Unit 2

PHYSICAL ENVIRONMENT OF THE WORLD AND ETHIOPIA

Unit Outcomes

After completing this unit, you will be able to:

- analyze the internal and external forces that change the surface of the earth and relate them to the resulting landforms;
- appreciate the origin, composition and the layers of the earth's atmosphere;
- analyze the association between elements and controls of climate and interpret climate data;
- realize the concept of region and distinguish different temperature zones of the earth and describe Ethiopia as a tropical mountainous country;
- assess the concept, components, interdependence and, the factors that affect the distribution and features of ecosystems;

Main Contents

2.1 **FORCES THAT CHANGE THE SURFACE OF THE EARTH**

2.2 **WEATHER AND CLIMATE**

2.3 **NATURAL REGIONS OF THE EARTH**

2.4 **ECOSYSTEM**

2.5 **VILLAGIZATION OF THE WORLD THROUGH DISTANCE-TIME DECAY**

- *Unit Summary*
- *Review Exercise*

INTRODUCTION

Geography, as a discipline, helps us to learn about people, their life styles, and the ways their lives are affected by their interactions with their physical environments. Geography also provides us with closely related facts about how such factors affect our own day-to-day lives throughout our lifetimes.

In the previous unit, you have learned about the concept of geography and map reading. In this unit you will learn about the physical environment of the world and Ethiopia. The unit is organized in five sub-topics. These are ***Forces that Change the Surface of the Earth, Weather and Climate, Natural Regions of the Earth, Ecosystem and Villagization of the World through Distance-time Decay.*** You were introduced to most of these topics in earlier units. This unit presents them in greater detail to give you more information about our physical environment and to help you interactively learn more about them.

2.1 FORCES THAT CHANGE THE SURFACE OF THE EARTH

At the end of this section, you will be able to:

- list the landforms formed by each internal force;
- describe the process of each internal force;
- relate some major landforms with their respective internal forces;
- explain the effects of earthquakes on infrastructure; like buildings, dams, roads;
- review external forces;
- state the meaning of weathering;
- distinguish the different types of weathering;
- identify land features resulting from chemical weathering; stalactite, stalagmite, pillar etc;
- explain the types and characteristics of agents of erosion;
- relate types of erosions;
- state the effects of erosion on human activities; with various landscapes;
- explain the process of deposition;
- recognize erosion-deposited soils and landforms.

Key Terms

- Block mountains (Horst)
- Caldera
- Crater
- Earthquake
- Epicentre
- Faulting
- Fissure
- Folding
- Fold mountains
- Focus
- Force
- Landform
- Lava
- Magma
- Orogeny
- Rift valley
- vent
- Volcanism

Start-up Activity

1 What is a landform? What are the factors that influence the formation of landforms?

2 Look at Figure 2.1 and describe what you can see.

3 Then categorise them into internal forces and external forces.

Figure 2.1 **Different forces that are shaping the surface of the earth**

2.1.1 Internal Forces

What are the internal forces that affect the formation of landforms?

Those forces that drive energy from the interior part of the earth are called *internal forces*. Internal forces form the ups and downs on the earth's crust by breaking and bending (faulting and folding) it. Forces inside the crust cause folding, faulting (cracking), volcanism and earthquakes.

➲ **Folding** is one of the *internal processes* which occurs when two forces act towards each other from opposing sides. Due to this force, rock layers are bent into folds. The process by which folds are formed due to *compression* is known as *folding*. There are large-scale and small-scale folds. Large-scale folds are found mainly along destructive plate boundaries.

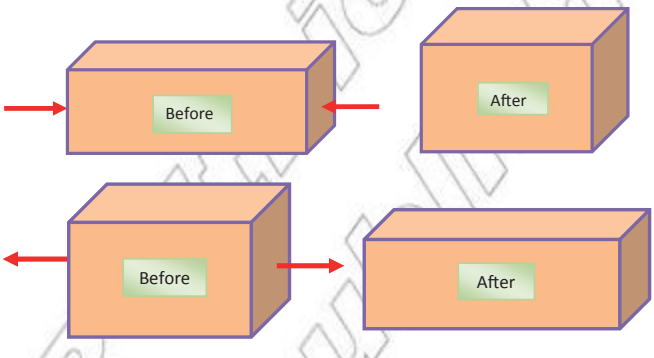


Figure 2.2 **Compression forces and their resulting effect**

Figure 2.3 **Tensional forces and resulting effects**

Folding can be explained using two important parameters

⇨ *Axial Plane* ⇨ *Limbs*

Types of folding: different types of folds are created, based on the nature of the forces applied on bedrock. If the fold is upward and convex, it is called **anticline**. If the fold is downward, it is called **syncline**.

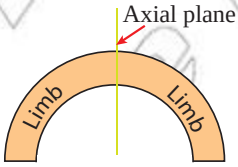
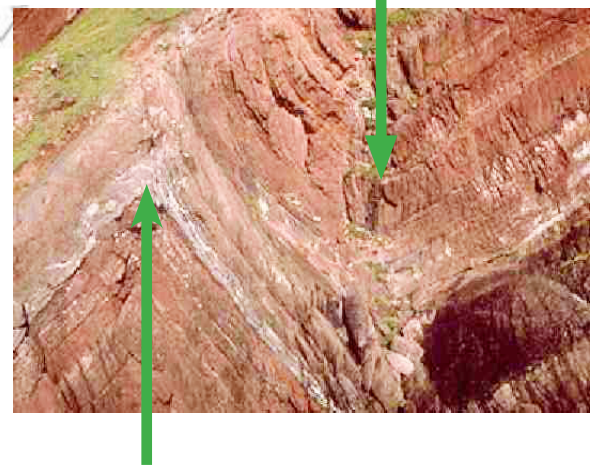


Figure 2.4 **Syncline fold**

Figure 2.5 **Anticline fold**



Fold Mountains

What are fold mountains? How are fold mountains formed? Name some of the fold mountains of the world.

Fold mountains are formed by crust which has been uplifted, and folded by compressional forces. They are formed when two plates move towards each other. The compressional force which is created as a result of this movement pushes sedimentary rocks upwards into a series of folds. Fold mountains are usually formed from sedimentary rocks and are usually found along the edges of continents. This is because the thickest deposits of sedimentary rock generally accumulated along the edges of continents. There are two types of Fold Mountains: young fold mountains (10 to 25 million years of age, example, the Atlas, Rockies and the Himalayas) and old fold mountains (over 200 million years of age, example, the Cape Range, the Urals in Russia and the Appalachians of the USA).

Many ranges of mountains have been formed by folding. The **Andes**, the **Rocky** mountains, the **Alps**, the **Himalayas** and the **Australian Alps** are some examples. The **Atlas** mountains in north west Africa and the **Cape Range** in South Africa were formed by folding. This process of mountain building is called *orogeny*.

Faulting

What is faulting? Describe types of faults.

Movements in the crust of the earth sometimes make cracks. These cracks are called *faults*. Faulting can be caused by either lateral or vertical forces, which can be either *tensional* or *compressional*. Tension causes a **normal fault**, and compression causes a **reverse fault**.

Activity 2.1

1 Study Figure 2.6 and identify the difference between a reverse fault and a normal fault.

2 Explain the difference between tensional and compressional forces.

3 Is faulting a way by which the surface of the earth is changed? Why or why not?

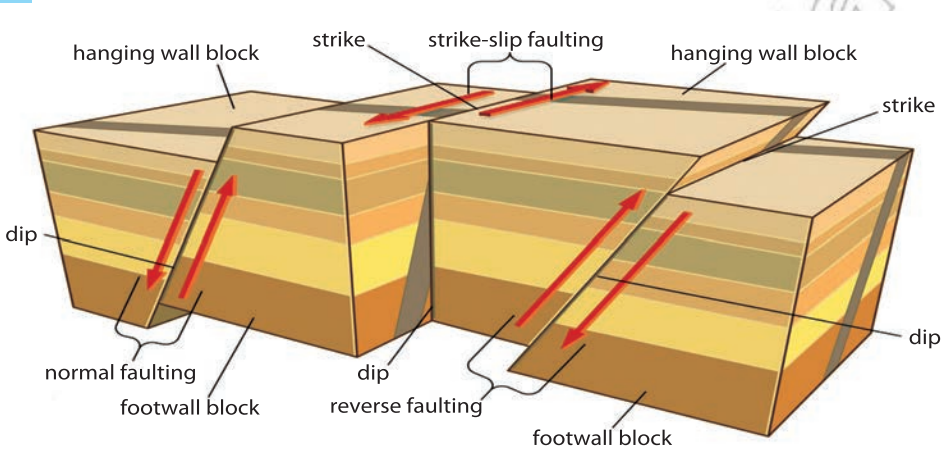


Figure 2.6 **Formation of normal and reverse faults**

Major features formed by faulting include *rift valleys* and *block/Horst mountains*

Rift Valleys

What is rift valley? How are rift valleys and block mountains formed?

