere also comprises of many other traces of gases. Some of these gases are Argon, Beryllium, Helium, Krypton, Lithium, Methane and Xenon. These gases are usually inactive. However, under extreme conditions, some of these gases become reactive and are called Noble gas. Argon, Radon, Krypton and Xenon are some of the noble gases.

vii) Water vapour

The gaseous form of water present in the atmosphere is water vapour. Its composition differs in space and time due to variation in the global hydrological cycle. It is a source of precipitation and helps in absorbing dust particles in the atmosphere. Water vapour also helps to moderate the temperature of the Earth.

viii) Aerosols

Aerosols are suspended particles such as sea-dust, mineral-dust, organic matter and smoke found in the lower layer of the atmosphere. These particles are released into the atmosphere from natural sources and by human activities. It acts as hydroscopic nuclei in the process of condensation. Aerosols also scatter light in different directions. Blue light is scattered more than red light which makes the sky appear blue.

Learning Activity:

Solve the riddle.

Riddle	Who am I?
I have same lifeblood as ozone but I am not ozone.	
I am the most dominant member of our family.	
I defend the inhabitants of living planet from the harmful rays.	
People compare me with their transparent house.	
I may be very negligible in our community but without me the Earth will be dry.	
I am twice as big as life giving air in producing universal solvent.	
We hardly socialise with other members of our family.	

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6.3 Structure of the atmosphere

There is variation in temperature, pressure and density of air. On the basis of these factors, atmosphere is divided into five layers.

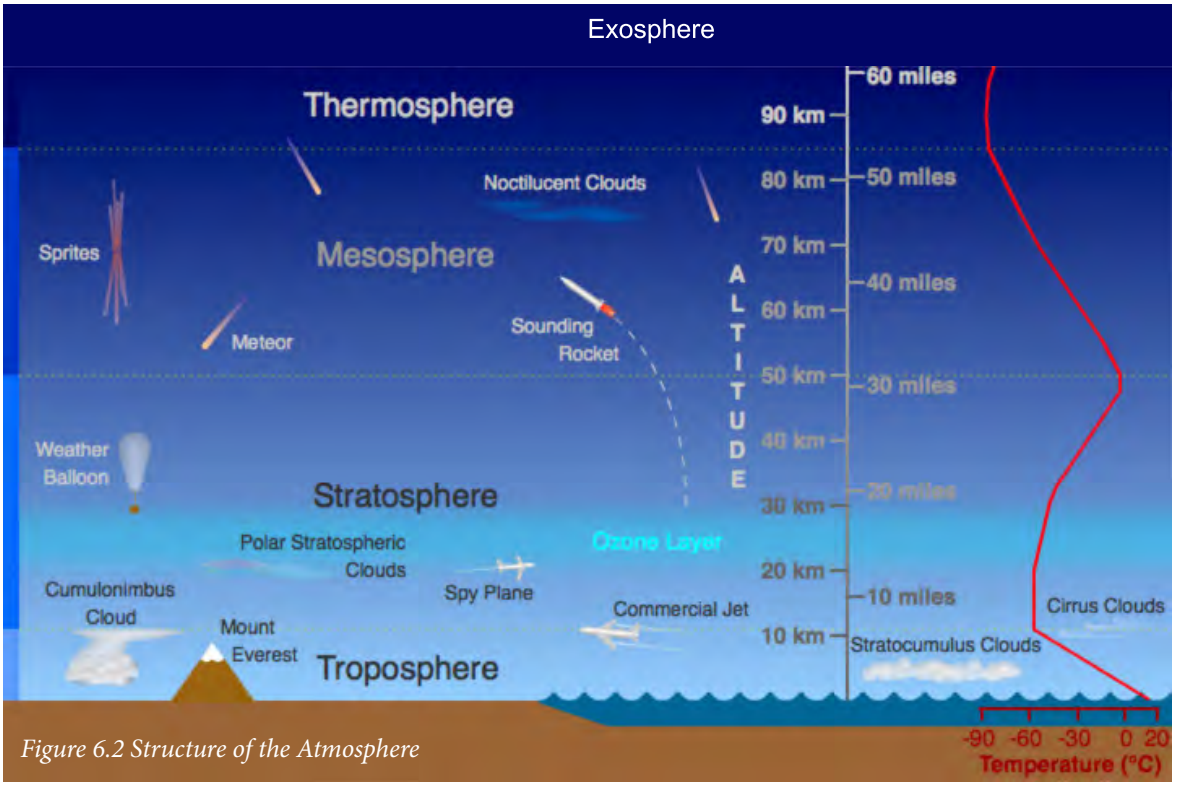

Figure 6.2 Structure of the Atmosphere

i. Troposphere

Troposphere is the lowest layer of the atmosphere that extends about 8 kilometers at the poles and 16 kilometers at the equator. Troposphere constitutes about 75% of the total gaseous mass of the atmosphere. The word 'tropos' means turbulence and all weather phenomena occur in this layer due to concentration of water vapour and aerosols. Temperature decreases with increase in elevation at the rate of 1° Celsius for every 165 metres.

Troposphere acts as a thermal insulation and moderates the temperature. Tropopause separates troposphere from stratosphere.

ii. Stratosphere

Stratosphere begins from tropopause and extends up to 50 kilometres. Temperature remains constant in the lower part of this layer as the radiation absorbed is equal to the

radiation emitted. This sub layer is known as isothermal zone. It is ideal for aviation as there is little vertical air movement.

The temperature increases beyond isothermal zone due to concentration of ozone. This sub layer is called ozonosphere. Ozonosphere absorbs ultraviolet radiation that results in temperature inversion. The upper boundary of the stratosphere is called stratopause.

iii. Mesosphere

This layer starts at stratopause and extends about 80 kilometres. Temperature decreases with increase in height due to thin atmosphere. Mesosphere protects the Earth from large meteoroids because the friction within this layer causes meteoroids to burn up leaving fiery trails in the sky at night. The boundary between mesosphere and thermosphere is called mesopause.

iv. Thermosphere

Thermosphere extends from the mesopause to about 500 kilometres. This layer is also known as thermal layer as it is the hottest layer of the atmosphere. The absorption of solar radiation by oxygen and nitrogen increases the temperature with height. It contains electrically charged particles of ions and is also called as *ionosphere.* These ions reflect radio waves to the Earth. Most of the world's satellites are placed in ionosphere, which is considered the first part of outer space. The boundary between thermosphere and exosphere is called thermopause.

v. Exosphere

Exosphere is the uppermost layer of the atmosphere that extends upward from the thermopause and gradually merges with the outer space. The air in the exosphere is extremely thin and finally fades away.

KNOW MORE

- Aerology is the study of the atmosphere.
- Richard Assmann (German) and Leon Teisserenc de Bort (French) are pioneers of Aerology.

Richard Assmann

Teisserenc de Bort

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Learning Activity:

1. Which layer of the atmosphere is most favourable to support life? Explain.
2. "Ozone depletion is one of the global concerns." In relation to the statement answer the following questions using internet or library books. Present it to the class.
   a. What is ozone depletion?
   b. Discuss the causes and consequences of ozone depletion.
   c. Suggest ways to minimise ozone depletion.

6.4 Weather instruments

There are various weather instruments. Some of the instruments are:

i) Thermometer

A thermometer measures air temperature of a place. The mercury in thermometer rises when temperature increases and falls when temperature decreases. Unlike water, mercury freezes at minus 39°C (-39°C) and boils at 357°C. The units for measuring temperature are degree Fahrenheit and degree Celsius.

Figure 6.3 Thermometer

ii) Aneroid barometer

An aneroid barometer measures air pressure or barometric pressure. It is a container that holds a sealed chamber from which some air has been removed, creating a partial vacuum. An elastic disc covering the chamber is connected to a needle or pointer on the surface of the container by a chain, lever, and springs. The increase or decrease in the atmospheric pressure makes the elastic discs contract or expand causing the pointer to move accordingly.

Figure 6.4 Aneroid barometer

KNOW MORE

Torricelli, an Italian scientist built the first barometer in 1643.

The barometer dial is marked in two scales as outer scale and inner scale. Outer scale shows the units in inches of mercury and inner scale shows air pressure in millibars. Change in air pressure indicates change in the weather.

Rising air pressure will indicate fair weather due to cooler and drier air, whereas falling air pressure indicates wet weather with warm and moist air. Air pressure is affected by temperature.

iii) Anemometer

An anemometer measures the speed and strength of wind. The most common types of anemometer have a mechanism that rotates as wind blows.

Anemometer consists of a vertical rotating spindle with four arms at the end. Four hemispherical cups are attached to the ends of each horizontal arm. The cups rotate and subsequently the spindle also rotates as the wind blows. The rotation of the spindle shows the wind speed. The speed of the wind is directly related to its strength. Wind strength is commonly reported on the Beaufort scale. The Beaufort scale rates the strength of wind on a scale of 0 – 12, zero indicates total calm and 12 indicates cyclone (exceeding 119 kilometres (approximately 74 miles) per hour).

Figure 6.5 Anemometer

Figure 6.6 Wind vane

iv) Wind vane

A wind vane is an instrument used to determine the wind direction. It consists of a freely moving arrow-shaped horizontal pointer mounted on top of a pole. The wind catches the tail of the arrow and swings the pointer to the direction from which the wind blows.

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v) Hygrometer (Dry and wet bulb thermometer)

A hygrometer measures relative humidity. It consists of two thermometers with dry and wet bulbs. The dry bulb remains dry in the air where as the wet bulb is attached to a cotton wick that is dipped in water. The wet bulb plays the main role in measuring humidity.

A hygrometer works on evaporative cooling process. When water evaporates from any surface, it becomes cool as water molecules take heat energy from the surface. Due to this cooling effect, the wet bulb always shows a lower temperature than the dry bulb. The air is saturated when the reading is 100%.

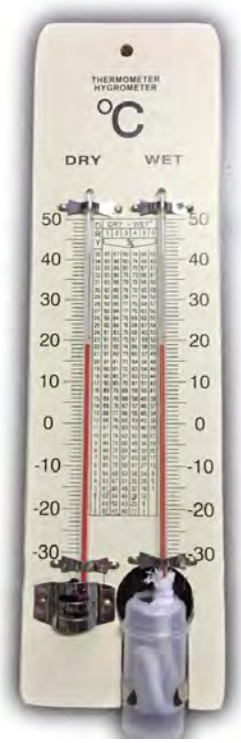

Figure 6.7 Dry and wet bulb thermometer

Figure 6.8 Rain gauge

vi) Rain gauge

A rain gauge is an instrument used to collect and measure the amount of liquid precipitation over a set period of time. Most standard rain gauges have a wide funnel leading into a cylinder that is marked in centimeters/millimetres. Rain water is collected in a funnel-shaped collector that is attached to a measuring tube. An amount of rainfall collected is measured in a measuring cylinder.

The amount collected is insignificant to be measured during light rain or drizzle. However, any snow collected in the funnel is measured when it melts.

Learning Activity:

1. Rearrange the letters to name the weather instruments.
2. Match the names with the picture number and functions.

maemeonert	rebamorte	Nwid nave	temtemhreor	Irna uggae
				

Test yourself:

1. Which layer of the atmosphere favours air transport? Explain.
2. Troposphere is thicker at the equator than the poles. Discuss.
3. One of the greenhouse gases (GHG) is carbon dioxide. Explain how increase in the amount of carbon dioxide in the atmosphere causes global warming?
4. Why is mercury used in thermometer?
5. Suggest measures to reduce the amount of carbon dioxide in the atmosphere.

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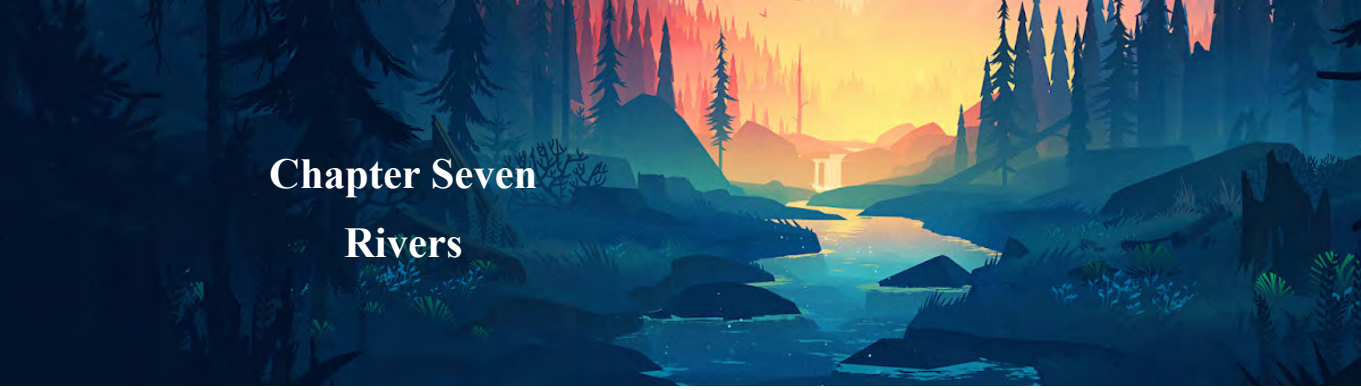

Chapter Seven

Rivers

Learning Outcome(s):

- Explain the sources of river with the help of a diagram
- Describe river as an important agent of gradation
- Discuss various features formed by rivers in different stages with the help of diagrams
- Evaluate the importance of river in the socio-economic development

7.1 Introduction

A river is a natural flow of water through a channel on the surface of the Earth. Rivers are a part of the hydrological cycle. It is one of the agents of gradation. Rivers are responsible for the formation of land features along its course. It is a source of water for irrigation, hydroelectricity generation and industries. Increase in developmental activities pose threat to rivers. Thus, conservation and protection has become necessary for river sustainability.

7.2 Sources of river

The source of a river or stream is the point from where the river originates. A river often has many sources and it is difficult to trace the main source. It often starts as a small stream but gathers water from numerous other sources such as springs, rainwater, bogs, marshes and lakes. Most of the rivers in Bhutan originate from melting glaciers.

Learning Activity:

Developmental activities pose a threat to water sources. Design a poster to suggest measures to conserve water sources and display in the class.

7.2.1 Hydrological Cycle

The hydrological cycle is responsible for most of the water on the Earth. Water continuously circulates from the oceans, sky and land through physical processes such as

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evapotranspiration, condensation, precipitation, infiltration and surface runoff.

The Sun's heat causes evaporation and transpiration. The increase in altitude causes the rising water vapour to condense and form clouds. Condensation continues and then leads to precipitation. The water falling on the land collects in rivers, lakes, soil and porous layers of rock, while much of it flows back into the oceans.

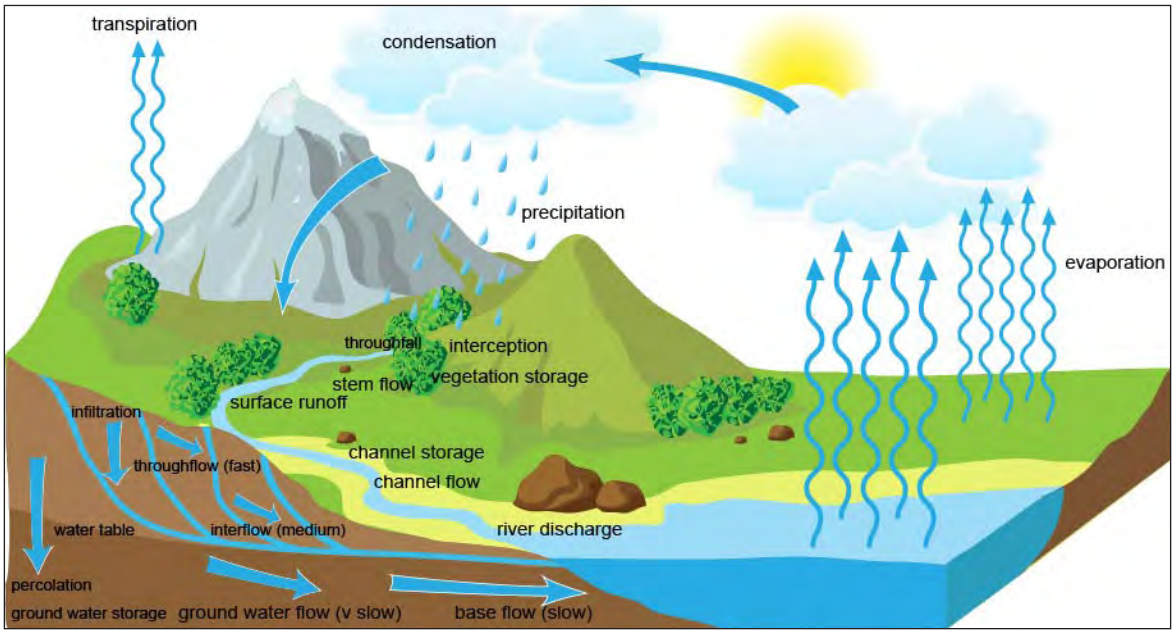

Figure 7.1 Sources of river

KNOW MORE

- Longest river in the world is Nile which stretches 6650 kilometres, flowing through 11 countries.