A rift valley is a linear shaped lowland area between highlands or mountain ranges created by geologic rifts or faults.

A rift valley is a valley formed by faulting. When two parallel faults occur on the surface of the earth, and when the land between the two faults sinks down, a rift valley is formed.

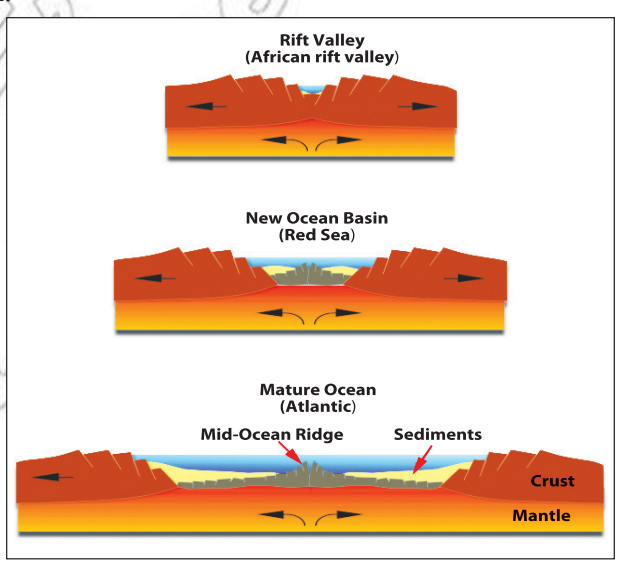


Figure 2.7 **Formation of a rift valley**

Activity 2.2

In your group, answer the following question and perform the following task.

1 Which is the largest rift valley in the world?

2 Identify the location of the largest rift valley on a map.

The largest rift valley in the world is the East African Rift Valley. It extends from Syria to Mozambique, passing through the Red Sea, Eritrea, Ethiopia, Kenya, Tanzania, DR Congo, Rwanda and Burundi.

What other countries are touched by this rift valley?

The total length of the East African Rift Valley is about 7,200 km, of which 5,600 km is in Africa.

The Ethiopian Rift Valley is a part of the East African Rift Valley. It extends from northeast to south west. Features found in the Rift Valley include active volcanoes, lakes, hot springs and fumaroles.

Figure 2.8 **East African Rift Valley**

Block (Horst) Mountains

What is block mountain? How do block mountains form?

Block mountains are formed when land between two parallel faults is pushed upward due to pressure from inside the earth. If there are two parallel faults, the crustal block between them may either rise to produce a Horst (block) mountain, or fall, to produce a rift valley.

Examples:

- *The Sierra Nevada mountains in North America.*
- *The Harz Mountains in Germany.*
- *The Afar block mountain in Ethiopia.*
- *The Ruwenzori in Africa.*

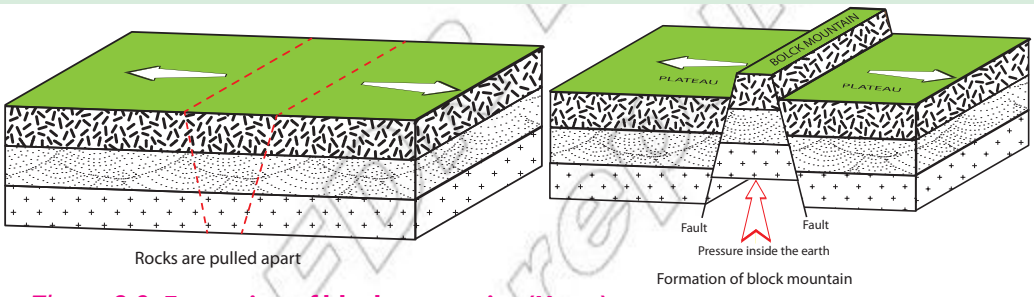


Figure 2.9 **Formation of block mountains (Horst)**

Activity 2.3

1 Prepare models representing
   - Types of folds
   - Anticline and syncline
   - Rift valley and block mountains using mud, paper mach'e, wood blocks, etc.

2 Explain the meanings of
   - Syncline and anticline
   - Tensional forces and compressional forces.

Volcanism

What is volcanic activity?

What landforms are associated with volcanic activity?

Volcanic activity is another internal force which changes the surface of the earth. It is caused by internal movements within the earth. Volcanism is the process by

which magma, gases, water vapour, ashes and other solid materials are forced out to the surface. Inside the earth the temperature is very hot. This high temperature changes rocks into molten magma. When this magma reaches the surface, volcanic activity takes place. When the magma emerges on to the surface, it cools and hardens. It is then called **lava**.

Figure 2.10 **The process of volcanic activity**

Magma reaches the earth's surface through two kinds of holes. They are **vents** and **fissures**. Magma may force its way violently through a small hole called a vent. If lava emerges via a vent, it builds up into a volcano (cone-shaped mound), and if it emerges via a fissure, it builds up to form a lava plateau or lava flow. Magma may pour quietly through long cracks (fissures) onto the earth's surface.

If the magma flows to the surface through a vent, acrater is formed. Sometimes a volcano erupts very forcefully. When this happens, the top part of the volcano is blown away. This forms a large crater called a *caldera*. Water collects in the crater or in the caldera and forms a lake. We call this a **crater lake** or **caldera lake**. In Ethiopia there are many crater lakes such as Zuquala, Wonchi and Dendi.

If an eruption begins again in a caldera, a new small cone-shaped volcano is formed inside the caldera. These are known as *caldera cones*.

Part of the magma may not reach the earth's surface, and when this magma cools, solidifies and forms rocks inside the crust, features such as **batholiths**, **lacoliths, sills and dikes**, are formed.

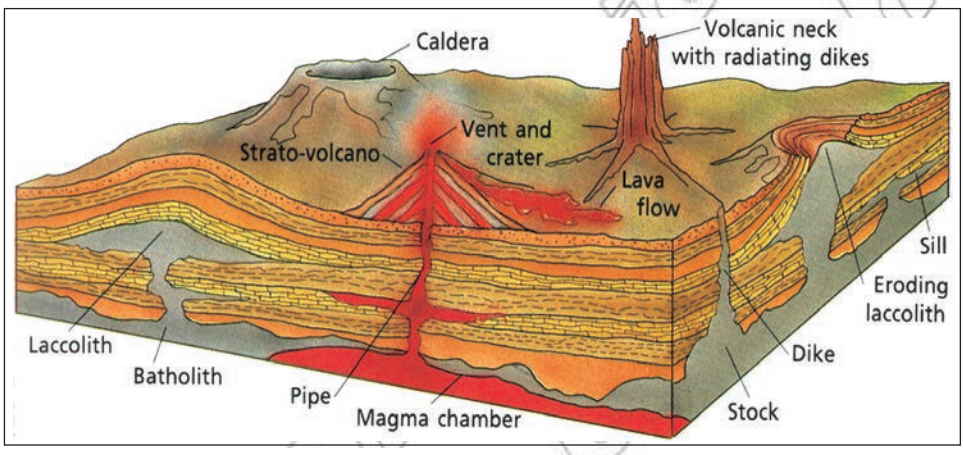


Figure 2.11 **The most important types of volcanic intrusion and extrusion features**

- **A batholith** *is a very large mass of magma which accumulates in the crust. It is the largest structure.*
- **A laccolith** *is a mushroom shaped body of intrusive igneous rock. Smaller than a batholith.*
- **A dike** *is formed when magma solidifies in a vertical or near-vertical crack.*
- **A sill** *is formed when magma solidifies horizontally or nearly horizontally along a bedding plane.*

Table 2.1: **Types of volcanoes**

Active volcano	Erupts from time to time	Erta'li, Fentale Dubbi and Damiali
Dormant volcano	Has not erupted for a long time but may erupt again in the future	Tatali and Dabbahu
Extinct volcano	Has not erupted within historic time	Mt. Zuquala, Ras Dashen and Batu

Importance of volcanic eruptions:

- *Give us some ideas about the interior of the earth.*
- *Provide fertile soil.*
- *Provide hot springs (with medical value).*
- *Generate geothermal energy.*
- *Help in the formation and concentration of minerals.*
- *Help in the creation of new land.*

Activity 2.4

Make models of volcanoes and show the different parts of a volcano, using wooden blocks, mud or paper mach'e.