7.3 Denudation work of rivers

Denudation is the process by which the land areas are continually being reduced and reshaped. The agents of denudation are running water, glaciers, wind and waves. Rivers are one of the most widespread agents of denudation. Work of rivers involves erosion, transportation and deposition.

7.3.1 Erosion

Erosion is the process of wearing down of the Earth's surface. The rate of erosion is higher in mountainous regions due to high river velocity. Erosional works of rivers are:

i) Abrasion/Corrosion

Abrasion is wearing away of the river bed and banks by the grinding of materials carried by the river. This results in widening and deepening of the river channel.

ii) Hydraulic Action

Hydraulic action involves erosion of river beds and banks by the force of flowing water. It is more prominent during floods.

iii) Attrition

Attrition is the breaking down of river load into smaller particles due to constant collisions against each other and with river beds and banks.

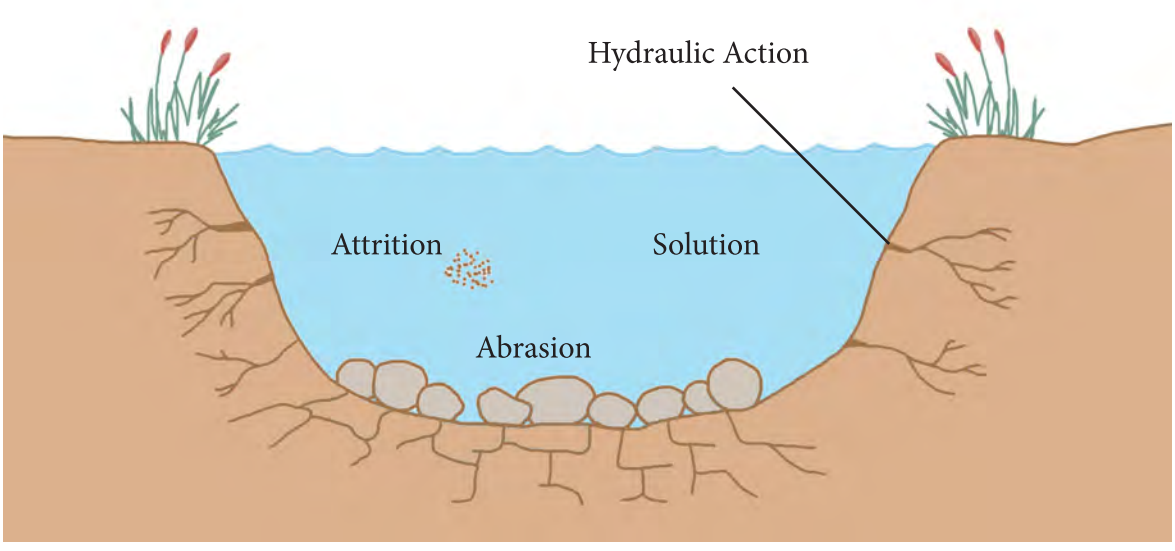

Figure 7.2 Erosion processes of river

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iv) Solution/ Corrosion

Some minerals in rocks dissolve in water. This process weakens the rocks and gets easily eroded by abrasion.

7.4.1 Types of erosion

i) Headward Erosion

Erosion by the river at its source is known as *Headward* erosion. This leads to lengthening of the stream channel. It is also called backward erosion.

ii) Vertical Erosion

The fast flowing rivers in the upper stage rodes the river bed vertically deepening the valley. This is also known as downward erosion.

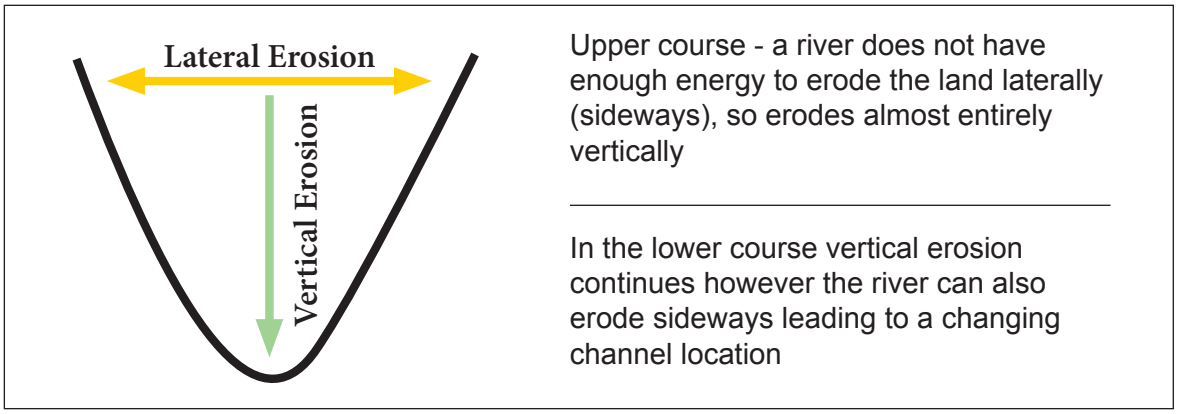

Figure 7.3 Erosion processes of rivers

iii) Lateral Erosion

The speed of the river decreases in the mature stage. This results in eroding the banks and widens the valley. This process is also called sideward erosion.

7.4.2 Transportation

Rivers carry rocks, stones, sand, silt and clay from one place to another. These materials are referred to as river load. Transportation is dominant in the middle course of a river. A river transports its load in four ways:

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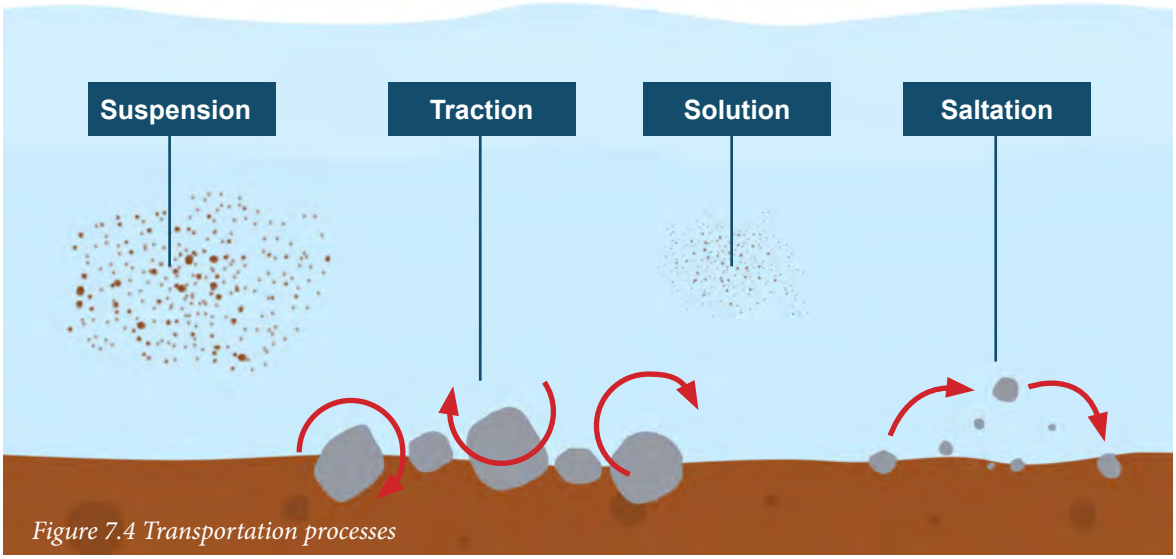

Figure 7.4 Transportation processes

(i) ***Traction:*** It is a process of rolling and pushing large material such as boulders along the river bed by the force of river water.

(ii) ***Saltation:*** The process of transporting medium sized materials like gravels by bouncing on the river bed is called saltation.

(iii) ***Suspension:*** It is a process of transporting fine particles such as clay and silt as a result of turbulence. During the rainy season turbulent rivers carry more suspended materials which make rivers appear muddy.

(iv) ***Solution:*** The process of transporting river load in the form of a dissolved mineral and salts is known as solution. It is prominent in limestone areas.

7.4.3 Deposition

Deposition is the process of dropping the eroded materials by river. This process occurs due to the decrease in gradient and velocity of a river. It occurs in areas where a gradient is less, at the confluence, and when a river meets the sea.

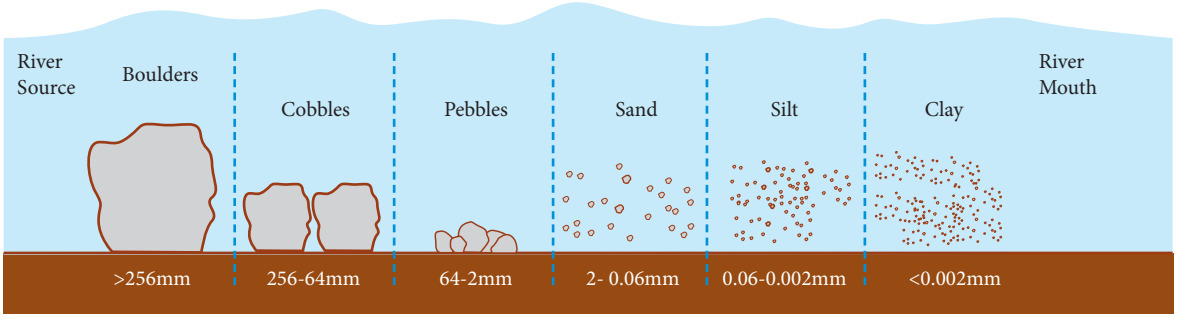

Figure 7.5 Order of deposition

Learning Activity:

The transport capacity of a river increases with increase in volume of water. Why is transportation minimum in the old stage despite having maximum volume of water? Discuss.

7.5 Factors affecting the work of a river

The work of a river is affected by the following factors:

i) The gradient

Process of denudation by the river depends on the gradient of the slope which determines the velocity of river. On the steeper slope, the river flows at a greater speed and the erosion along with transportation work is more dominant than the deposition. In plains, the velocity of river is low and erosion is also comparatively less whereby deposition work becomes most active.

ii) Volume of water

Increase in volume and velocity of a river causes more erosion creating a wider and deeper river channel in the upper courses. In the plain areas, the increased volume of a river results in the deposition of materials due to reduced velocity.

iii) The shape and size of the channel

The shape and size of the channel affects the velocity of a river. Water flowing through a wide, deep river channel encounters less resistance than water flowing in a narrow and shallow channel.

7.6 Features formed by a river

A river forms different landforms from its source to its mouth. The type of landforms formed differs from one stage to another.

7.6.1 Upper stage

The upper course of a river starts from its source and flows through steep gradients. The volume of river is low and flows with high speed. Erosion is the main work of the river and some of the features formed in this stage are:

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i) Gorge and Canyon

A gorge is a deep valley with steep and rocky side walls. They are formed due to active down-cutting and deepening of the valley. The deeper and narrow gorge, usually with a river flowing through it, is called a canyon.

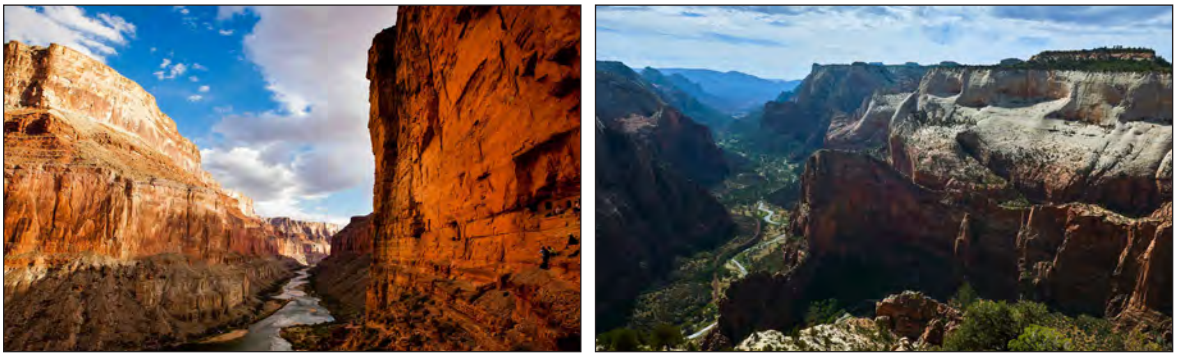

Figure 7.6 Gorge and Canyon

ii) V-shaped valley.

A V-shaped valley is a v-shaped depression formed when vertical and lateral erosions are carried out simultaneously by a river. It is formed in areas of moderate rainfall where the rocks are generally soft.

Figure 7.7 V-shaped valley

iii) Water fall and Plunge Pool

A water fall is a sudden plunging of a river vertically from a high cliff with great force. It is formed when a river encounters a layer of hard rock overlying soft rock across its path. A river erodes the soft layer more easily than the hard rock. This leads to the formation of a cliff over which the water falls.

A plunge pool is a pool created by force of the falling water. The small debris wears away the base of a water fall forming a depression.

Figure 7.8 Water fall and Plunge Pool

iv) Interlocking spurs

An interlocking spur is a feature formed when a number of projecting ridges extends alternately from the opposite sides of a V-shaped valley. A river flows down winding between the overlapping spurs.

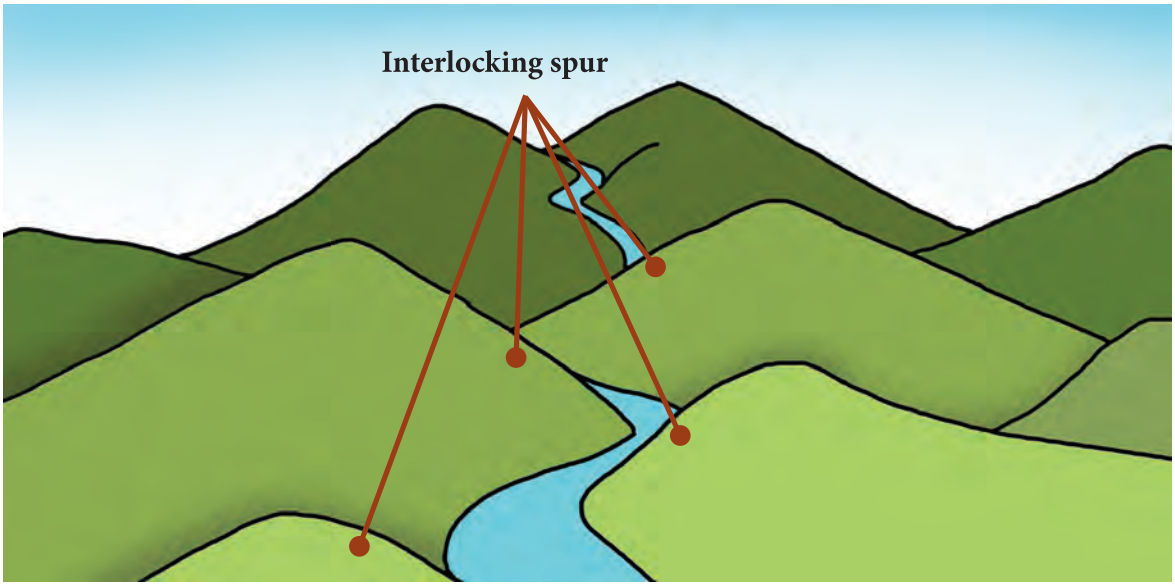

Figure 7.9 Interlocking spurs

v) Rapids and Cascade

Rapids are sections of a river where water flows fast over undulating bed. Sometimes, hard and soft rocks are arranged at right angles across the river course. Soft rocks are eroded quickly while the hard rocks are resistant and maintain its position. This leads to the formation of rapids. A series of rapids across a river is known as cascade.

Figure 7.10 Rapids

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vi) Potholes

A pothole is a depression formed in the river bed that varies in depth and diameter. Soft rocks on its course get eroded when water eddies and whirls pluck sediments forming deep and cylindrical depression.

Figure 7.11 Potholes

7.6.2 Middle stage

In the middle stage, a river flows through a gentle slope. There is decrease in speed and increase in volume of the water. Transportation is the main work while deposition and erosion also take place. Some of the features formed are:

i) Alluvial cones

A cone shaped accumulation of thick coarse alluvial materials at the foothills of a mountain is called as alluvial cone. The deposition is caused due to a sudden decrease in slope and velocity of a river.

Figure 7.12 Alluvial Cones

ii) Alluvial fan

An alluvial fan is a fan-shaped alluvial deposit found at the foot of a mountain. It is formed by deposition of sediments when there is sudden decrease in velocity of a river due to decrease in slope. It is broad with gentle slope compared to an alluvial cones. Alluvial cone may turn into alluvial fans in due course of time.