Earthquake

What is an earthquake? Why do earthquakes occur?

Earthquakes are sudden movements in the earth's crust. They are caused by internal movements deep down inside the earth. Earthquakes are frequently associated with faults. They take place along fault lines where the earth's crust is weak. When an earthquake occurs, vibrations from the centre spread out in the form of waves in all directions.

The point at which an earthquake originates is called the **focus**. The point on the earth's surface immediately above the focus is called the **epicentre**. As the vibrations spin out from the centre, the damage they cause becomes less and less.

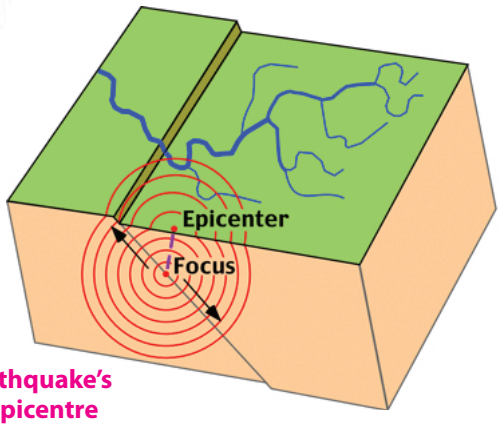


Figure 2.12 **An earthquake's waves, focus and epicentre**

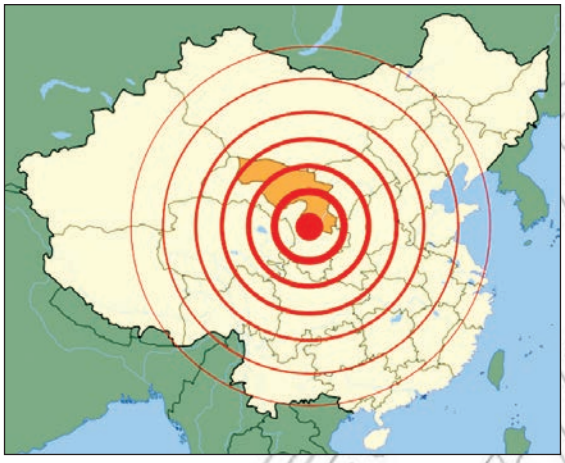


Figure 2.13 **The wave pattern and strength of an earthquake**

How do we determine the intensity or magnitude of an earthquake?

The intensity of an earthquake is measured by an instrument called a **seismometer,** and is recorded on a seismograph. It records the vibrations produced by an earthquake. The scale which gives the magnitude is called the **Richter scale.** It ranges from 0 to 9. Each number of this scale indicates a tremor that is ten times stronger than the next lower number. An earthquake with a magnitude of 4.0 is ten times stronger than one that measures 3.0. Readings of 7.0 or higher indicate a strong or major earthquake. The strongest ever recorded earthquake was the Valdivia earthquake in Chile that occurred on May 22, 1960 (9.5 on the Richter scale).

Table 2.2: **Richter scale values and the corresponding magnitude of earthquakes**

The Richter Scale	Effects
< 3.5	Detected only by instruments (seismometers)
3.5 – 4.8	Feels like a lorry passing
4.9 – 5.4	Loose things fall
5.5 – 6.1	Walls crack
6.2 – 6.9	Chimneys fall, some buildings collapse
7.0 – 7.3	Many buildings fall, landslides
7.4 – 8.1	Most buildings and bridges are destroyed
> 8.1	Total destruction

Effects of Earthquakes

What are the effects of Earth quakes?

Indian Ocean Earthquake

In December 2004, an earthquake with a magnitude of 9.1 to 9.3 rocked the Indian Ocean and caused a tsunami, known as the Boxing Day Tsunami. The initial death toll reported by the Associated Press was 100,000, but after the final count, it was reported that the death toll reached up to 225,000.

In addition to destruction of life and property, an earthquake causes:

- *displacement of parts of the earth's crust vertically or laterally.*
- *landslides and deep cracks in surface rocks.*
- *the devastation of cities, fires and diseases.*
- *the rise or lowering of the sea floor.*

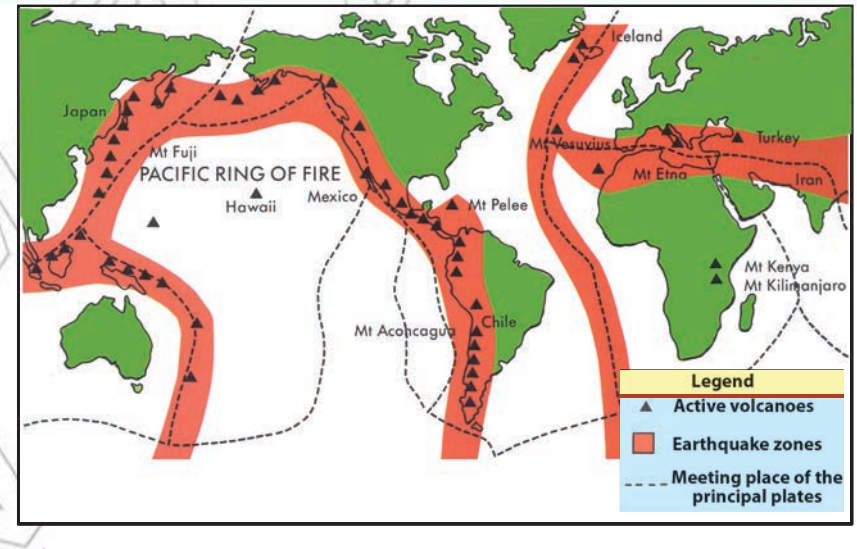


Figure 2.14 **The major earthquake and volcanic belts of the world**

About 80% of all earthquakes occur in three regions. They are

- *Around the Pacific Ocean zone. The largest earthquake and volcano zone lies along the edges of the Pacific Ocean. This zone is known as the Pacific Ring of Fire.*
- *Across Southern Europe and Southern Asia.*
- *The west-coast areas of North and South America.*

The two most recent earthquakes in Ethiopia measuring more than 5 on the Richter Scale occurred:

- *July 14, 1960, near Lake Shalla with a magnitude of 6 on the Richter Scale.*
- *June 2, 1961, in Karakore.*

Activity 2.5

In your geography work group, perform the following tasks.

1 Describe the effect of earthquakes on people, buildings and the infrastructure.

2 Name ten countries within the Pacific Ring of Fire.

2.1.2 External Forces

Weathering

What is weathering? What is the effect of weathering on landforms?

External forces can lower the level of the land by washing it away, and this process is called **denudation**. They also can raise the level of the land by **deposition**. **Denudation** consists of **weathering** and **erosion**.

Weathering includes *disintegration* (physical weathering), which breaks rocks into smaller pieces and **decomposition** (chemical weathering), which forms new substances.

Physical (Mechanical) Weathering

What is physical weathering? What are the main agents of physical weathering?

Physical weathering breaks the rocks into smaller pieces. Its main agents (causes) are **temperature changes**, **frost action** and **the action of plants and animals**.

The effects of temperature changes: The temperature variation between day and night causes rock to expand and to contract. This process causes cracks to develop. In time, the cracked layer peels off and falls to the ground. This process is called **exfoliation** (see Figure 2.15).

Figure 2.15 **Exfoliation domes**

The effects of frost action: Due to frost action, rock breaks up into pieces and these fragments accumulate around the lower slopes of the rock. This material is called **scree**. Frost action is very common in the winter season in the temperate zone and in some high mountains all year round (see Figure 2.16).

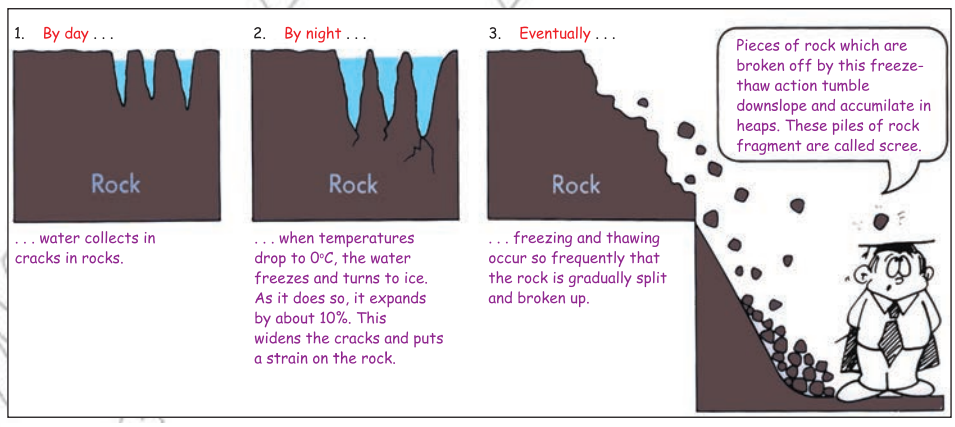


Figure 2.16 **The breaking of rocks by the action of frost**

The effects of plant and animal action: Plants and animals also cause weathering. For example, seeds may fall in cracks of rocks. If water collects there, it forms suitable conditions for the seeds to germinate and grow. As plants develop their roots may push the rock apart. Some animals burrow, and this also helps to break up rocks.