Figure 7.13 Alluvial Fan

iii) U-shaped valley

A U-shaped extended depression formed by a river is called U-shaped valley. It is characterized by steep sides and a flat or rounded bottom. It is formed when lateral erosion is more active than vertical erosion.

Figure 7.14 U-shaped valley

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7.6.3 Lower Stage

A river flows slowly over plain areas. The carrying capacity of a river is drastically reduced due to decrease in velocity and increase in volume. Deposition is the main work in this stage. Landforms formed are:

i) Meander

Meander is a winding path or bends of a river. It is formed when moving water erodes the outer banks and deposits silt on the inner banks. It is caused due to decrease in gradient and velocity. Meanders are formed both in middle and lower courses.

Figure 7.15 Meanders

ii) Braided stream

It is a river in which the main channel is divided into a complex network of shallow converging and diverging streams, separated by bars of sand and islands. It is formed when the river is unable to carry the load. So the river is forced to flow around the deposits making into different channels.

Figure 7.16 Braided stream

iii) Natural Levee

Natural Levee is a deposit of sand or mud along either side of the flood plain of a river. Levees are natural embankment of a river which confines the river within its channel and prevents flooding.

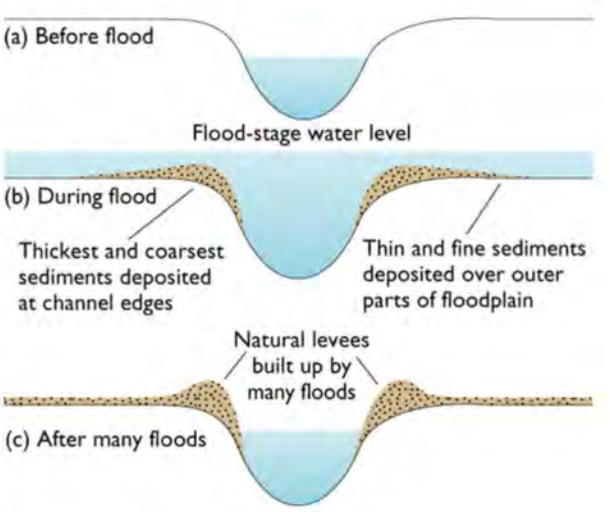

Figure 7.17 Formation of Natural Levee

iv) Flood plain

A flood plain is an area of low lying ground adjacent to a river. It is formed by deposition of sediments during a flood when a river overflows the banks. Flood plains are relatively flat and broad.

Figure 7.18 Flood plain

v) Ox-bow lake

An ox-bow lake is an abandoned meander loop created when a river breaks across the neck of a well-developed meander. It is formed over a time as erosion and deposition change the river's course. The meandering river erodes its outer bend and deposits in the inner bend. This process continues and finally results in cutting across the narrow neck of a bend leaving behind a loop of stagnant water.

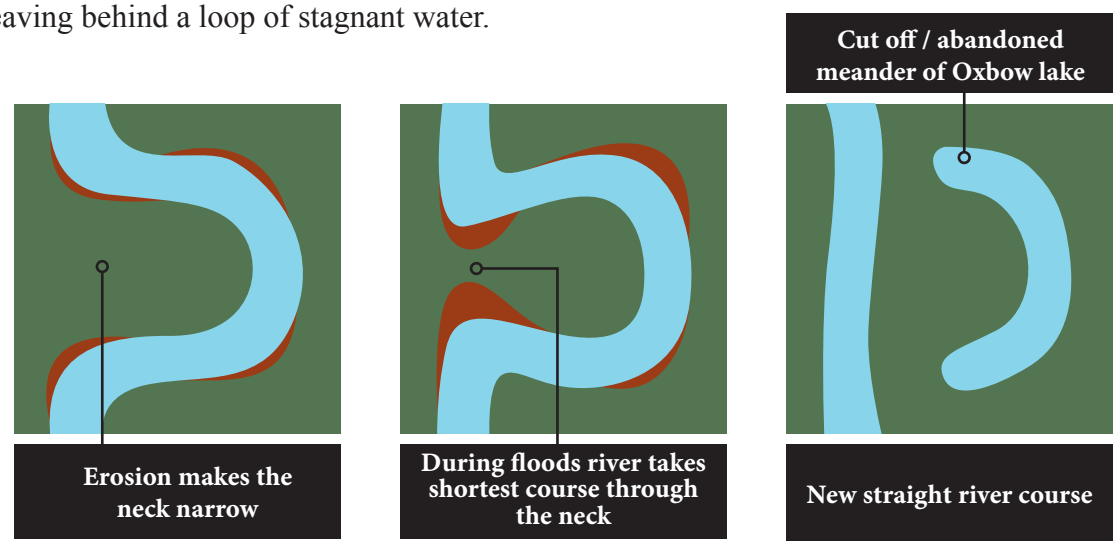

Figure 7.19 Formation of an Ox-bow lake

Figure 7.20 Delta

vi) Delta

Delta is a fan-shaped triangular alluvium tract of land which is deposited at a mouth of a river. It is formed when a main channel is blocked by deposits and a river is forced to divide into several channels. These channels are known as distributaries that discharge sufficient deposits on its way before entering into a sea.

7.7 Importance of rivers

Bhutan has an abundance of fresh water in the form of perennial rivers. Rivers are important natural resource for the socio-economic development of the country. Rivers play an essential role in agriculture, hydropower, tourism and industries.

Livelihood of people depend mostly on agriculture which uses water resources for irrigation. Major settlements in Bhutan are found along the river valleys due to the availability of water and fertile soil.

Figure 7.21 Irrigation canal

Learning Activity:

Discuss human-environment interactions along a river from its source to the mouth and list the land use along a river. (Land use may include settlements, farms, industries etc.) Fill up the columns with necessary information in a chart.

Land use	Impacts on environment	Impacts on humans

Rivers in Bhutan have huge hydropower potential of producing over 30,000 Megawatts. It is one of the main sources of revenue for the country. The first mega hydro-power plant was built in 1986 with 336 Megawatt over Wang Chhu in Chukha.

The development of tourism industry greatly depends on factor such as attraction, accessibility and adequate infrastructure facilities. Thus, rivers flowing through beautiful valleys play an important role in attracting tourists.

Rivers provide building materials such as sand and boulders. Industries and automobile workshops also depend on water.

Conservation of rivers is very important. It can be done by protecting its source, reducing pollution and minimizing the wasteful use of water.

Figure 7.22 A dam

Figure 7.23 River Rafting

Figure 7.24 Quarrying of Sand

Test Yourself:

1. Many rivers in Bhutan are fed by glaciers which are retreating due to climate change. Do you think construction of hydro-power plants will sustain the socio-economic development in the long run? Justify.
2. Which type of landforms are commonly found in Bhutan? Explain.
3. Why do river channels in the lower course tend to be wider than the upper course?
4. Why do steep gradient rivers transport large sediments?
5. How do developmental activities in an area affect the river system?
6. How would building a dam or water treatment plants affect a river?
7. River systems have helped agriculture and harnessing hydro-electricity in Bhutan. Analyse the role of rivers in the socio-economic development of a country.
8. Suggest measures to control river pollution.

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Chapter Eight
Population Distribution

Learning Outcome(s):

- Explain the factors affecting the distribution of population
- Interpret data on distribution of population
- Discuss population pyramid

8.1 Introduction

Population is unevenly distributed in the world. There are different factors responsible for the distribution of population. Distribution of population across the place differs in density from one region to another. The study of spatial distribution and its density helps to understand population distribution. A population pyramid helps in understanding population distribution in terms of sex and age groups.

8.2 Population Density

Population density is the number of people living in a unit area and it varies widely. It provides information on the concentration of people living in an area. Population density is calculated by dividing the number of people by the geographical area. This type of density is known as the Arithmetic density. It is expressed as:

$$\textit{Arithmetic density of population} = \frac{\textit{(Total Population)}}{\textit{(Total Area)}}$$

However, there is another type of density known as physiological density. The physiological density of population is the ratio of total population to the total cultivable land available in that country. It is expressed as:

$$\textit{Physiological density of population} = \frac{\textit{(Total Population)}}{\textit{(Total Cultivable Area)}}$$

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Learning Activity:

The 2017 PHCB revealed that as of 30 May 2017, total Bhutanese population was 681,720 persons. However, the arable land is 3071.52 km² of the total area of 38,394 km².

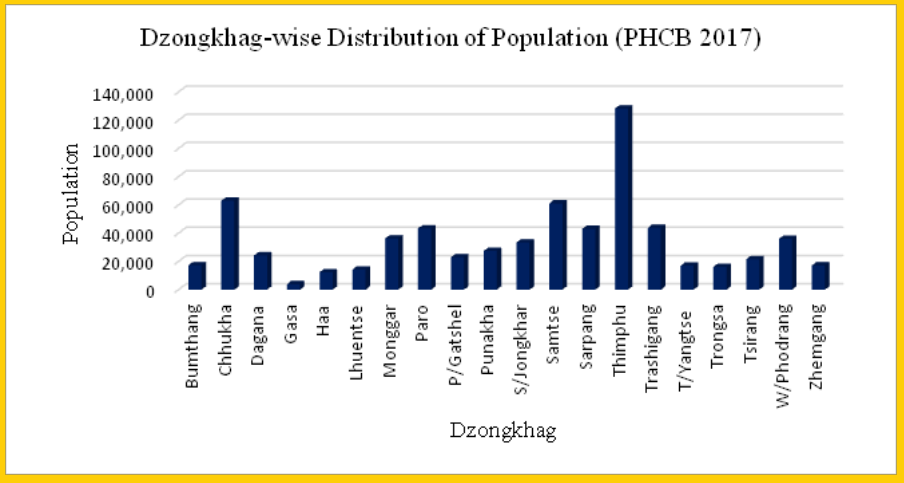
1. Calculate the arithmetic and physiological density of Bhutan.
2. Find the population density of your dzongkhag using population figures of PHCB 2017 and present it in the class.

8.3 Spatial population distribution

Population distribution is the spread of people across a place or region. The population is unevenly distributed in the world. Some places are densely populated while others are sparsely populated. Sparsely populated places tend to be difficult places to live. These are usually the places with hostile environments like Antarctica. In contrast, places with favourable conditions attract more people and are densely populated like Bangladesh. Population distribution is also uneven within a country. For example, the northern part of Bhutan has a lower population density than southern foothills. In the north, the relief is mountainous with harsh climatic conditions; however, in the south, the relief is flat with favourable climatic conditions.

Learning Activity:

Study the graph and answer the following questions:



1. List five most populated and five least populated dzongkhags.
2. What would be the situation of population distribution in Bhutan 10 years from now? Give your justification.

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Learning Activity:

If you were to settle anywhere in the world, where would you settle and why?

8.4 Factors affecting population distribution

Population distribution is a social phenomenon caused by the combination of various factors. The factors affecting distribution of population differ from one region to another and these factors are:

1. Topography

Topography is the physical landscape of an area. It is an important factor which influences the growth and distribution of population. Plain areas have higher density of population than the mountainous regions. The mountain slopes limit the availability of land for agriculture, development of transport, industries and other economic activities.

Figure 8.1 Settlement in steep terrain and dense settlement in flat area

2. Climate

Temperate areas experience moderate climate and attract more people than areas with extreme climatic conditions. Temperature and rainfall are two main influential climatic elements. There are less people settled in desert due to extreme temperature and less rainfall. The tundra region is also sparsely populated due to harsh climatic conditions.

Figure 8.2 Settlement in desert

3. Soil fertility

River valleys are usually fertile because of the deposition of sediments by the river. Areas with rich and fertile soil allow successful agricultural activities, which leads to have higher population densities than areas which have infertile soil.

Figure 8.3 Fertile area

4. Availability of water

Availability of water plays a significant role in determining the population of an area. It is used for domestic, irrigation, industries and transport. River is one of the important sources of water and most of the population is concentrated in the river valleys.

5. Mineral resources

Availability of minerals in an area attracts people from different places, which results in higher density of population. The same place is abandoned by the people after the minerals are exhausted and it becomes a dead town.

Figure 8.4 Settlement a site near mining

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6. Industrialisation

Industrialisation offers employment opportunities and acts as an attraction centre for people, particularly from the neighbouring areas. Hence, industrial areas are associated with areas of high population densities.

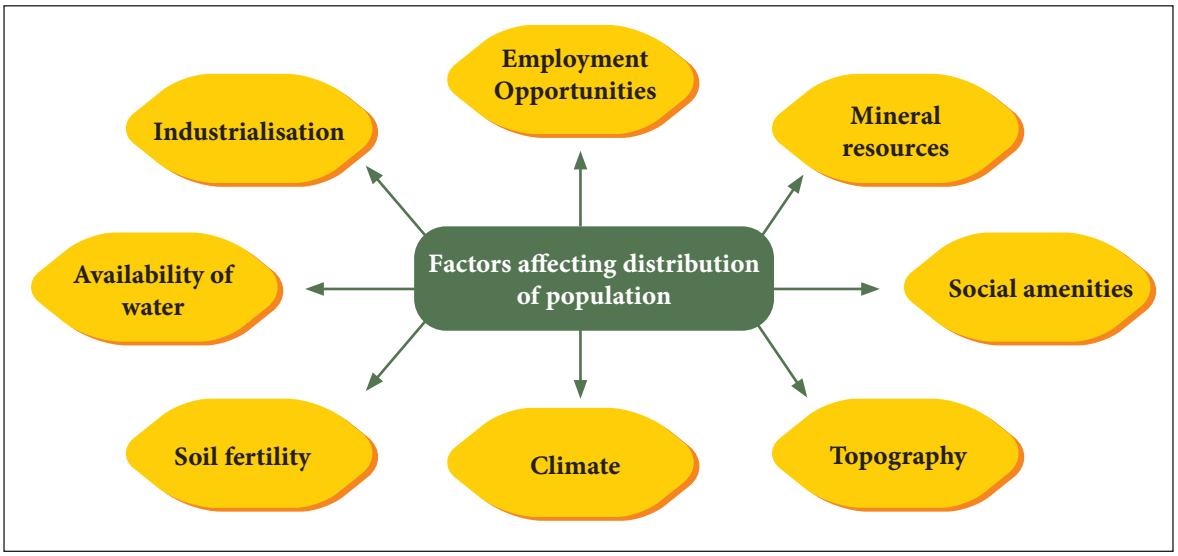

Figure 8.5 Factors affecting distribution of population

Learning Activity:

Thimphu is the most populated city in Bhutan with a population density of 67 persons per square kilometre as per PHCB 2017. People from other parts of Bhutan are attracted to Thimphu due to employment opportunities and social amenities.

How do employment opportunities and social amenities affect distribution of population in Bhutan?

Case Study

Population Distribution of China

Jobs is one reason for population distribution. This is because of peoples drive to earn more money and support their family. So they move to areas that have a job opportunities that fit their qualifications, most of these jobs are towards the east of China.

It's in the east where we find the oceans and rivers needed to facilitate communication and transportation. So because of these key ingredients, China was able to construct buildings, urbanize causing massive population growth in the east.

China's east coast ended up being to densely populated because that's where the rivers, sea-shores, and canals to ship soldiers, food, and goods are located.

So without the people wanting to find jobs to earn money to support their families and move away from the more rural areas, the east coast of China wouldn't be so densely populated.

Climate is another cause of population distribution because the people who would potentially live in that area would have to be comfortable with the temperature, too hot and nobody will like it, too cold and people will freeze so it is important that people feel comfortable with the temperature.

Some of the unfavourable factors such as steep slopes, frequent floods, infertile soils cause people to move to places with flatter land, dryer conditions and warmer temperatures, like the Huabei Plain, the land is flat and it is close of the coast which is good for trading, the overall climate would be better here. Recently in south China in a province called Guizhou there have been floods, hail and landslides, leaving many homeless. It is the climate like this that causes people wants to move.

Answer the following questions with reference to the article:

1. Discuss the factors affecting uneven distribution of population in China and present to the class.
2. Compare and contrast the factors affecting uneven distribution of population in Bhutan and China.

8.5 Population Pyramid

A population pyramid is a graphical illustration that shows the distribution of male and female within different age groups in a population. The growth of population determines the shape of a pyramid. Population pyramids of developing countries normally have a wide base and a narrow top. This represents a high birth rate and high death rate.

Population pyramids of developed countries normally have a roughly equal distribution of population throughout the age groups. The top gets narrower as a result of deaths.

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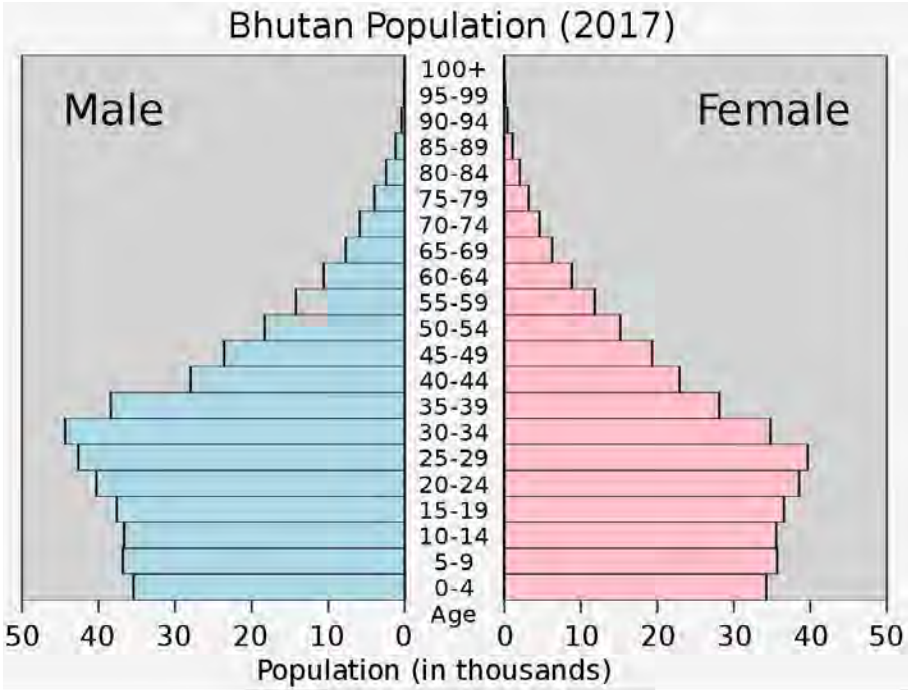

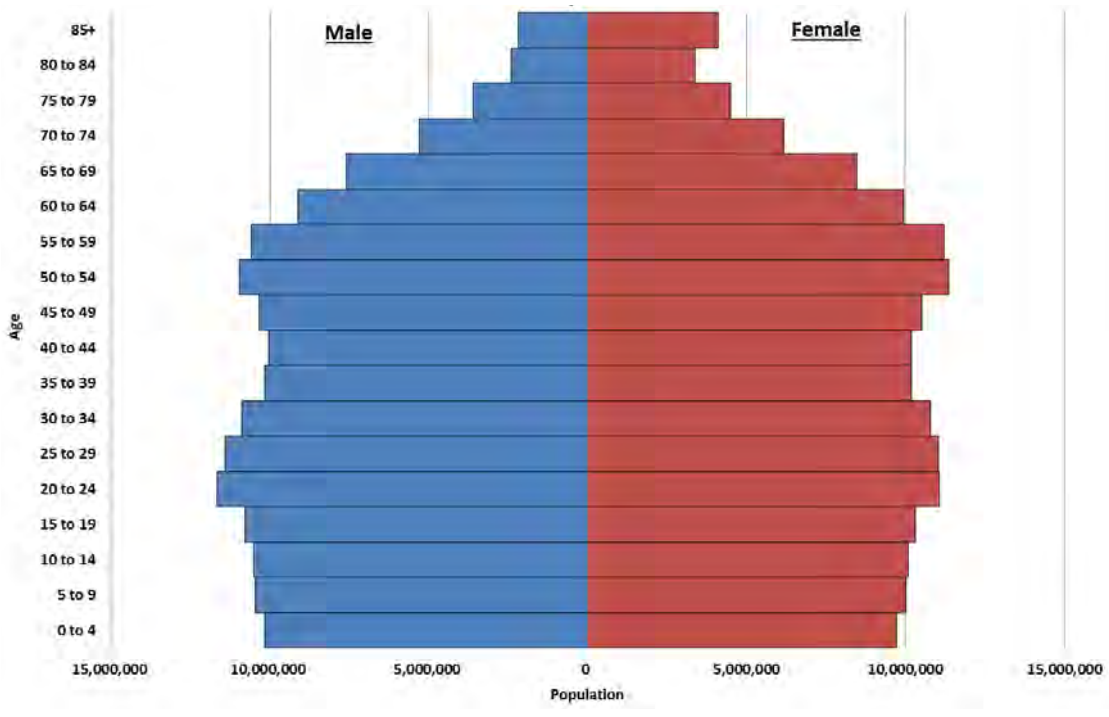

Figure 8.6 Population pyramid of Bhutan and United States of America

Learning Activity:

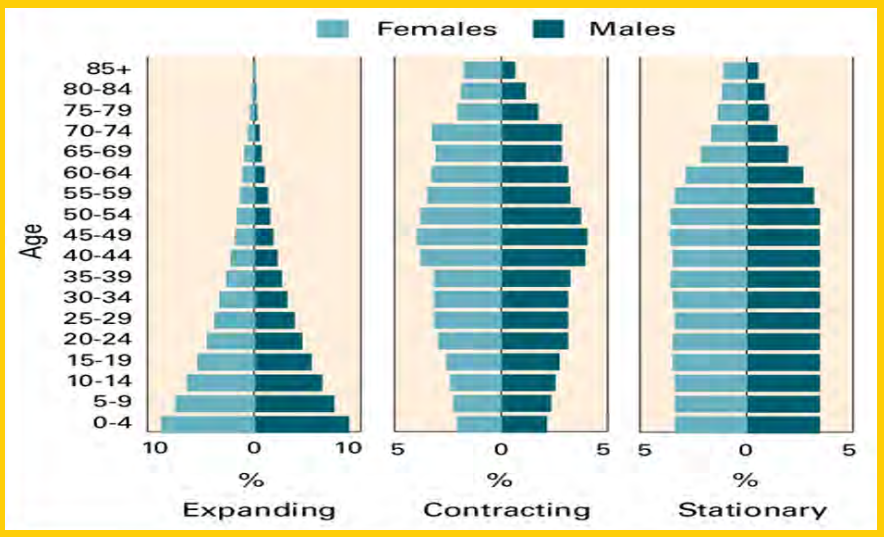

Figure 8.7 Types of population pyramid

Study figure 8.7 and answer the following questions.

1. Describe the characteristics of each population pyramid.
2. Discuss the impacts of population distribution on the country's development if the population pyramid is of contracting type.

Test Yourself

1. Differentiate between arithmetic and physiological density of population.
2. Which factors play a vital role in distribution of population? Why?
3. What do you understand by Population Pyramid? Mention its characteristics.
4. Use the picture to answer question 4a and b.

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a. Identify possible factors which have led to the concentration of population.
b. Bhutan does not have such population distribution scenario. Why?

5. Draw a pie chart for the table displaying the countries with least population in the world.

Country	**Total Population**
Vatican City	801
Tuvalu	9943
Nauru	10263
Palau	21501
San Marino	31950

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Chapter 9
Settlement

Learning Outcome(s):

1. Discuss hierarchy of settlement
2. Explain the factors affecting settlement
3. Describe the change in rural settlement

9.1 Introduction

Settlements differ in size, population, infrastructure and development. Some settlements develop rapidly while others change slowly or become abandoned over time. The change in settlements depends on various factors. Settlements which are close to urban areas have changed rapidly over time due to different factors. This has changed the functions of some settlements.

9.2 Hierarchy of settlement

A settlement hierarchy is an arrangement of settlements ranked based on their size, functions and population. However, population size is not a reliable determinant of ranking urban settlements as it is used variably in different countries. For example, the population size of urban settlements in Bhutan is smaller than rural settlements in India.

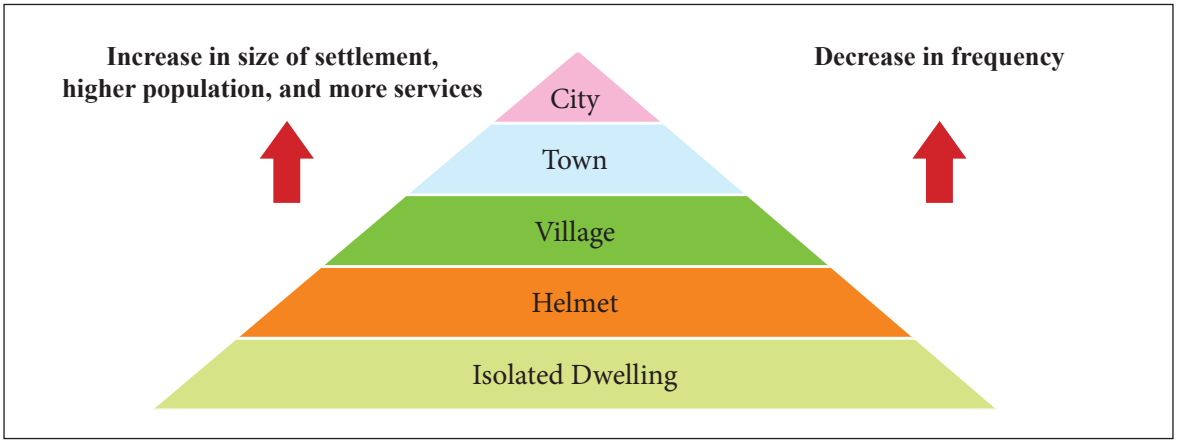

Figure 9.1 Hierarchy of settlement

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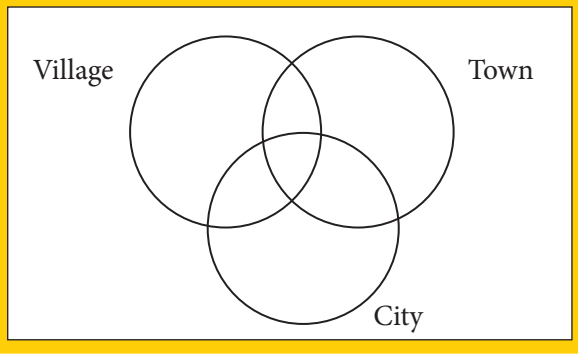
In settlement ranking, settlements with the lowest population and basic services are placed at the bottom of the hierarchy. Settlements in the lower categories are expected to be more in number as they require less infrastructure and facilities to sustain. Settlements grow in size and services with change in rank but the number decreases.

Learning Activity:

A list of services available in settlements are given. Write the number of services in an appropriate part of the Venn diagram. Services that apply to more than one type of settlement should be placed in the overlapping section.

1. Post office
2. Primary School
3. Football ground
4. Hospital
5. Shopping centre
6. Doctor
7. Several shops
8. Shop for daily goods
9. Bank
10. Basic Health Unit
11. Veterinary hospital
12. College
13. Bus station
14. Secondary school
15. Large shopping complex
16. Airport
17. Lhakhang
18. Hotels
19. Supermarket
20. Museum



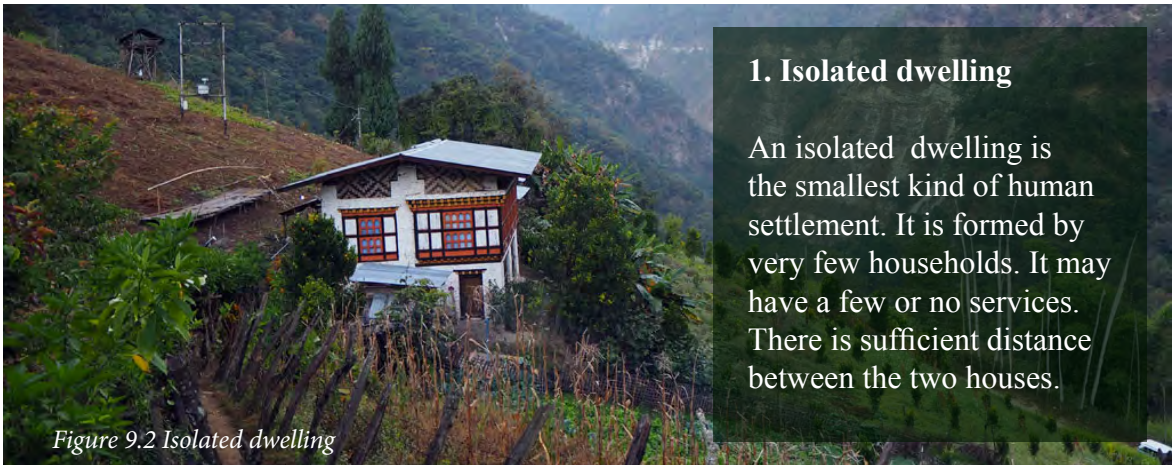


Figure 9.2 Isolated dwelling

1. Isolated dwelling

An isolated dwelling is the smallest kind of human settlement. It is formed by very few households. It may have a few or no services. There is sufficient distance between the two houses.

2. Hamlet

A hamlet is a tiny settlement larger than an isolated dwelling. It consists of a group of houses, surrounded by farmland. A hamlet generally has less than 100 people and might have a few basic services.

Figure 9.3 Helmet

3. Village

A village is larger than a hamlet but smaller than a town. Basic services such as a school, health facilities and roads are available in the village. The population ranges from a few hundred to a few thousand.

Figure 9.4 A Village

4. Town

A town is a medium-sized settlement with more and better services. It is characterised by the presence of many shops and service centres such as hospital, bank and telecommunication. The population of a town is more than a few thousand. Majority of the people are engaged in secondary and tertiary activities.

Figure 9.5 A Town

5. City

A city is a large settlement. It has lots of amenities and the population is usually over a hundred thousand people. A city provides a wide range of services. It is characterised by tall buildings, shopping complexes and has high population density. Most of the people in the city are engaged in business, service and manufacturing industries.

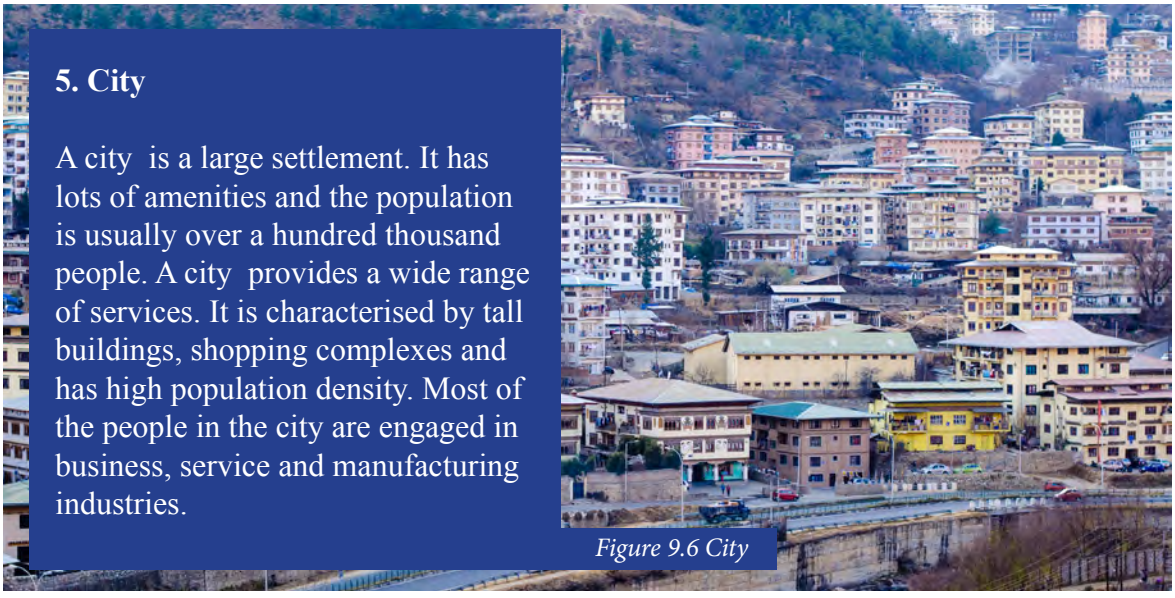


Figure 9.6 City

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Learning Activity:

1. Think of a settlement you live in and answer the questions:
   a. List services and functions that are available in the settlement.
   b. Which category does your settlement fall? Why?

2. Find the terms related to settlement.

b	p	a	t	t	e	r	n	a	l	q	o	y	l	h
k	r	a	p	e	c	n	e	i	c	s	e	t	i	s
g	n	o	i	t	a	u	t	i	s	l	t	i	d	k
p	n	o	w	u	a	h	i	e	r	a	r	c	h	y
b	u	s	i	n	e	s	s	p	a	r	k	r	y	u
f	c	f	x	t	f	d	d	b	g	u	i	e	f	t
q	l	u	k	l	a	i	l	m	a	r	j	n	w	n
r	e	n	o	i	t	s	e	g	n	o	c	n	u	e
e	a	c	o	n	b	p	i	l	t	b	y	i	r	m
t	t	t	s	e	y	e	f	n	d	c	o	a	b	e
a	e	i	x	a	p	r	n	d	a	s	y	w	a	l
i	d	o	v	r	a	s	e	i	n	b	i	c	n	t
i	a	n	d	u	s	e	e	f	h	s	r	t	u	t
b	r	u	b	u	s	d	r	k	b	n	g	u	e	e
l	o	s	l	l	a	m	g	n	i	p	p	o	h	s

9.3 Factors affecting settlements

There are many factors responsible for the location of settlements. These factors are:

1. Physical factors

The physical factors of a place like relief features, climatic conditions, fertile soil and water supply determine the location of a settlement. Settlements develop in a place where there is a presence of one or more of these factors. The ancient civilizations originated along the river valleys due to availability of water and fertile soil. Settlements in the past developed in a strategic location like hill tops for protection.