Figure 2.17 **Breaking of rock by a plant**

Chemical Weathering (Decomposition)

What process is important in chemical weathering? What are main agents of chemical weathering?

Chemical weathering is a process that forms new substances, and it is affected by the minerals in the rock. Its main agents are rain action and plant and animal actions.

As rain water passes through the atmosphere, it takes in carbon dioxide (CO_2) and forms a weak carbonic acid. When this acid water comes into contact with rock, it begins to dissolve minerals in the rock. The rate at which rock dissolves depends on the type of rock. Limestone, for example, dissolves very quickly. This process is known as **carbonation**.

$H_2O + CO_2 \Rightarrow$ carbonic acid $\Rightarrow$ dissolves and erodes limestone and forms caves.

Example:

Sofomer Cave along the River Weiyb in Bale.

Figure 2.18 **Sofomer Cave, in Bale formed by the River Weiyb and seeping rainwater**

In underground rivers, seeping rain water continues to dissolve the limestone beneath the surface, gradually forming passages and caves. These caves contain features such as stalactites, stalagmites and pillars.

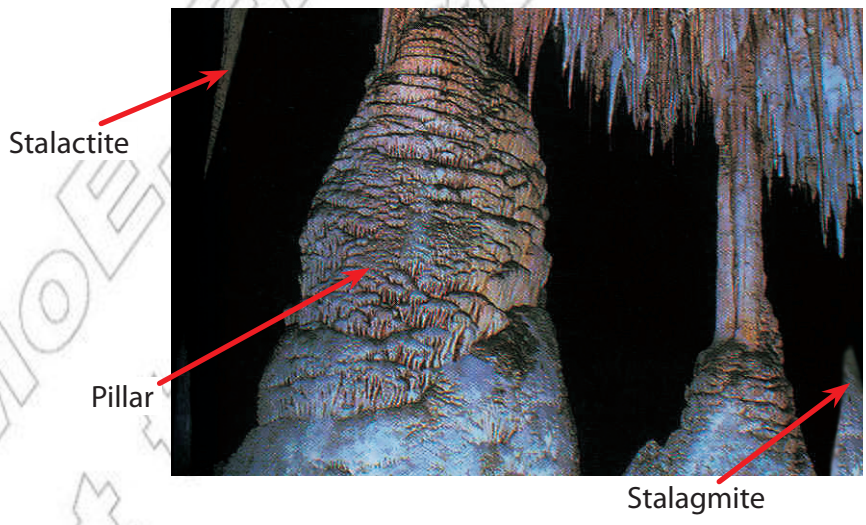


Figure 2.19 **Underground cave in a limestone area**

- *A stalactite is a limestone column that hangs down from the ceiling of the cave.*
- *A stalagmite is a limestone column that builds upwards from the floor of the cave.*

- *A pillar is formed when a stalactite and a stalagmite join together.*

When rain water dissolves oxygen and reacts with iron in rocks, the rocks become rusty.

Pollution in towns and cities increases chemical weathering.

How do plants and animals act as agents of chemical weathering?

Plants absorb minerals, and decaying vegetation produces organic acid, which causes a further breakdown of minerals.

Bacteria in the presence of water breaks down certain minerals in the soil.

Leaching is a major soil-forming process. It occurs when substances are dissolved in water that percolates through soil. Such substances include soluble chemicals that move out of biological tissues into soil - for example, rainfall causes potassium and other ions to be lost by foliage.

Erosion

What is erosion? What are the major agents of erosion? What are the major types of erosion? What are the characteristics of the agents of erosion?

Erosion is the transporting of weathered material by various natural forces such as moving water, wind and moving ice.

Erosion occurs when particles of rock or soil are:

- *washed away by a river*
- *removed by waves of the sea*
- *crushed under a glacier*
- *blown away by the wind*

Erosion by Running Water

How does running water cause erosion? What processes are included in erosion?

Rivers are the most important of all natural agents which help in shaping the earth's surface. The work of running water includes **eroding, transporting** and **depositing** eroded material.

There are three types of running water erosion:

1 **Sheet erosion**: occurs when surface water moves in a wide flow.

2 **Rill erosion**: occurs when surface water cuts relatively small channels.

3 **Gully erosion**: occurs when floods cut deep wide gorges.

The course of a river, from its source to its mouth, can be divided into 3 stages. The action of the river is different in these three parts. The stages are upper course, middle course and lower course.

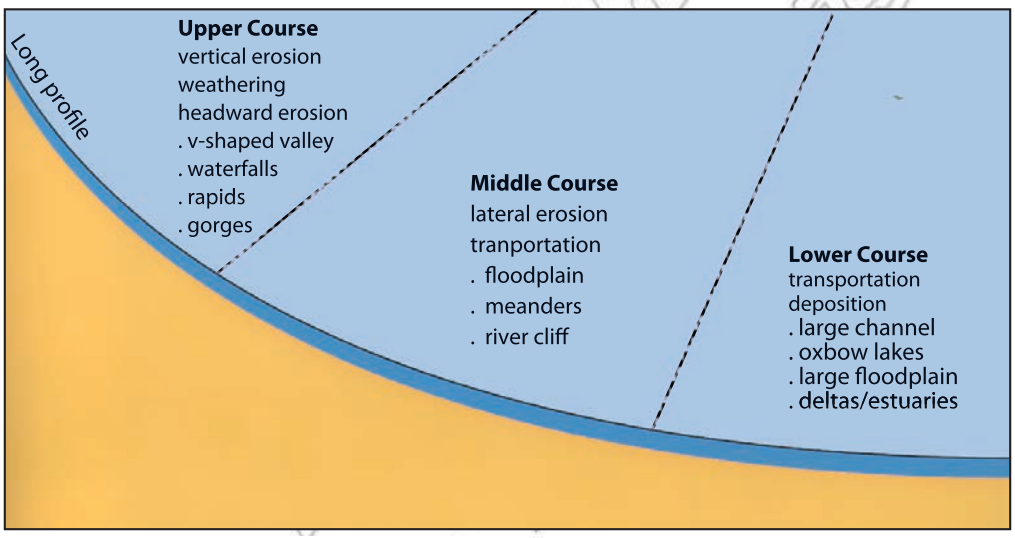


Figure 2.20 **The three stages of a river**

Activity 2.6

In pairs, discuss the followinq questions.

1 What are the main characteristics of the river stages shown in Figure 2.20?

2 Which stage has a steeper slope?

Upper Course

In this stage the river water is usually small in volume. As the river flows very fast down steep-slopes, a V-shape valley, waterfalls and deep gorges are formed. The fast flow of the river causes vertical erosion and destruction. The V-shape valley has steep sides and a narrow floor. The fast flowing river cuts down deeply into the land.

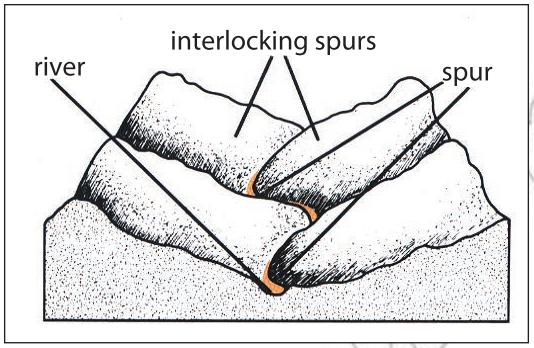


Figure 2.21 **Features of the upper course of a river**

Waterfalls are caused by sudden drops in the level of rivers. Waterfalls are formed when water flows over hard rock which cannot be eroded easily, while soft rocks are easily eroded. The hard rock produces an overhang, and the water flows over it as a waterfall.