2. Economic factors

The economic factors like availability of natural resources, transport and communication play a vital role in development of settlements in an area. Settlements start in a place

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where resources are available and communication is easier. In the past, settlements developed along the river valley where it was possible to bridge with the settlement located on the other side. The rural settlement resulting from economic factors may either develop into an urban settlement or disappear.

Learning Activity:

Sonam is a farmer in remote area of Chukha Dzongkhag. After the opening of a new road from Damchu to Chukha in 2018, he has moved and settled near the highway.

Using Paint Net or MS Paint program, draw a picture of Sonam's new place. In your drawing, show how he is benefited or affected by living near one of the busiest highways in Bhutan? Print and paste your drawing in the class.

3. Cultural factors

Cultural factors like land tenure, agriculture and social customs affect rural settlements. A land tenure system involves a landlord owning large acres of land and leasing it to landless farmers for cultivation. These farmers start living in and around the leased land leading to expansion of settlements.

Land inheritance system also affects the settlement. This practice leads to land fragmentation, which results in additional households forming new settlements. Some settlements have developed around places of religious significance.

Figure 9.7 Settlement at Gangtey

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Learning Activity:

Choose a site for settlement in the area of land shown in figure 9.8. Observe the places labeled A to E, and discuss the advantages and disadvantages of each site. Present your observations to the class.

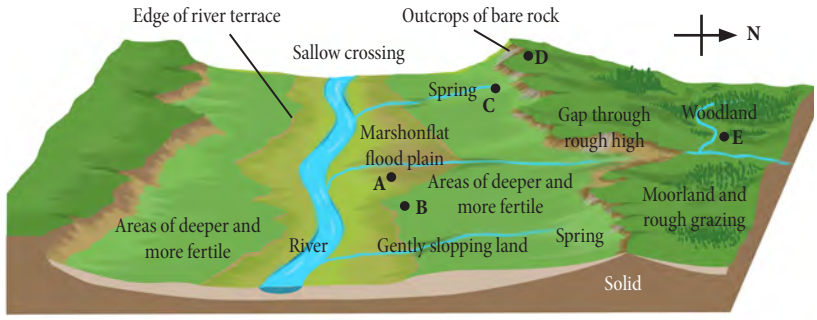

Figure 9.8 Sites of settlement

9.4 Changing Settlements

Settlements change over time. It becomes big or small depending on various factors. This change can be seen in the form of expanding settlements or abandoned houses.

Rural settlements are usually characterized by people engaged in primary activities such as agriculture. It is generally a small size settlement with limited social infrastructure. The settlement can expand with the development of infrastructure and growth of population. It will gradually become an urban settlement. For example, Thimphu was a group of small villages in 1960s.

Figure 9.9 Thimphu in 1960s

Figure 9.10 Thimphu in 2018

Learning Activity:

1. What changes have you noticed in the settlement where you live?
2. List features that have disappeared and developed in recent years in the settlement.
3. Why has your settlement changed?

Test Yourself:

1. Study figure 9.11 and answer the question.

Figure 9.11 Settlements

2. There are 89 empty houses (Gungtongs) in Kangpara gewog, Trashigang. Some of the houses in the gewog have been abandoned for more than two decades as of 2017.
   Discuss the impacts of increasing Gungtongs on the community.

3. A large percentage of the population in developed countries live in urban settlements while in developing countries a majority of the population live in rural settlements. Give reasons.

4. Ask the following questions to someone who has lived in your locality for a long time:
   i. What changes have you observed in your settlement over the last 10 years?
   ii. What do you think are the possible reasons?
   iii. Are you happy with the changes? Why?

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CHAPTER 10
NATURAL ENVIRONMENT

Learning Outcome(s):

- Describe the components and types of ecosystems
- Explain the structure and function of ecosystem
- Identify natural and human induced factors responsible for change in the ecosystem

10.1 Introduction

The natural environment is a unit consisting of plants, animals and microorganisms in an area. The living components interact with non-living physical components of the environment forming an ecosystem. Ecosystems are broadly classified as terrestrial and aquatic ecosystems. Ecosystems are dynamic in nature and change due to various factors.

Figure 10.1 Natural environment

10.2 Components of Ecosystem

An ecosystem is a structural and functional unit of the biosphere. It consists of both living organisms and non-living physical conditions. The components of an ecosystem are:

1. Abiotic components

Abiotic components are non-living physical and chemical factors of an ecosystem. The non-living factors are either resources or conditions. It is also called as ecological factor. The abiotic factors vary from one ecosystem to another. Important abiotic components are:

1.1 Soil

Soil is a medium for growth of plants in an ecosystem. The characteristics of soil such as composition and texture determine the percolation and water holding capacity. These characteristics along with parameters such as pH, mineral composition and topography determine the type of vegetation and organisms in an area.

1.2 Air

The air is a significant component as it provides all necessary gases required for sustenance of life forms in the biosphere. The most important gases used by plants and animals are oxygen, carbon dioxide and nitrogen. Oxygen is used by living organisms during respiration. Carbon dioxide is used by green plants during photosynthesis. Nitrogen is made available to plants by certain bacteria and through lightning.

1.3 Water

Water is also an important component of an ecosystem. It helps in photosynthesis and biogeochemical cycles. It is also a source of food and shelter for many organisms. The water bodies help to moderate temperature and create a favourable environment for life.

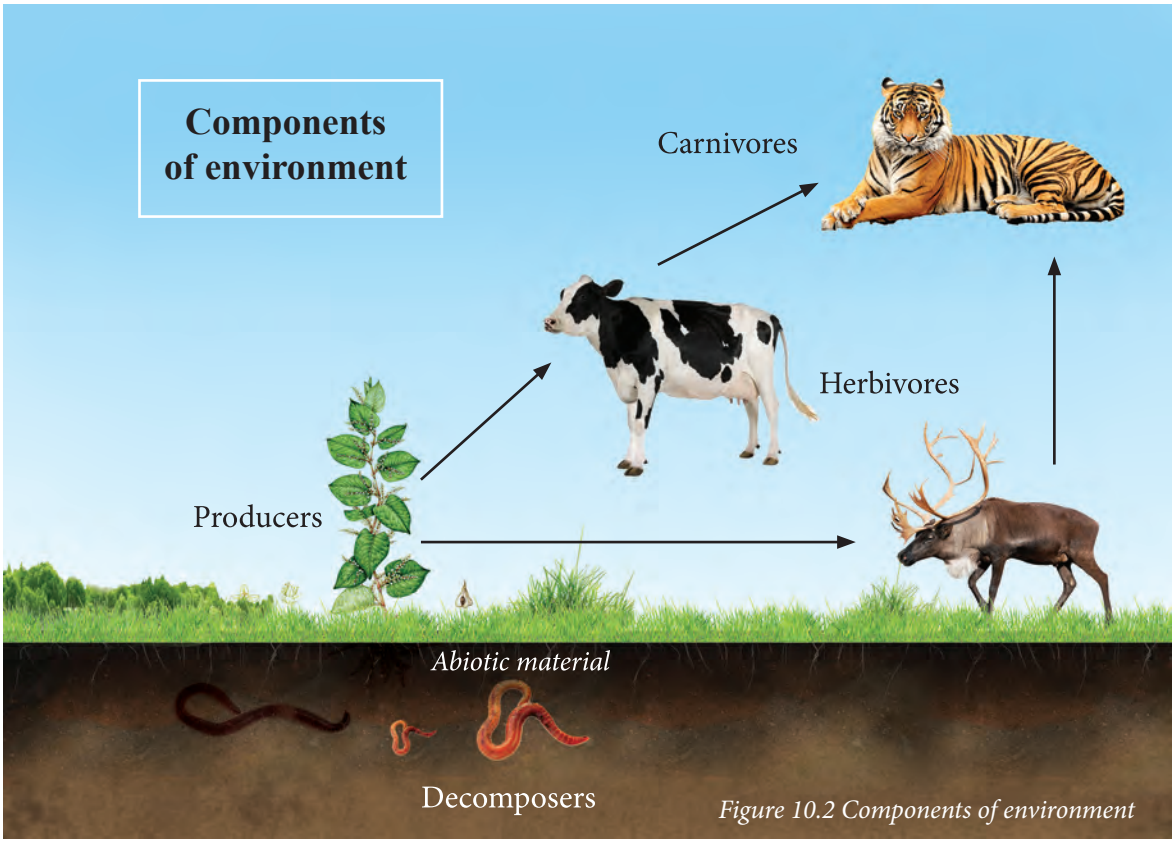

Figure 10.2 Components of environment

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2. Biotic component

The living components of an ecosystem are the biotic components. It includes plants, animals, fungi and bacteria. The biotic components can be further classified based on the energy requirement source as producers, consumers, and decomposers.

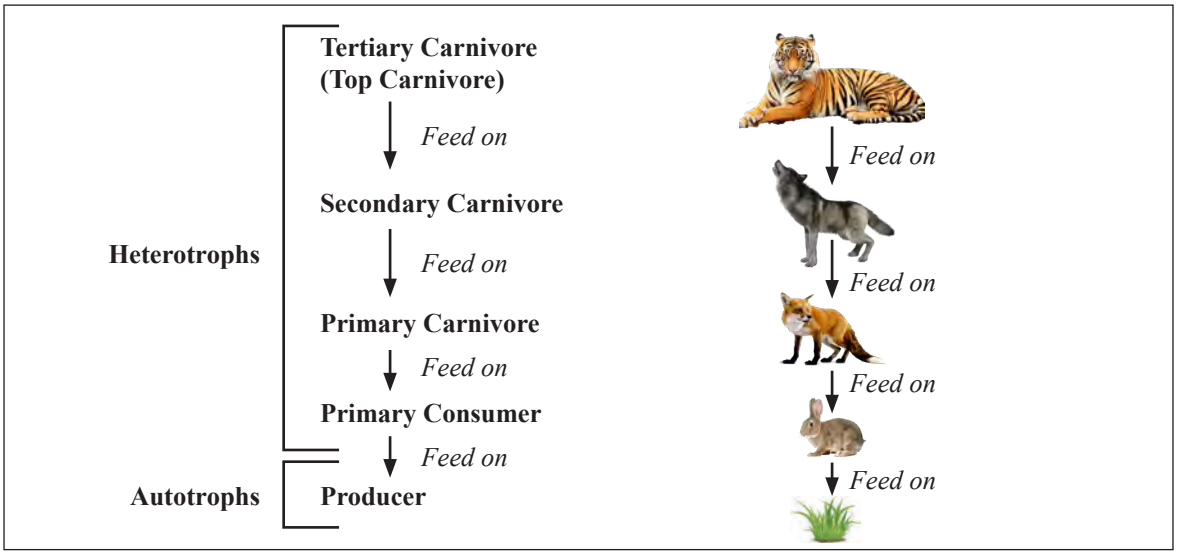

Figure 10.3 Biotic components

2.1 Producers

Producers are also called *Autotrophs*. They are plants in an ecosystem which can produce their own food through photosynthesis. Plants use energy from the sun and other inorganic sources to convert it into food. A portion of food synthesised is used by autotrophs for their growth and other biological functions and the remaining is stored for future use. This stored food in autotrophs is utilized as food by other organisms called heterotrophs. All living beings are dependent on plants for energy.

2.2 Consumers

Consumers are also called *Heterotrophs* and depend on food produced by autotrophs. Consumers are grouped into three broad categories as herbivores, carnivores, and omnivores based on the source of energy requirement. Herbivores are living organisms that feed on plants while carnivores feed on herbivores. Omnivores are animals that sustain on both plants and animals.

2.3 Decomposers

Decomposers are also called *Saprophytes* and help to break down organic materials to obtain nutrients and energy. Decomposition is a natural process and decomposers

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accelerate it. The nutrients of dead remains of living organisms go back to the soil. Decomposers convert the raw nutrients such as nitrogen, phosphorus, organic carbon dioxide and magnesium into a usable form for plants.

Learning Activity:

In teams, choose a park or a natural area within or nearby your school. Observe the ecosystem present there and discuss the following in your teams.

a. Name the non-living organisms that you find in the chosen ecosystem.
b. Name the living things that you find there. (You may dig the ground to observe life in soil.)
c. What would happen if one of the components is missing or removed?
d. Share your findings in the class.

10.3 Structure and function of ecosystem

An ecosystem is the basic functional unit in ecology. In an ecosystem, all living organisms interact with its physical environment. The ecosystem functions due to energy transmission through its components that make natural cycle functional. The main source of energy on the Earth is from the sun.

The energy transfer in the ecosystem occurs through the food chain. All living organisms in a food chain depend on energy flow for distribution and circulation of organic and inorganic matter in an ecosystem. The flow of energy is unidirectional while the circulation of matter is cyclic.

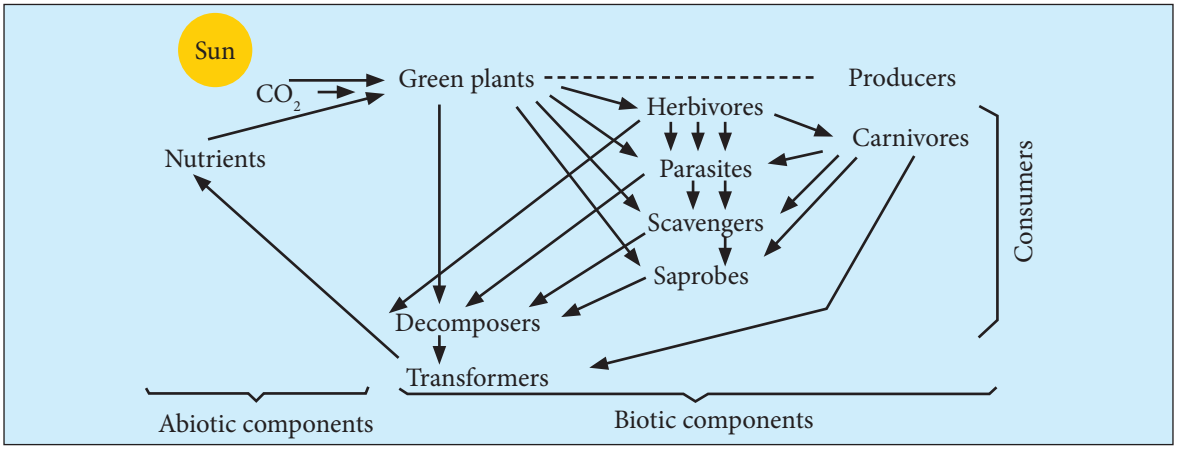

Figure 10.4 Flow of energy

Learning Activity:

1. Draw a food chain and describe the flow of energy.
2. Figure 10.5 shows flow of energy and cycle of matter. Compare flow of energy and cycle of matter, and write the differences.

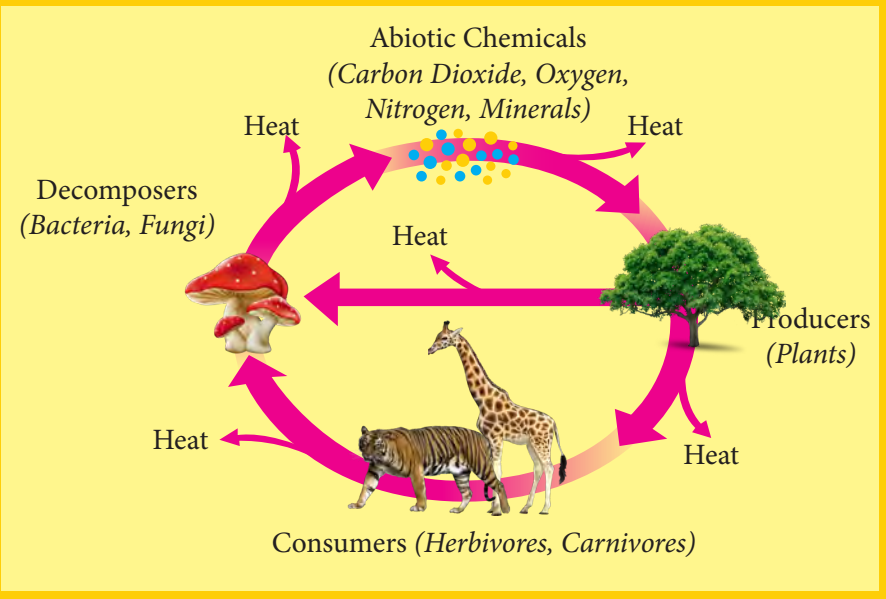

Figure 10.5 Flow of energy and matter

3. Study figure 10.6 and answer the questions

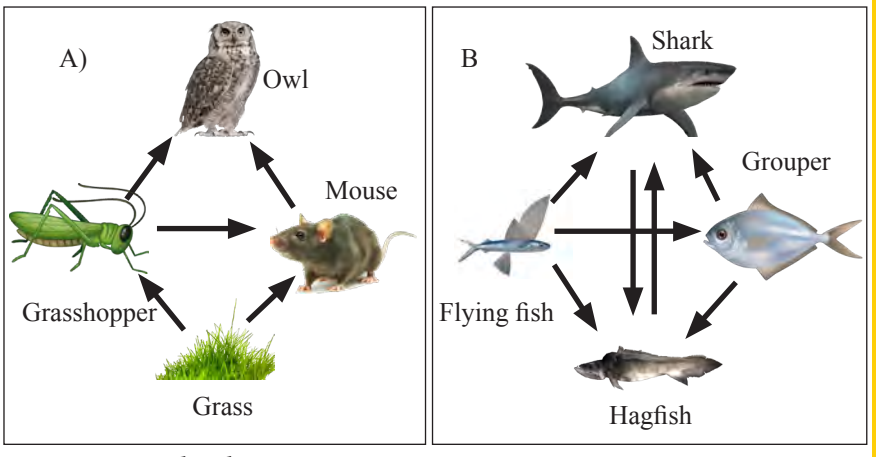

Figure 10.6 Food Web

i. What is missing from the food web in figure B?
ii. Why is it important in a food web? Give reasons.

10.4 Types of Ecosystem

There are broadly two types of ecosystem. They are Aquatic and Terrestrial ecosystems.

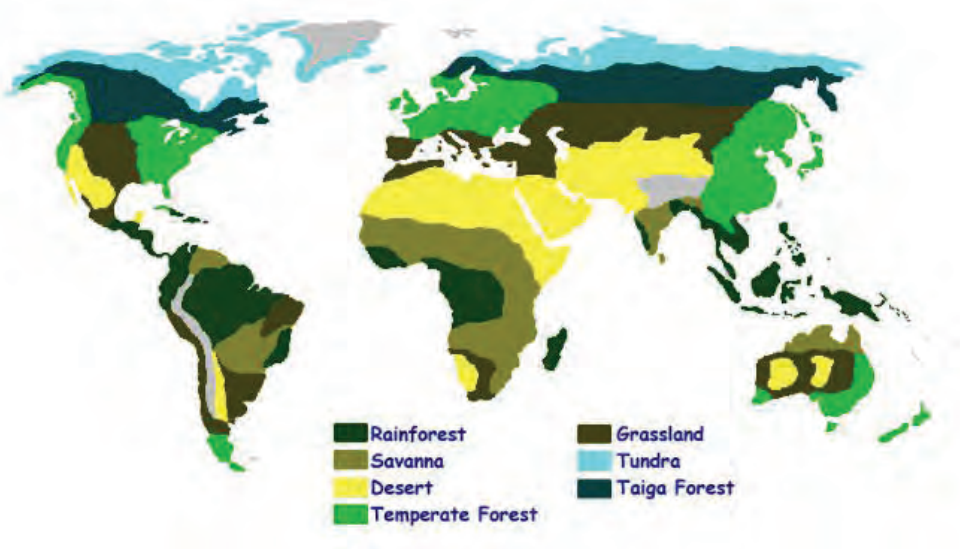

Figure 10.7 World Distribution of Biomes

10.4.1 Terrestrial Ecosystem

A terrestrial ecosystem is found on land and is broadly classified into:

i. Forest Ecosystem

A forest ecosystem is classified based on climate type as tropical, temperate or boreal. The tropical rainforest ecosystem contains diverse flora and fauna compared to other ecosystems. In temperate zones, a forest ecosystem is deciduous, evergreen or a mixture of both. In the far north, just south of the Arctic, boreal forest also known as Taiga is dominated by coniferous trees.

Figure 10.8 Taiga

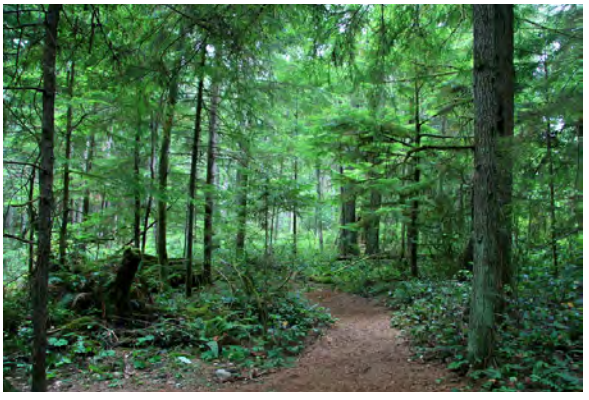

Figure 10.9 Temperate

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Figure 10.10 Desert

ii. Desert Ecosystem

A desert ecosystem is characterised by low rainfall, generally less than 25 centimeters per year. It is found from the tropics to the arctic and can be either hot or cold. In a desert ecosystem, vegetation is sparse or nonexistent. Plants and animals in the desert ecosystem are highly adaptable to extreme conditions.

iii. Grassland Ecosystem

Figure 10.11 Darling Downs

Figure 10.12 Mongolian Steppes

A grassland ecosystem is typically found in tropical or temperate regions, and also exists in cold areas such as Siberian Steppes. Some of the grassland ecosystems are prairies, savannas and steppes. Grasslands share the common climatic characteristic of semi-aridity.

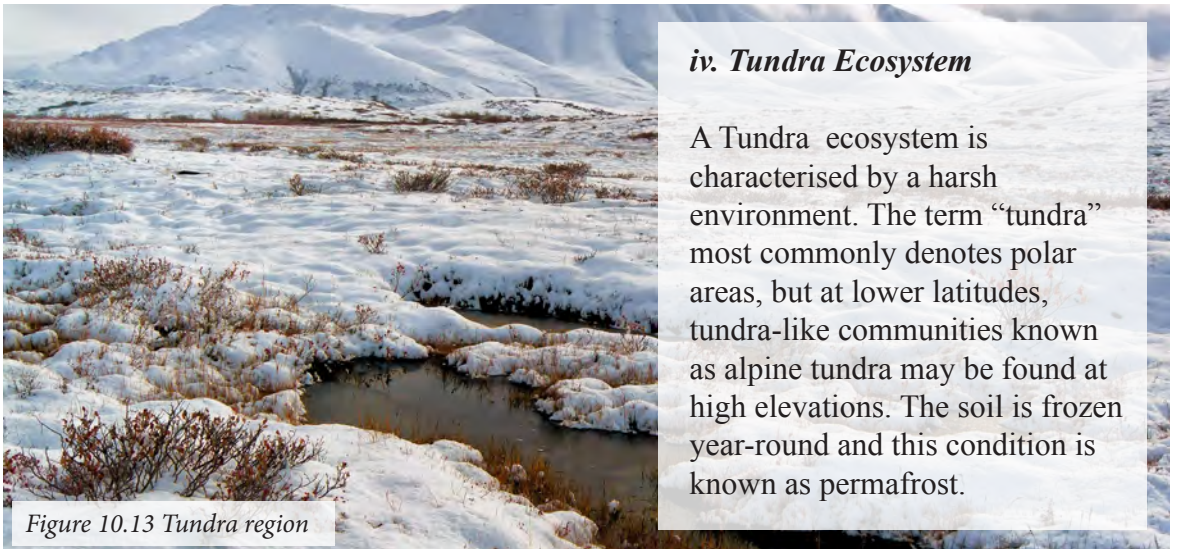

Figure 10.13 Tundra region

iv. Tundra Ecosystem

A Tundra ecosystem is characterised by a harsh environment. The term “tundra” most commonly denotes polar areas, but at lower latitudes, tundra-like communities known as alpine tundra may be found at high elevations. The soil is frozen year-round and this condition is known as permafrost.

10.4.2 Aquatic Ecosystem

The ecosystem found in water bodies is known as an aquatic ecosystem. It encompasses aquatic flora and fauna. Two types of aquatic ecosystems are marine and freshwater.

i. Marine Ecosystem

Marine ecosystem is the most abundant type of ecosystem in the world. It encompasses not only the ocean floor and surface but also tidal zones, estuaries, salt marshes and salt water swamps, mangroves and coral reefs.

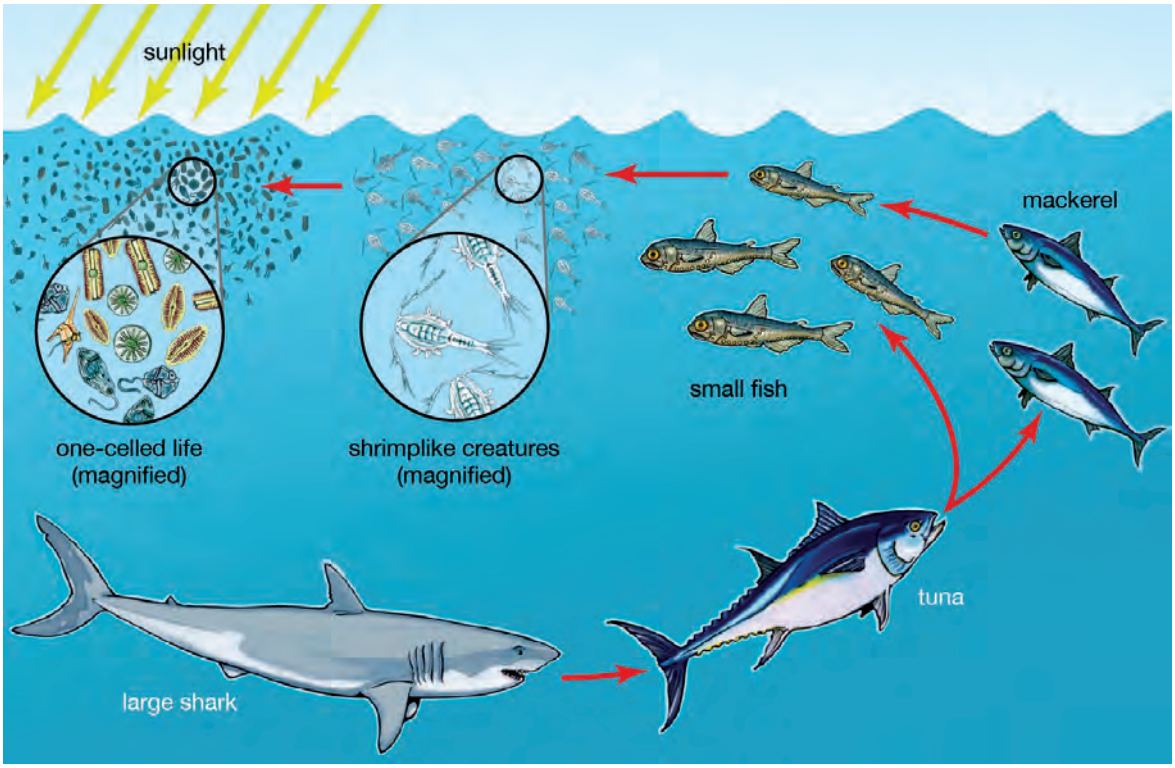

Figure 10.14 Ocean Ecosystem

ii. Freshwater Ecosystem

A freshwater ecosystem is found in streams, rivers, springs, ponds, lakes and freshwater swamps. It is subdivided into two types: those in which the water is nearly stationary, such as ponds and those in which the water flows, such as rivers. Freshwater ecosystems are also home to fish, plankton, amphibians and underwater plants.

Figure 10.15 Freshwater ecosystem

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Learning Activity:

Discuss the differences between terrestrial and aquatic ecosystems, and present to the class.

10.5 Ecosystem Change

Ecosystems continuously change with time. The change can be gradual or rapid depending on the nature of factor. The factors causing change in ecosystems are natural and human induced.

Natural Factor

Natural factors refer to natural phenomena which cause the ecosystem to change. Some of the natural factors are climate change, earthquake, landslide and volcanic eruption.

1. Climate change

Changing climate influences the kind of species found in an ecosystem. Increasing temperature is causing species to migrate to higher altitudes for their survival. As the Earth is getting warmer, some species become extinct, while new species evolve in new areas.

2. Earthquake

An earthquake either creates or destroys habitat. A strong earthquake can uplift a strip of a coast out of the sea, or submerge coastal land. Lifting of coastal land displaces the marine species and submergence causes loss of ecosystems.

3. Landslide

A landslide results in the loss of species and displaces the habitat of soil organisms. A series of landslides can lead to the widespread removal of forest cover. This affects the forest ecosystem.

Learning Activity:

Discuss the possible changes to the ecosystem in the affected area of landslide.

Figure 10.16 Landslide

4. Volcanic Activity

The lava flow from the volcanic eruption destroys the surrounding ecosystem. The hot lava burns the vegetation and kills or displaces the organisms. As the lava cools, volcanic soils are formed and results in the growth of thick vegetation creating a new habitat.

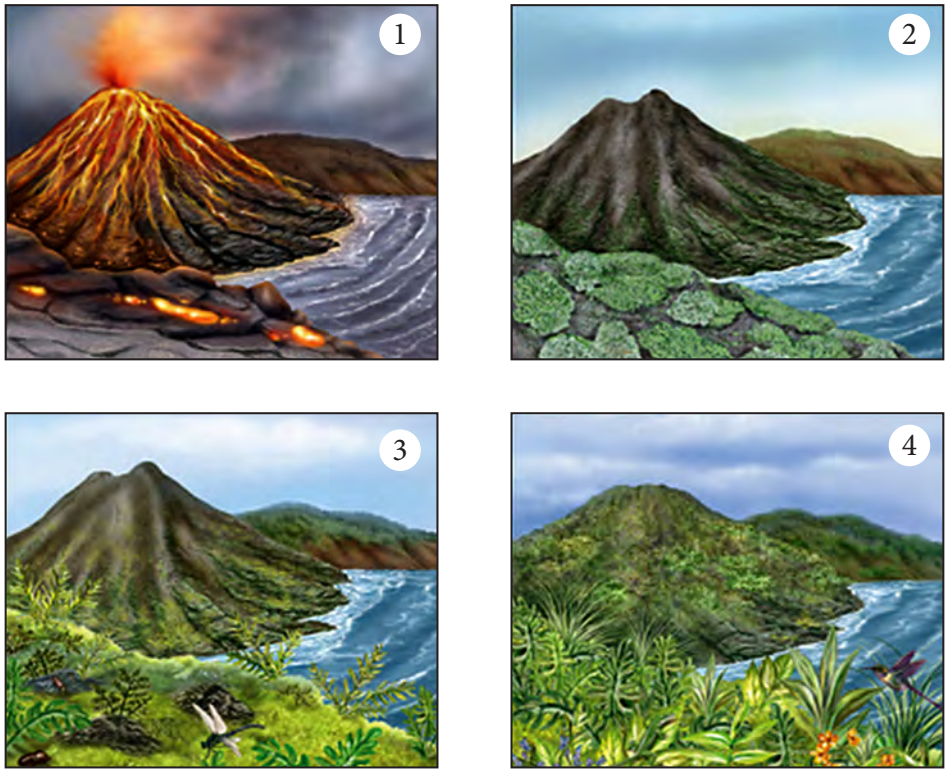

Figure 10.17 Ecological succession

Human Induced factors

1. Increase in population

The growing population in the world is exerting pressure on resources. This results in greater industrialisation, urbanisation and agricultural expansion causing change in an ecosystem.

2. Land- use change

Human activities such as mining, urbanisation and agriculture destroy natural landscapes and change land use pattern. Species are displaced or destroyed by changing their habitats.

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3. Pollution

People are continuously polluting resources like air, water and soil which require millions of years to replenish. Pollution occurs from runoff or disposal of chemical substances, or from energy sources. Pollution accelerates climate change and modifies species diversity.

Figure 10.18 Water pollution

4. New species

Human beings introduce non-native species into an ecosystem for better yield, prevention and overcoming unfavorable conditions. This affects the ecosystem because the introduced species may displace or invade native species.

5. Resource exploitation

Humans constantly consume resources for livelihood. Extensive use of resources such as fossil fuels, forest, minerals cause harm to the environment and change the composition of the ecosystem.

6. Deforestation

Deforestation is a major threat for the survival of different species. A large forested area is cleared to establish new settlements, industries and agriculture. This leads to global warming and loss of species.

Figure 10.19 Logging activity

Learning Activity:

Which human induced factors have more impact on the ecosystem in your locality? Give reasons.

TEST YOURSELF

1. Agricultural practices have environmental impacts that affect a wide range of ecosystem. Do you agree? Justify.
2. Hydropower dams, roads construction and mining along the rivers, extraction of sand from riverbed and introduction of exotic or alien species pose serious threat to ecosystem. What measures would you suggest to overcome such problems?
3. Observe figure 10.20 and answer the questions:
   i. List human induced changes in the ecosystem.
   ii. Discuss the impacts on ecosystem if the trend continues.