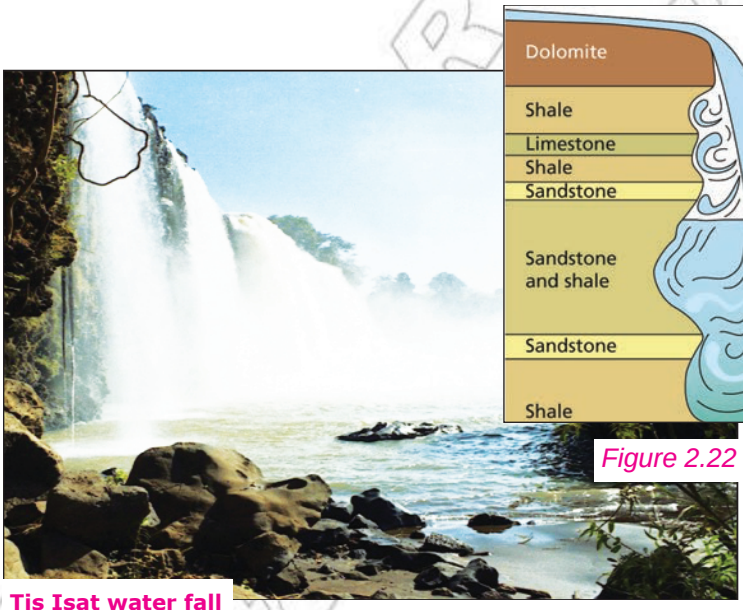


Figure 2.22 **Waterfall formation**

Tis Isat water fall

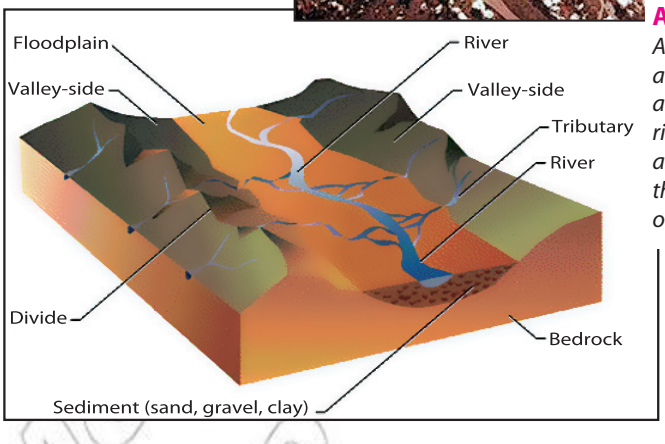
The Middle Course

During a river's middle course, the river valley becomes wider and larger. The river may receive waters of many tributaries, which increase the volume of water. Wide-floored valleys with gentle slopping sides are the main features of the middle course of the river. Instead of taking the most direct course possible, the river begins to meander. Meanders are pronounced curves in the course of a river.

The Lower Course

The river flows fast, meandering over wide plains, and makes widespread deposition. The load is so large that deposition occurs. **Flat floodplains**, **big meanders**, **levees**, **ox-bow lakes** and **deltas** are the main features of this course.

Nile Delta
This satellite image of the Nile Delta shows the Nile River spilling out from the Egyptian desert into the Mediterranean Sea. The longest river in the world, the Nile, has a delta about 250 km wide.



Anatomy of a Floodplain
A floodplain is a broad, flat section of a valley floor filled with sand, gravel, and clay. Floodplains form when a river running along a valley floods and spills out of its channel. The river then deposits sediments as it flows over portions of the floodplain.

Figure 2.23 **Features of the lower course of a river**

Floodplains are broad flat areas which border with the lower course of a river and are sometimes flooded by the river. They are covered with fertile alluvial soils which are deposited by the river when flooding. **Levees** are narrow ridges of alluvial deposits found along the bank of a river. **Ox-bow lakes** are crescent-moon shaped lakes created due to meanders that have been abandoned. They are formed when meanders are cut off from the main river channel. **Deltas** are usually triangular areas of land which are usually formed at the mouth of rivers.

Activity 2.7

In your group, perform the following tasks and answer the following question.

1 How do rivers transport materials?

2 If there is a river near your school, your teacher will organize a field trip to it. At that site, identify landforms such as meanders, waterfalls, gorges, floodplains, V-shaped valleys, etc. Then write a short note on your findings and present it in your classroom discussion.

3 Prepare charts or models representing major landforms associated with a river.

Erosion and Deposition by Sea Waves

What are coastal landform features produced by wave erosion?

Waves are formed when wind moves over the surface of the sea. This causes the particles of water to move in a circular motion, which forms a wave. This movement of water in the sea clashes against coastal lands and picks up rock particles and throws them into the sea as sediments. The work of the sea along the coast includes erosion, transportation and deposition. Some of these features formed along the shoreline are **beaches, spits** and **lagoons**.

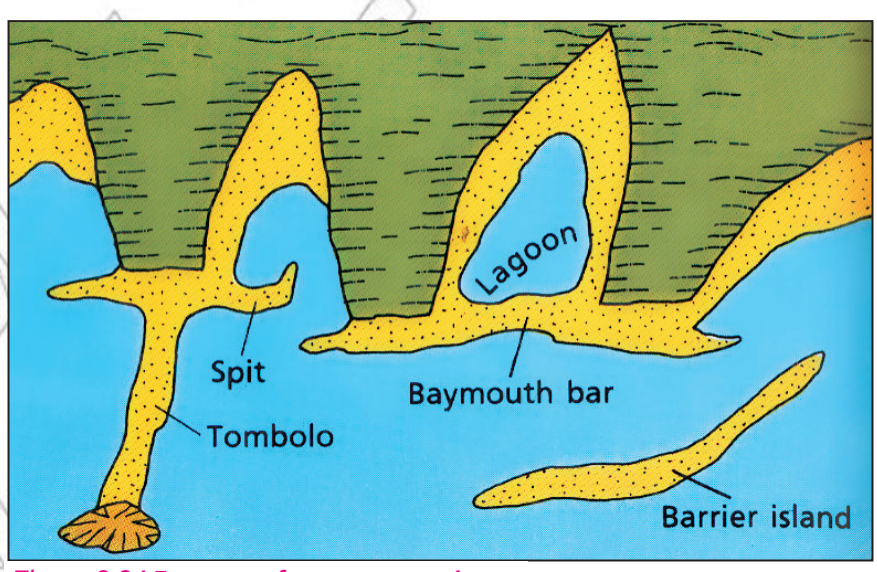


Figure 2.24 **Features of sea wave erosion**

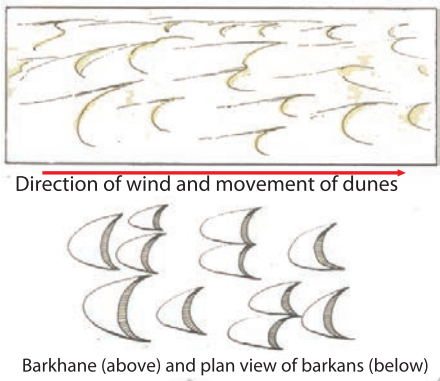
Beach is a strip of land along the sea coast covered with various types of sediment. A **Spit** is a narrow ridge of sand or shingle. It projects into the sea but is attached to the land at one end.

Lagoon is an area of saltwater separated from the sea by loose sandbanks.

Wind Erosion and Deposition

What is the most active agent of erosion in desert regions? What is the most common type of wind deposit?

Wind erosion is common in desert and semi-desert areas. Wind erosion and deposition form different landforms such as **sand dunes, barchans and loess deposits**.



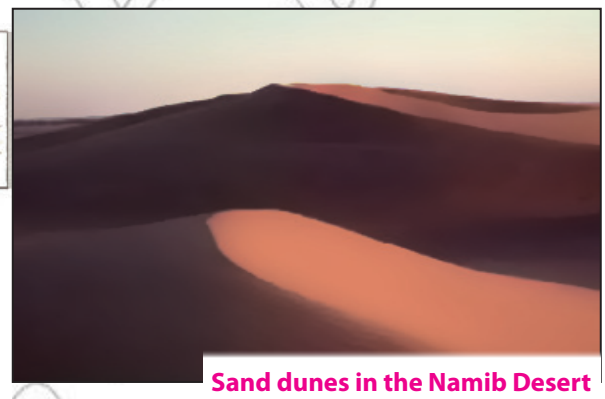

Sand dunes in the Namib Desert

Figure 2.25 **Landforms associated with wind erosion**

- **Sand dune** *is a small hill of sand formed by the action of the wind.*
- **Barchan** *is a sand hill that has a crescent-moon shape.*
- **Loess deposit** *is a deposition of fertile soil in the desert by wind.*

Activity 2.8

In your group, perform the following tasks and answer the following questions.