Figure 10.20 Human induced factors

4. Use figure 10.21 and answer the questions:
   i. Identify the change in the ecosystem.
   ii. What would be the reasons for such changes?
   iii. Suggest measures to control such change in the ecosystem.

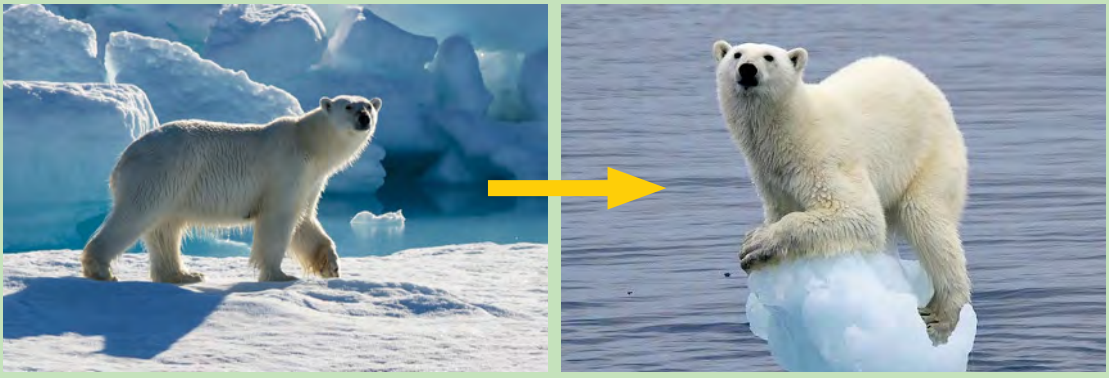

Figure 10.21 Natural factors

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CHAPTER 11
AGRICULTURE

Learning Outcome(s):

- Describe farming as a system
- Discuss agro-ecological zones and farming practices
- Explain the factors influencing agriculture

11.1 Introduction

Agriculture is the cultivation of crops and raising of livestock for livelihood. It has evolved from traditional to modern practices with development in science and technology. The development of farming in a region is determined by various factors.

11.2 Farming System

A farm is a system that has inputs, processes, outputs and feedbacks. A farming system is an approach to develop farming based on the principles of productivity, profitability and sustainability. The system can be carried out on a large or small scale depending on the level of technology and availability of land, labour and capital.

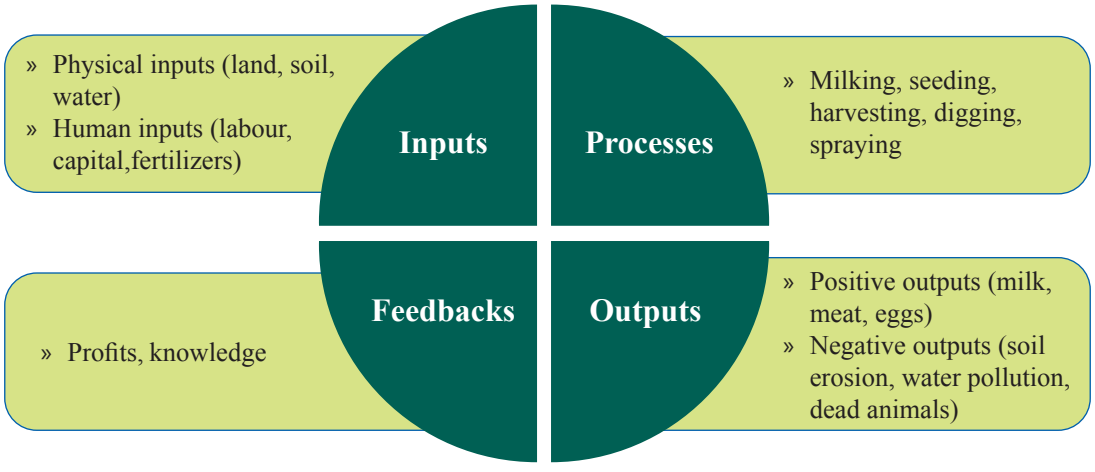

Figure 11.1 Farming System

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In Bhutan, subsistence mixed farming system is the dominant practice. There are more than one production systems operating in this farming system. In warm temperate zones, the production system operates on wet land and dry land. Rearing of livestock and utilization of forest resources also prevail.

Learning Activity:

1. Why do you think our farmers have adopted a mixed farming system?
2. Distinguish between wet and dry land production system.
3. Which production system is becoming popular in your locality? Why?

11.3 Agro-ecological zones and Farming Practices

Agro-ecology is the study of ecological processes applied to agricultural production systems. Agro-ecological zones (AEZs) are geographical areas with similar climatic conditions that determine the ability to support agriculture. AEZs are influenced by latitude, elevation, temperature and rainfall.

Bhutan is divided into six major agro-ecological zones corresponding with altitudinal range and climatic conditions.

Agro-Ecological Zone	Altitude Range (m.a.s.l)	Annual Rainfall (mm)	Air Temperature		
			Max ^{0}C	Min ^{0}C	Mean ^{0}C
Alpine	3600-4600	<650	12	-0.9	5.5
Cool Temperate	2600-3600	650- 850	22.3	0.1	9.9
Warm Temperate	1800-2600	650- 851	26.3	0.1	12.5
Dry Subtropical	1200-1800	850-1200	28.7	3.1	17.2
Humid Subtropical	600-1200	1200-2500	33	4.6	19.5
Wet Subtropical	150-600	2500-5500	34.6	11.6	23.6

Table 1: Major Agro-Ecological zones of Bhutan

The alpine zone which covers the northern region is characterized by alpine meadows and the temperature is too low to grow food crops.

In the cool temperate zone, the most common way of living is rearing livestock with some dry land farming. Some of the important crops grown are wheat, potato and buckwheat.

The warm temperate zone has moderately warm temperatures except during winter. In the wetland areas, rice is the main crop while other crops grown are wheat, potatoes, seasonal

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fodder and vegetables.

The dry subtropical zone is warm with moderate rainfall favouring the cultivation of a wide range of crops. Rice, maize, different types of legumes and vegetables are cultivated.

The humid subtropical zone has a relatively higher rainfall and temperature. The main crops cultivated are rice, wheat, orange and cardamom. In dry land areas, maize and millet are the predominant crops.

The wet subtropical zone favours intensive subsistence farming through different forms of multiple cropping. Rice is the main crop grown in summer while wheat and maize are grown in winter.

Learning Activity:

1. Mention the types of farming practice in the following agro-ecological zones:
   - Cool temperate zone
   - Humid subtropical zone
2. Crop rotation is a good practice in agriculture. Discuss.
3. Differentiate between modern and traditional farming system.

11.4 Types of Farming

It is difficult to classify farming types because of its complexity which include both growing of crops and raising of animals. Farming types are grouped according to their characteristic features. The following are some common types of farming:

1. Arable Farming

In this type of farming, people grow crops only, unlike in the mixed or pastoral farming. Crops produced include annual crops such as vegetables, plantain, cassava, grains and legumes. This type of farming is practiced either on a small or commercial scale.

Figure 11.2 Arable farming

2. Subsistence Farming

Subsistence farming is usually practiced on a relatively small land holding with simple farm tools for self-consumption. In this type of farming, farmers use farmyard manures, indigenous seeds and simple tools. Productivity is usually low.

Figure 11.3 Subsistence farming

3. Tseri Farming/Shifting Cultivation

In this type of farming, people clear a piece of forest land by felling and burning. This piece of land is used to grow crops for a few years and is abandoned. People then move to a new area to cultivate on a fertile land. The process is repeated and people may come back to cultivate former land after it has been left for years to regain its fertility.

Figure 11.4 Shifting cultivation

4. Nomadic Farming

Nomadic farming is rearing of animals on natural pastures. This type of farming is practiced by people of semi-arid and arid regions. People move with their animals in search of natural pastures for their livestock. The type of animals reared differs from one region to the other. Northern Africa, parts of Arabia and parts of northern Eurasia are the typical regions of this type of farming.

Figure 11.5 Nomadic farming

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5. Mixed Farming

Mixed farming is a farming system where farmers cultivate crops and raise animals simultaneously on the same land. This is mostly practiced in areas with good rainfall or irrigation facilities.

6. Livestock farming

Livestock farming is rearing of animals. It includes dairy farming, raising cattle for beef and sheep for wool. This farming has developed on a commercial basis in areas of the world such as the low rainfall areas of North America, South America and Australia.

Figure 11.6 Livestock farming

Learning Activity:

With milk quality improving, Koufuku International Limited (KIL), a dairy processing plant at Chenary in Trashigang is now focusing on producing premium dairy products.

Besides the company's initial premium product, gauda cheese, KIL is exploring means to diversify its products without replicating what local farmers are already producing. "We do not want to compete with the farmers but instead we want to improve their livelihood by adding value to their milk."

Today, the plant is running at about 45 percent of its full capacity. It receives around 1,800 litres of milk daily. The CEO said that the company aims to function at 50 percent by the end of the year.
The company is currently working with nine farmer's milk groups, three private and a public dairy farm in Trashigang. More than 200 households supply milk to the company. (Kuensel dated 23 May 2018)

Q. In what ways has the establishment of this plant benefited the local and the national economy? Share your findings in the class.

7. Commercial Farming

Commercial farming is growing of crops or raising of animals for commercial use. It is a modern method of farming that is practiced on a large scale. This type of farming uses large land, labourers and machines.

Figure 11.7 Commercial farming

8. Plantation Farming

This is also known as tree crop farming. People grow a single crop on a relatively large area of land. Crops cultivated include hazelnut, apple, orange and areca nut. It is usually done on commercial basis with a substantial amount of capital investment.

Figure 11.8 Plantation farming

Gasa lives the organic dream

In the past, being cut off from other parts of the country since the dzongkhag was not connected by road, farmers in Gasa had no access to chemical fertilizers; they were forced to use only organic manure to grow crops.

Then in 2004, former agriculture minister, Sangay Ngedup, visited the dzongkhag and assessing the situation declared Gasa an organic dzongkhag. Farmers in Gasa still do not use chemical fertilizers or pesticides.

However, Gasa was certified to produce and sell organic produce only last year with a farmers' group, Rangshin Sonam Detshen from Khatoed gewog, marching towards the vision of going 100% organic. Bhutan Agriculture and Food Regulatory Authority (BAFRA) certified it as the first organic group in the country last year.

The group owns 25 acres of land where they grow potatoes and garlic as certified organic products. From this year, the farmers have started cultivating red carrots as well.

The group comprising 52 members has demarcated land for production. Each member works on 20-30 decimals and gathers produce at the gewog center. The members have to pay Nu 100 each every month as membership fee. (29 July 2017, www.bhutantimes.com)

1. Gasa is marching towards the vision of going 100% organic. How would this move impact the people and the dzongkhag in the long run? Discuss and share your work with the class.
2. With easy accessibility to modern farming inputs and increasing demand, do you think the dzongkhag would achieve this vision? Justify. Present your answer to the class.

11.5 Factors influencing agriculture

A farming system is the result of an interaction of interdependent factors which are both natural and human made. These factors play a vital role in agricultural development although it can be modified to some extent by human effort.

1. Physical factors

Agriculture depends on the natural factors of an environment. The type of agriculture practice is related to its natural environment. Humans without technology and science have little control over the success or failure of agricultural activities. The natural factors influencing agriculture are topography, climate and soil.

Topography affects agriculture as it relates to soil erosion, difficulty of tillage and poor transportation facilities. Temperature and rainfall affects agriculture. Plants require sufficient heat and moisture for their growth. Rich soil is important for a successful agriculture. Poor soils have low productivity in amount and variety.

2. Human Factors

The increase in our world population leads to an increase demand for food. This affects the farming practices of farmers. Farmers tend to increase crop production by expanding the area of agricultural land or enhancing productivity on existing agricultural lands. The productivity is enhanced through use of fertilizers, irrigation and adopting new methods like precision farming.

The policies of the government influence agricultural development. Government policies dictate the types of farming and production. Policies such as land use, subsidies, loans, purchase policies, tax policy, marketing and trade of the government have a direct impact on agricultural production and its development.

Loans at a lower interest rate provide farmers with financial assistance for investment in farm machineries and commercial farming. Purchase and trade policies guarantee a market for the agriculture produce. Governments also provide trainings to build capacity and construct infrastructures.

Figure 11.9 Modern technology

Learning Activity:

We are an agrarian society. A significant portion of our population is still in agriculture. Yet we do not produce enough to feed ourselves, let alone export what we grow.

Recently, when the country faced shortage of chilli, people had to wait in long queues in the Centenary Farmers' Market in Thimphu. At one point of time the shortage was so bad that it pushed the price of the vegetable up to about Nu 500 a kg. We have had to use aircraft to fly in chillies from India even as we know that vegetable imported from India contain high level of hazardous chemical contents.

Today it is chillies. Tomorrow it could be onions or tomatoes. This compels us to look into how we have prioritised this important sector. (Kuenselonline dated December 8, 2106)

a. *"Tomorrow it could be onions or tomatoes."* Considering the Bhutanese food habits, would Bhutanese people wait in long queues to buy tomato and onion? Give reasons.
b. Emadatsi is a popular Bhutanese cuisine prepared using chilli. A long term shortage of chilli may change the Bhutanese food habit. However, Ap Bokto is planning for a mass commercial chilli production for which he seeks financial and technical support from the Dzongkhag Agriculture Office. Prepare a power point presentation on behalf of Ap Bokto taking into account the following points for his proposal.
    1. Reasons for commercial production
    2. Place of cultivation and reasons for choosing this place
    3. Market target
    4. Estimated profit
    5. Proposal for assistance from the Dzongkhag Agriculture Office

3. Economic Factors

Modern farming inputs ranges from improved seed, fertilizer, crop protection chemicals, machinery, irrigation and knowledge. Improved seeds increase farm production. Fertilizers supply nutrients to the soil. Irrigation enables off-season farming, provides potential for multiple harvests per year and brings additional land under cultivation. Chemicals such as pesticides, herbicides, insecticides and fungicides control weed species, harmful insects and plant diseases that afflict crops. Technical knowledge and machinery enhance labour efficiency and increase farm production.

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Learning Activity:

Bhutan imported 62,069MT of rice in 2017, a drop of three percent compared to the same period in 2016. In the same year, import of fresh vegetables decreased by about nine percent, dried vegetables by seven percent, fresh fruits by about a percent, dried fruits by 27 percent, meat by four percent, dairy products by 18 percent, and fish products by 28 percent and potatoes by three percent. (Kuensel dated 28 July, 2018)

1. What factors could have led to decrease in import?
2. Do you think the decreasing trend in import of agriculture produce would continue? Justify.
3. If you were the Agriculture Minister, what measures would you adopt to enhance food security in our country?

Test Yourself

1. Study figure 11.10 and answer the questions.
   i. Compare the activities between two figures.
   ii. Discuss how figure B will bring improvement in farming.

Figure (A) 11.10 Farming activities

Figure (B)

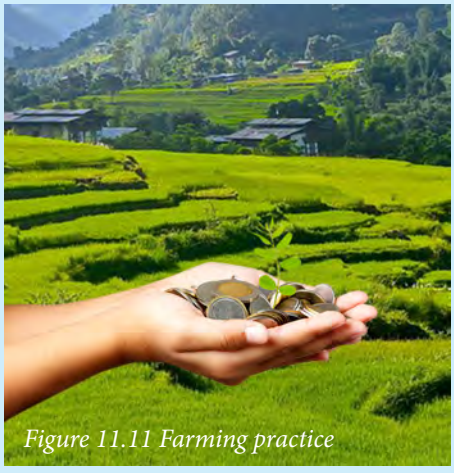

Figure 11.11 Farming practice

2. Why are Bhutanese youth not willing to take up agriculture as their profession?
3. Which type of farming is more prevalent in the place where you live? Why?
4. School Agriculture Programme (SAP) was introduced mainly to promote dignity of labour among the students. Explain how SAP promotes dignity of labour among the students.
5. Interpret the message conveyed by figure 11.11 Write your interpretation?

Chapter Twelve
Hazard and Disaster

Learning Outcome(s):

- Discuss major disasters and its causes
- Describe common disasters in Bhutan
- Explain disaster management approaches

12.1 Introduction

A sudden event that disrupts the functioning of a community is called a disaster. It causes human, environmental and economic loss which exceeds the community's ability to cope using its own resources.

A disaster occurs when a hazard impacts vulnerable people, environment and economy. Disasters can be both natural and human-induced. The combination of hazards, vulnerability and inability to reduce the potential risk results in disaster.

12.2 Major disasters in the world

i) Earthquake

An earthquake is a tremor or vibration caused by the sudden movement of the Earth. Earthquakes cause destruction to lives and properties. It normally causes greater harm in places near the epicenter.

A high-intensity earthquake may rupture dams or levees along a river resulting in floods. It also causes faulting and land displacement. Buildings and structures which are poorly constructed are damaged even by low intensity. Earthquakes sometimes cause fire and affects even animals and vegetation.

Figure12.1 Earthquake destruction

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KNOW MORE

The Valdivia earthquake (Great Chilean Earthquake) of 1960 is to date the most powerful ever recorded with 9.5 Magnitude which generated a Tsunami (14485 Km).

Chile town destroyed by an earthquake in 1960

ii) Tsunami

A tsunami is a series of waves caused by the vertical displacement of water. It is generated by earthquakes below the sea floor, violent volcanic eruptions, landslides and large meteorites striking the sea. A tsunami is one of the worst natural disasters in coastal areas.

Tsunami damage is first caused by the immense force of the tidal wave hitting the shoreline. The waves then continue inland and cause additional destruction.

A tsunami not only changes the landscape, it scrapes the seafloor sediments, mangles invertebrates, and destroys coral reefs. Soil and sea water also becomes contaminated.

Figure12.2 Sea wave

iii) Cyclone

A strong inward spiraling wind, that circulates around a strong centre of low atmospheric pressure, is called a cyclone. It is a devastating natural disaster that causes huge destruction to lives and properties People and structures with a weak foundation along it's track are at high risk.

Cyclones often bring heavy rainfall which intensifies the risk by felling and uprooting trees. This event also poses a threat to wildlife and commuters.

Figure 12.3 Destruction by cyclone

iv) Industrial Accidents

An industrial accident is an event that suddenly occurs when there are technological and mechanical failures causing devastation in industrial areas. It is caused by chemical, electrical or other process failures due to negligence or incompetence. Major industrial accidents are fatal and cause huge loses to humans infrastructure and the environment.

Some of the major industrial accidents are nuclear explosion/radiation, chemical explosion, mine explosion and structural collapse.

Figure 12.4 Industrial accidents

v) Volcanic eruption

A volcanic eruption is the release of magma from the Earth's interior. Primary hazards include pyroclastic flows, air-fall tephra (rock fragments), lava flows and volcanic gases. Famine, ground deformation, lahars (mudflow), landslides and tsunamis are secondary hazards.

Volcanoes with heavy ash fall make breathing impossible and many die from suffocation. Lava flows over human settlements, agricultural fields and other structures causing devastation. It also causes power shutdowns, drinking water contamination, wildfires, rain, thunder and lightning.

Figure 12.5 Lava flow

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Figure 12.6 Flood

vi) Flood

A flood is an overflow of water beyond its normal limits that submerges land, properties and vegetation. Places near the rivers are more vulnerable to floods. It also creates hazardous living conditions if water is not cleaned up immediately.

Economic hardships such as loss of livestock, crops, damage to food stores and industries are the long-term effect of floods.

Figure 12.7 Forest Fire

vii) Fire

Fire is one of the most destructive events causing destruction to human and animal life, forests and properties. Most of the deaths are due to suffocation. It also disrupts the local climate due to the increase in air pollution created by smoke.

Learning Activity:

Explore the following websites to gather information to answer the questions.

a. (https://www.nationalgeographic.com>natural disasters)
b. (https://https://www.livescience.com/biggest-natural-disasters-throughout-history)

i) List some natural hazards
ii) In teams, discuss one of the hazards and create a hazard profile.
iii) Where do these kinds of disaster occur and what are its causes?
iv) What are the damages to the people and environment?
v) How do people prepare for those types of disaster?

12.3. Common disasters in Bhutan

Bhutan experiences increasing disasters due to human intervention in the natural processes. Some of the common disasters are:

i) Earthquake

Bhutan lies in seismically active zone and is prone to earthquakes. Earthquakes have occurred several times in the past and caused destruction. There is high likelihood of a major earthquake in the future. The earthquakes have great impact on people, environment and properties.

Figure 12.8 House destroyed by an earthquake

ii) Glacial Lake Outburst Flood

Bhutan is prone to Glacial Lake Outburst Flood (GLOF) due to a large number of glacial lakes. Global warming is causing rapid retreating of glaciers resulting in the overflow or outburst of glacial lakes. The risk is intensifying as the climate changes. GLOF is also triggered by natural forces such as earthquakes, avalanches, heavy rain and landslides. GLOF causes loss of lives and livelihood by destroying agricultural land. It also damages essential infrastructure, such as hydropower systems, industrial estates, human settlements, historical and cultural monuments, roads, bridges and communication infrastructure.

Figure 12.9 Glacial Lake

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Figure 12.10 Landslide

iii) Landslide and Flash flood

The most recurring disaster in Bhutan are landslides and flash floods. The topography makes the land vulnerable to a rapid sliding of masses of rock, debris down a slope usually during heavy rainfall. Absence of vegetation cover in an area, poor land management by human encroachment, development activities and earthquakes are triggering factors of landslides and flash floods. These cause destruction to the natural environment, transportation systems, agricultural land and even loss of lives and properties.

iv) Fire

Fire event is another recurring disaster in Bhutan. Forest fires occur during dry months when trees become most combustible and intense wind prevails. Some causes of structural fires are human negligence, electrical short circuit and lightning.

Figure 12.11 Fire destruction

Learning Activity:

1. Fire disaster is becoming rampant in many parts of Bhutan. In relation to this, answer the questions in teams and present it to the class.
   a. Analyse the causes of fire
   b. Discuss short and long term impacts
   c. Suggest measures to control fire accidents

2. Flashfloods have destroyed human settlement, infrastructure, agricultural fields, grassland and ecosystem. Prepare slides using Power Point Presentation to show how human activities induce flashfloods and suggest measures to minimise it.

v) Windstorm

Disastrous wind storms are becoming an annual phenomenon due to climate change. Powerful winds usually destroy poorly constructed houses, crops and infrastructure. Sometimes falling trees and thunderstorms injure and kill humans and animals.

Figure 12.12 Roofs blown off by a windstorm

vi) Pest

A pest is any living organism which is invasive or troublesome to plants, livestock and humans. These pests are agricultural problems, but when they cause widespread damage it becomes a disaster. Some of the pests are moths, cutworms, aphids, army worms, wild boars, monkeys, porcupines, deer, rats, bears, elephants and birds.

Figure 12.13 Cutworms

Learning Activity:

Farmers are losing a major portion of their harvest to various pests. Using internet/library, explore various measures to control pest. Share your findings to the class.

KNOW MORE

Preparedness approaches are the formation of viable emergency plans, the development of warning systems, training of personnel, search and rescue measures as well as evacuation plans.

12.4 Disaster management

Disaster management approaches aim to reduce or avoid the potential losses from hazards. A plan assures prompt and appropriate assistance to victims of disasters and achieve rapid and effective recovery.

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Disaster management approaches involves seven key stages:

a. Preparedness

Preparedness is the measure that enables one to respond quickly to a disaster situation and to cope with disaster effectively. This is to reduce the potential threat for human, material, or environmental losses caused by hazards and to ensure that these losses are minimized when disaster actually strikes.

b. Disaster event

The event of a hazard occurring and affecting elements at risk.

c. Response and Relief

Response and relief refers to the reaction to any calamity. Setting up control rooms, putting the contingency plan in action, issue warning, action for evacuation, taking people to safer areas, providing medical care, food, water, and shelter are some examples of response and relief.

d. Recovery

The recovery activities encompass three overlapping phases of emergency relief. The first phase includes rescue activities undertaken during and immediately following a disaster. Rehabilitation activities such as providing temporary public utilities and housing as interim measures to assist long term recovery are in the second phase. Finally, reconstruction activities begin with attempts to return communities to improve pre-disaster functioning such as replacement of buildings, infrastructure and lifeline facilities so that long term development prospects are enhanced.

e. Development

Development refers to ongoing activities such as long term prevention and disaster reduction measures such as construction of embankments against flooding and irrigation facilities for drought prone areas. This is for rapid recovery and to prevent vulnerable conditions.

f. Prevention

Prevention is reducing the risk of disaster to reduce or modify the scale and intensity of the threat by improving the conditions of elements at risk.

g. Mitigation

Mitigation refers to all the measures taken to reduce both the effect of the hazard, and the vulnerable conditions to minimise the scale of any future disaster.

Disaster management cycle is an ongoing process by which governments, businesses, and civil societies plan. This process indicates the plan to reduce the impact of disasters, react during and immediately following a disaster and take steps to recover after a disaster has occurred.

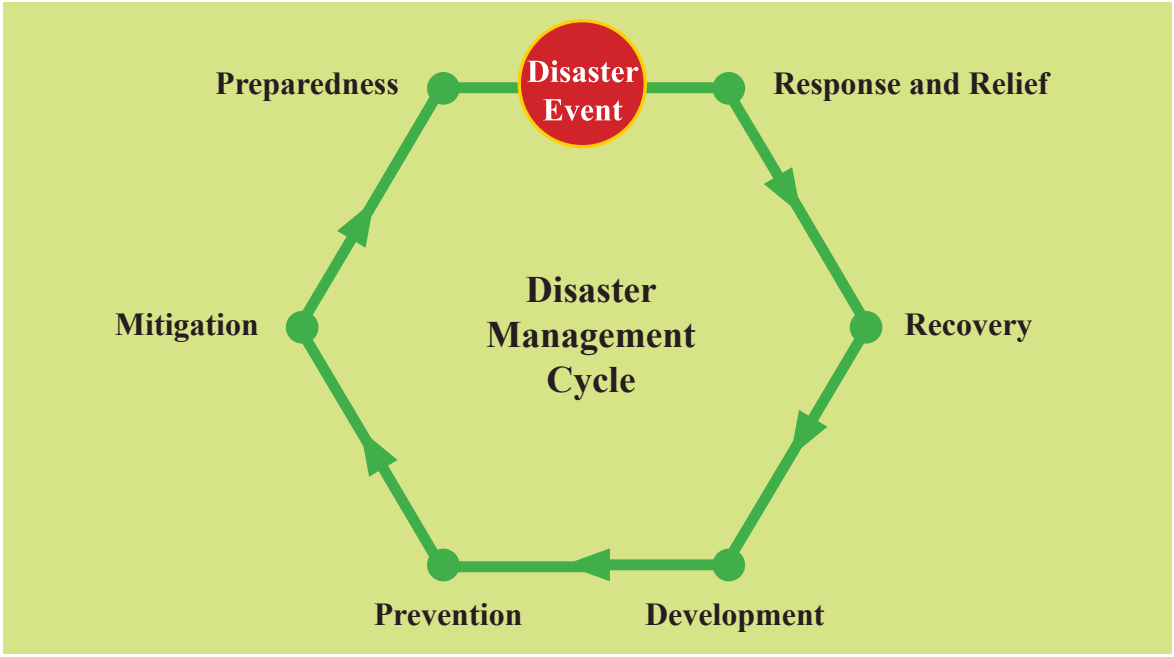

Figure 12.13 Disaster Management Cycle

Learning Activity:

Prepare a disaster contingency plan for a family and share it in the class.

Test Yourself:

1. Why is fire disaster common during winter and landslides during summer? Give reasons to support your answer.
2. Prepare a list of activities that should be carried out before disaster as a part of the disaster management approach.
3. Complete the given activity.

Reprint 2024

Disaster type	Definition	Effects
GLOF		
	Instances of combustion in which fuel or other material is ignited.	
		The crops grown by farmers get damaged.
Flash flood		
	The movement of a mass of rock, debris, or earth down a slope	

4. Find out any prominent disasters in your community with the help of internet or secondary sources and present it through graphical representation showing their frequency of occurrence for the past five years.
5. List the potential hazards in your school and suggest measures.
6. Which disaster in the world is the most dangerous according to you? Discuss some ways to mitigate such disaster.
7. Bhutan is experiencing multiple threats due to climate change. Discuss all possible disasters that could be caused by the climate change.

Assessments

Weighting and instructional time

Sl	Strands	Chapters	Weighting	Instructional time in Minutes	No of periods (40 Min)	Weighting
1	Time and Space	1. The Earth- A Unique Planet	5	240	6	40
		2. Rotation and Revolution	4	240	6	
		3. Latitude and Longitude	6	400	10	
		4. Map Reading and Interpretation	25	480	12	
2	Physical Environment	5. Soil	8	280	7	30
		6. Atmosphere	7	240	6	
		7. Rivers	8	360	9	
		8. Natural Environment	7	240	6	
3	People & Environment	9. Population distribution	8	360	9	30
		10. Settlement	8	280	7	
		11. Agriculture	7	240	6	
		12. Hazard and Disaster	7	240	6	
Total			**100**	**3600**	**90**	**100**

Assessment Matrix- Broad assessment based on Knowledge, Skills and Values & Attitudes (KSA)

Assessment type	Formative assessment			Continouos assessment			Summative assessment	
Domains	**Knowledge**	**Process (skills)**	**Values & Attitudes**	**Knowledge**	**Process (skills)**	**Values & Attitudes**	**KSA Term I**	**KSA Term II**
Techniques	Self and peer assessment, quiz, debate, homework, classwork, class interaction	Map work, Case study, sketching, drawing, making models, using instruments	Field work, group work, self and peer assessment, interaction, case analysis, resolving social and environmental issues, moral dilemma	Homework, classwork, project work and test	Project work, map work, test, models, field work, case study, sketching, drawing, making	Field work, group work, test, interaction, case analysis, resolving social and environmental issues, moral dilemma	Terminal examinations	Terminal Examinations
Assessment tools	Question & answer, checklist, rating scale, rubrics	Question & answer, checklist, rating scale, rubrics	Question & answer, checklist, rating scale, rubrics	Question & answer, checklist, rating scale, rubrics	Question & answer, checklist, rating scale, rubrics	Question & answer, checklist, rating scale, rubrics	CBT-MCQs, completion, matching, true/false, short answer, essays	CBT-MCQs, completion, matching, true/false, short answer, essays
Frequency	Maintain either checklist/ rating scale/ rubrics for each chapter	Maintain either checklist/ rating scale/ rubrics for each chapter	Maintain either checklist/ rating scale/ rubrics for each chapter	Minimum two Homework and two classwork to be graded for each term	One Project (different types)	Maintain either checklist/ rating scale/ rubrics for relevant content	Once a term	Once a term
Weighting			**Term I**	**Term II**	**Term I**	**Term II**	30	50
			HW, CW & Test =7	HW, CW & PW=7	3	3		

Samples of criteria, rubric and rating scale for Assessment that teachers can modify and adapt as per the relevancy and need.

Criteria for Project work and field work

Name	Criteria					Total 20
	Content (4)	Language (4)	Presentation (4)	Process (4)	Originality & creativity (4)	

Rubrics for project and field work

Name	Marking Range				Score
	4	3	2	1	
Content	Information presented is relevant, accurate and in logical order.	Information presented is substantially relevant, accurate and in logical order.	Information presented is to some extent relevant, accurate and in logical order.	Information presented is not relevant, accurate and in logical order.	
Presentation	Exceptionally clear and precise expression of ideas, transfer of ideas into product with appropriate illustrations.	Clear and precise expression of ideas, transfer of ideas into product with appropriate illustrations.	Little expression of ideas, transfer of ideas into product with appropriate illustrations.	No clear and precise expression of ideas, transfer of ideas into product with appropriate illustrations.	
Process	Proper planning with regular consultations.	Partial planning with some consultations.	Little planning with little consultations.	No proper planning and Consultation.	
Language	Language without grammatical error	Language with few grammatical errors.	Language with few grammatical errors.	Language full of grammatical errors.	
Originality & Creativity	Display of original and creative ideas.	Partial display of original and creative ideas.	Little display of original and creative ideas.	No display of original and creative ideas.	
Total Score					

Teachers may use the above rubric for assessing project and field work. ***(Sample rating scale for Affective domain)***

Name	Criteria										Teacher's comments
	Participation in learning activities	Respect for others views	Curiosity for exploration	Responsibility	Empathy for others	Punctuality	Honesty	Intellectual drive	Concern for environment	Collaboration	

Note: The above parameters to be rated as: A-Outstanding, B- Very Good, C- Good, D-Fair and E- Need improvement. This rating scale is to be used at least once a term to assess the development of values and attitudes.

Reprint 2024

Criteria for Home Work

Name	Criteria					Total 20
	Completion (4)	Accuracy (4)	Presentation (4)	Originality & creativity (4)	Timely submission (4)	

Rubric for Home Work

Name	Marking Range				Score
	4	3	2	1	
Completion	100% complete	75% complete	50% complete	25% complete	
Accuracy	100% correct	75% correct	50% correct	25% correct	
Presentation	Work is crystal clear and legible	Work is clear and legible	Poor clarity and less legible	Not clear and illegible	
Originality & Creativity	Display of original and creative ideas.	Partial display of original and creative ideas.	Little display of original and creative ideas.	No display of original and creative ideas.	
Timely submission	Work submitted on time	Work submitted one day late	Work submitted two days late	Work submitted three days late	

Note: Homework as per the requirement