1 Describe the difference among spit, lagoon and beach.

2 Compare and contrast barchans, sand dunes and loess deposits.

Exercise 2.1

Word Game

Down

1 The method by which the strength of an earthquake is measured.

Across

2 Sleeping volcano.

3 The opposite of compression.

4 Young fold mountain in North America.

5 Young fold mountain in Asia.

6 Sudden movement in the earth crust.

7 Magma may force through this narrow hole.

8 Types of erosion occur when surface water cuts relatively small channels.

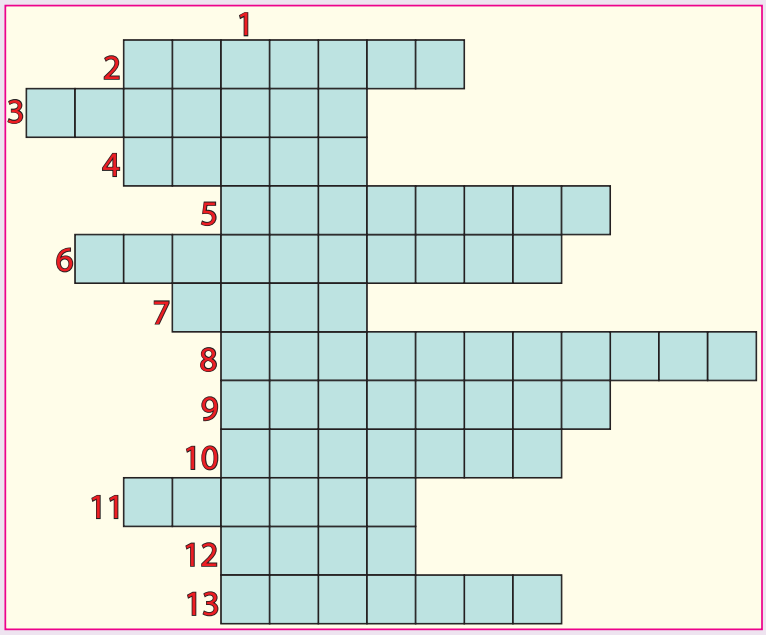
9 Downward fold of bedrock.

10 Large crater at the top of volcano.

11 Circular funnel-shaped depression produced by volcanic eruption.

12 The side of an upfold.

13 The transporting of weathered materials by water, wind, etc.



2.2 WEATHER AND CLIMATE

At the end of this section, you will be able to:

- explain the meaning of atmosphere;
- discuss the composition and layers of the earth's atmosphere;
- explain weather and climate;
- express the concept of temperature;
- appraise the variation of temperature;
- demonstrate how to measure and record temperature data;
- compute normal temperature lapse rate;
- interpret temperature data;
- explain the formation of rain;
- discuss the types of rainfall;
- relate the various roof slopes of houses in various climatic regions to the respective types of rainfall;
- explain what cloud is;
- describe types of clouds;
- practice measuring and recording rainfall data;
- differentiate types of winds (local, monsoon and planetary winds, including cyclones and anticyclones);
- relate direction and deflection of winds to the earth's rotation;
- interpret wind speed and direction from wind gradient map;
- explain how conditions of wind affect structures of buildings and crop production;
- Identify types of atmospheric pressure;
- relate atmospheric pressure with temperature and altitude;
- demonstrate the pressure belts of the world:
- develop the skills of measuring and recording atmospheric pressure;
- analyze the position of the sun at various latitudes at noon time of Dec. 22/ June 21;
- examine the impact of latitude on temperature;
- justify the effect of altitude on the characteristics of temperature, rainfall and air pressure;
- compare and contrast the condition of rainfall and temperature between places of coastal and interior areas;
- express the meaning and types of ocean current;
- identify the impacts of ocean currents;
- recognize the effects of ocean currents on temperature and rainfall on land surfaces;

- discuss the types and location of pressure belts of the world;
- state seasonal movements of pressure belts in relation to the apparent movement of the sun;
- relate movements of planetary winds with pressure belts;
- predict the impact of cloud cover on temperature.

Key Terms

- Aerosols
- Atmosphere
- Convectional
- Cyclonic
- Evaporation
- Exosphere
- Jetstream
- Lapse rate
- Mesosphere
- Ocean current
- Orographic
- Precipitation
- Radiation
- Stratosphere
- Thermosphere
- Troposphere

2.2.1 Earth and Atmosphere

What is atmosphere? How do you explain the importance of atmosphere for human beings or for all life forms?

The air that surrounds the earth is called the atmosphere. It is an envelope of transparent colorless, tasteless and odorless gases found above the earth's surface.

Composition of the Atmosphere

The earth's atmosphere is a mixture of gases, suspended dust particles and condensed moisture droplets which are collectively known as **aerosols.** The gases are different in their volume.

Table 2.3: **Gases of Earth's atmosphere**

Major gases		Minor gases		Rare gases
Nitrogen	78%	Argon	0.93%	Hydrogen, ozone, methane, neon, helium, krypton , xenon, carbon monoxide
Oxygen	20.95%	Carbon dioxide	0.03%	

Activity 2.9

In your geography work group, perform the following task and answer the following questions.

1 Is carbon dioxide useful? If yes, how?

2 Why are carbon dioxide, oxygen, and ozone important to the earth's organisms?

3 How could plants or agricultural crops and animals in your locality be affected by the atmosphere?

Structure of the Atmosphere

The earth's atmosphere is divided into four layers based on temperature variation. They are troposphere, stratosphere, mesosphere and thermosphere (see Figure 2.26).

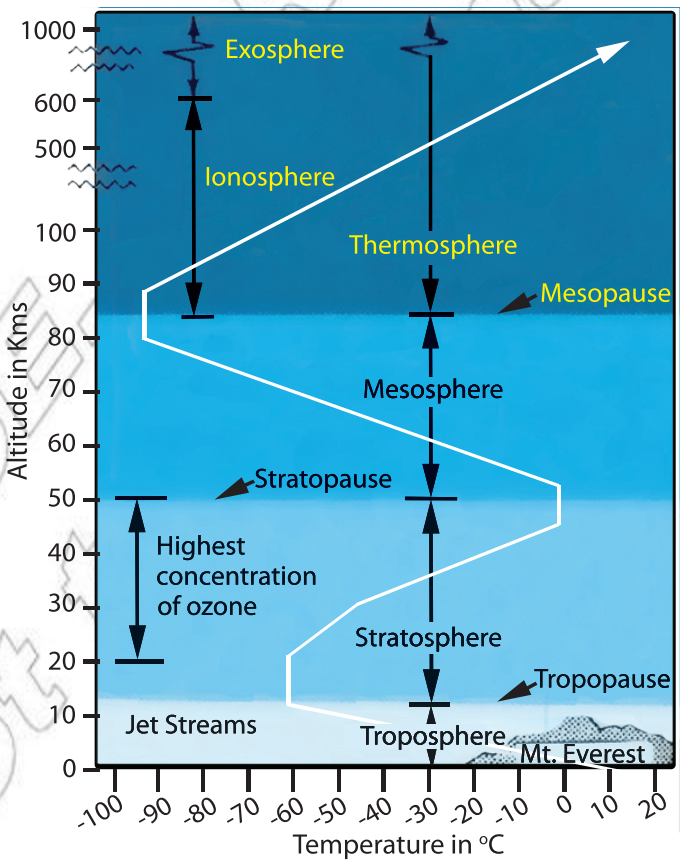


Figure 2.26 **Vertical structure of the atmosphere**

Table 2.4: **Atmosphere layers and their characters**

Name of the layer	Average height	Major characteristics
Troposphere	Extends from sea level to 8/16 kms	⇨ Contains 75% of the atmospheric mass. ⇨ Uniformly, temperature decreases with an increase of altitude. ⇨ The top boundary is known as the tropopause, which is characterized by jet streams (high velocity winds).
Stratosphere	Extends up ward to 50 kilometres	⇨ Has constant temperature. ⇨ High concentration of ozone gases. ⇨ Its upper limit is called the stratopause.
Mesosphere	Extends from 50 to 80/85 kilometres	⇨ It is the coldest part of the atmosphere. ⇨ Its upper surface is known as the mesopause. ⇨ Temperature decreases to nearly –100°C at the top of the mesosphere. ⇨ Meteorites burn and disintegrate because of friction here.
Thermosphere ⇨ Ionospheres ⇨ exosphere	Extends from 80/85 kilometres upward into space	⇨ Have extremely low density ⇨ Very little heat can be absorbed, held or conducted. ⇨ Temperature rises as high as 1200°C. ⇨ The ionosphere is a layer of electrically charged particles. These electrons and ions are useful for communication because they reflect radio waves. ⇨ The exosphere begins at an altitude of about 500 to 700 kilometres above the earth's surface and extends to interplanetary space.

Activity 2.10

Discuss the following issue and questions in pairs.

1 The main characteristics of the layers of the atmosphere.
2 Which layer of the atmosphere contains ozones? Discuss the use of ozone gas.
3 What is the coldest layer of the atmosphere?

2.2.2 Meaning of Weather and Climate

What is the condition of the atmosphere today? What is weather? What is climate? How is climate different from weather?

Weather is the condition of the atmosphere over a short period of time. Weather includes daily changes in **precipitation, air pressure, temperature, wind,** etc. Weather refers to atmospheric conditions in a given location.

What is the weather like in your locality today?

Climate is the average of all weather conditions of an area over a long period of time. These conditions include **average temperature, air pressure, humidity,** and **days of sunshine for a period of 30 years**. Climate tells us what it is usually like in the place where we live.

Major Elements of Weather and Climate

The major elements of weather and climate are **temperature, rainfall, winds, air pressure, clouds,** etc. You will learn more about these elements of weather and climate.

Temperature

What is temperature?

Temperature is the amount of hotness or coldness of an object. The sun is the primary heat source for the earth and its atmosphere. The sun's energy is called **insolation** or **solar radiation**, and this turns into heat energy at the earth's surface.

How is energy transferred in the atmosphere?

Not all the energy that originates from the sun reaches the earth's surface.

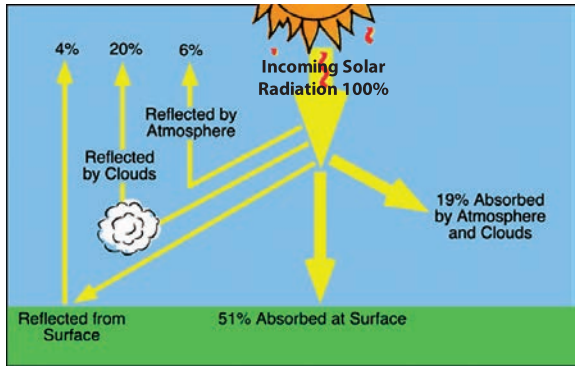


Figure 2.27 **Global modification of incoming solar radiation by atmospheric and surface processes**

Heat transfer takes place in three ways. These are

- Radiation
- Conduction
- Convection

Radiation is the transfer of energy from one body to another by means of electromagnetic waves. Energy transmitted from the sun reaches the earth's surface through the process of radiation. Electromagnetic waves usually travel through empty space. When these electromagnetic waves come in contact with an object, they transfer the heat to that object. The sun warms the earth through radiation of electromagnetic waves.

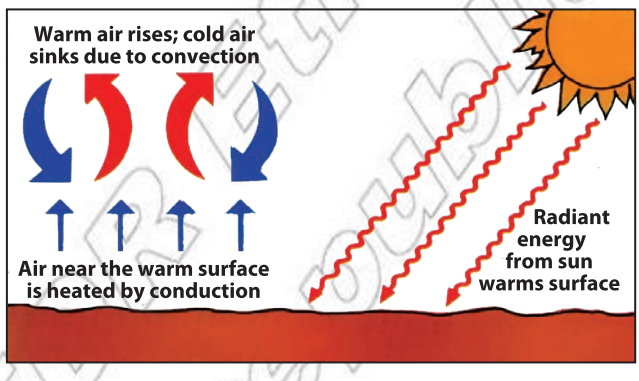


Figure 2.28 **Solar energy reaches earth by radiation**

Conduction refers to the transfer of heat through molecular contacts within and between bodies. Molecules are always in motion. The process of conduction is more important in solids. Air and water are poor conductors of heat.

Convection is the transfer of heat due to differences in density. As gas or liquid either warms and rises or cools and falls, it creates convection currents. Convection is the method by which heat moves through gases or liquids. As gas or liquid is heated, it warms, expands and rises because it becomes less dense. When the gas or liquid cools it becomes dense and falls. Heat gained through radiation or conduction usually transfers by convection.

Activity 2.11

In pairs, perform the following task and discuss the following questions.

1. Explain weather and climate.
2. How does energy in the atmosphere transfers?
3. Why is convection the most important form of heat transfer in the atmosphere?
4. Which method of heat transfer is the most important to bringing heat to the earth's surface?

Measuring and Recording Air Temperature

What is the instrument that is used to measure temperatures? Explain how air temperature is measured and recorded?

We measure temperature with thermometer. There are two types of thermometers: *maximum* and *minimum thermometers*.

A **maximum thermometer** is a mercury-in-glass thermometer that has a constriction near the bulb end. When the temperature of air rises, the mercury in the thermometer expands and forces its way into the stem past this constriction. But when the bulb cools, none of the mercury above the constriction moves back into the bulb. Therefore, the length of the mercury in the stem remains the same. The end of the mercury thread, which is the farthest from the bulb, registers the highest temperature reached in a day.

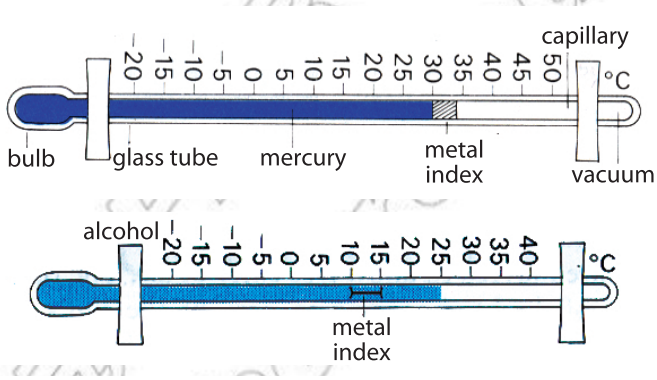


Figure 2.29 **The maximum and minimum thermometers**

- ⇨ *The freezing point of mercury is –38.83°C, and the boiling point is 356.73°C*
- ⇨ *Alcohol freezes at a temperature of negative one hundred thirty degree Celsius (–130°C)*

A minimum thermometer has alcohol as its liquid, and it sets a metal index. When the temperature falls, the alcohol column drags the index towards the bulb end. When the temperature rises, the alcohol column expands and runs past the index without disturbing it. Thus, the end of the index, moves the farthest from the bulb and gives the lowest temperature attained in a day. **Alcohol thermometers** may be used to measure temperatures from -130°C (freezing point of alcohol) to 785°C (boiling point of alcohol). The standard thermometer for environmental measurements needs only to cover the range between -30°C to 50°C.

Maximum and minimum thermometers are kept in a box-like shelter which is known as a **Stevenson screen**.

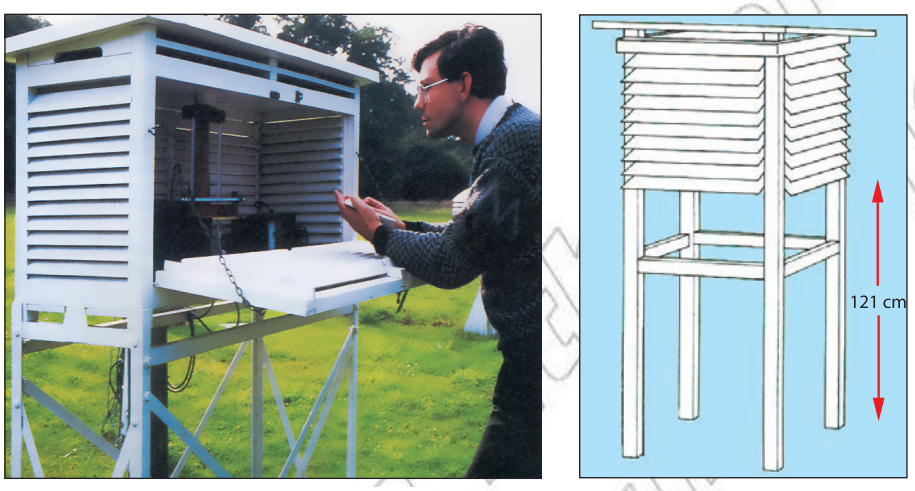


Figure 2.30 **Stevenson screen**

The temperature of the air changes from time to time. Typically we measure the daily and annual variations. The changes between the highest and the lowest temperatures during 24 hours of a day is known as the **daily march of temperature or the diurnal range.**

The changes of temperature from month to month within a year is known as the **annual march of temperature**. To describe this temperature variation, we have to use records for a long period of time. We use words like **average** and **range** to indicate the variations.

Daily average (mean) temperature: is obtained by adding the maximum and minimum temperatures of a day and dividing the sum by two.

Example 1:

If the maximum daily temperature is 25°C, and the minimum daily temperature is 5°C, daily average temperature = $\frac{25^{o}C + 5^{o}C}{2} = 15^{o}C$

- ⇨ *Monthly average (mean) temperature is calculated by adding all daily averages and dividing the sum by the number of days of the month.*
- ⇨ *Annual average is obtained by adding the average monthly temperatures and dividing the sum by 12.*
- ⇨ *Daily (diurnal) range is the difference between the maximum and minimum temperature in a day.*

Example 2:

If the maximum temperature is 25°C, and the minimum temperature is 5°C,

- ⇨ *Daily range = maximum – minimum* = 25°C – 5°C = 20°C.
- ⇨ *Annual range is the difference between the temperatures of the hottest and coldest months in a year.*

Example 3:

If the hottest month is 40°C, and the coldest moth is – 10°C,

Annual range = 40°C −(−10°C) = 50°C

Table 2.5: **Average annual temperature for Addis Ababa**

Months	J	F	M	A	M	J	J	A	S	O	N	D
Annual Max.Temp (°C)	23.3	24.3	24.8	24.2	24.4	22.8	20.6	20.6	21.3	22.3	22.6	22.8
Annual Min.Temp (°C)	9	10.8	11.6	12	12.3	11.2	11.3	11.2	11	9.9	8.7	8.1

Activity 2.12

1 By referring to Table 2.5,
   - a Calculate annual range of temperature.
   - b Calculate annual average (mean) temperature.
   - c Convert the data into graphs

2 When do the maximum and minimum temperatures of the month occur in Ethiopia? Why?

Rainfall

What is rainfall?

Rainfall is liquid precipitation. Any moisture that falls from the clouds towards the earth's surface is called precipitation. Precipitation may occur in the form of rain, snow, hail, sleet and drizzle. Precipitation is part of the water cycle or hydrological cycle. The water cycle begins as water is changed from liquid to vapour by evaporation and transpiration of water vapour. Once water vapour is formed, it expands and cools. Then, **condensation** occurs, forming clouds, and the water falls as snow, sleet or rainfall. The whole process is powered by solar

energy and is repeated continuously. This whole process is called the hydrological cycle.

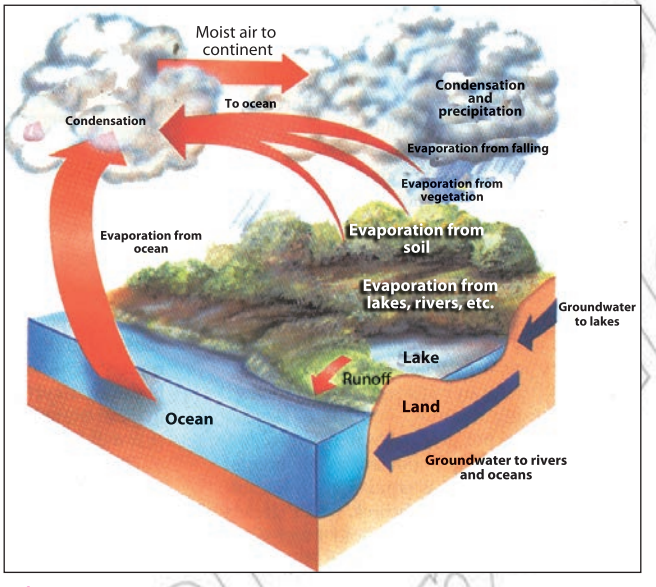


Figure 2.31 **The hydrological cycle**

- *Evaporation is the process by which liquid water is converted into gases.*
- *Transpiration is the transfer and change of water from plants to water vapour in the air.*
- *Evapotranspiration is the combined loss of water through the process of evaporation and transpiration.*
- *Condensation is the process by which vapour becomes liquid.*
- *Sublimation is the process in which ice changes into water vapour without first becoming a liquid, and vice versa.*

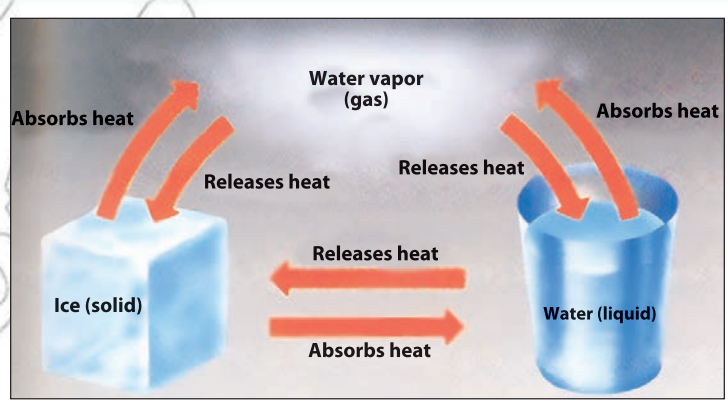


Figure 2.32 **Water exists in three forms**

Water is a unique substance, because it can exist in three states as liquid, solid and gas) in the atmosphere. Water either absorbs or releases heat when changes from one state to another (see Figure 2.32).

Types of rainfall

What are the types of rainfall? Explain their formation.

Rain is given three different names according to the different ways in which moisture is forced to rise. They are:

- Convectional rainfall
- Orographic or relief rainfall
- Cyclonic rainfall

1 **Convectional rainfall:** When the ground surface is heated by the sun, the air above it is warmed up. At high altitudes, the water vapour cools, condenses to form clouds and falls as rain. This type of rainfall is common in humid areas where temperature is high throughout the year.

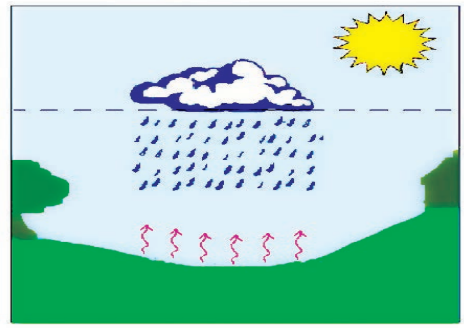


Figure 2.33 **Convectional rainfall**

2 **Orographic (relief) rainfall**: occurs when moist air is forced to rise over mountains. As it rises, it cools, then condenses and falls as rain. Almost all orographic rainfall falls on the windward side of mountains.

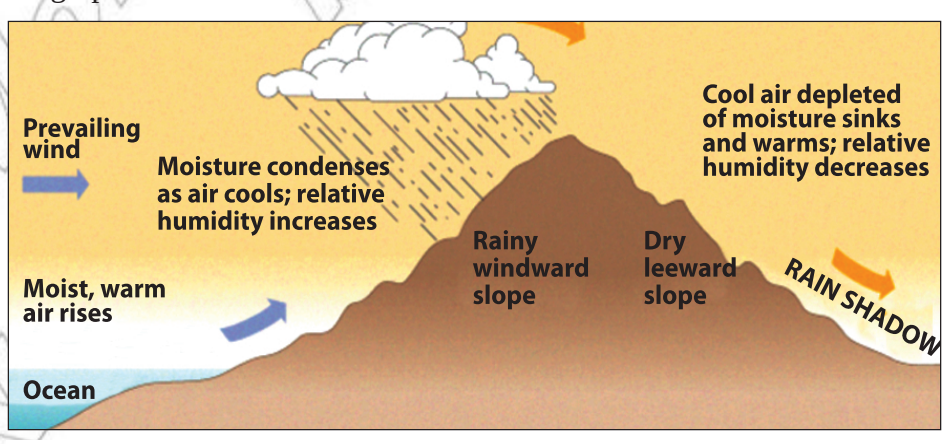


Figure 2.34 **Orographic (relief) type of rainfall**

3 **Cyclonic or Frontal rainfall** when two air masses (warm and cold) meet, they do not mix freely with each other. They remain separated with a boundary surface between them. The warmer and less dense air is forced to rise over the colder and heavier air. As the warmer air rises, it cools and condenses. Then clouds form and rain falls. The place where warm air and cold air meet is called a **front**. Frontal rainfall is very common in the middle and high latitudes (60° north and south from the equator).

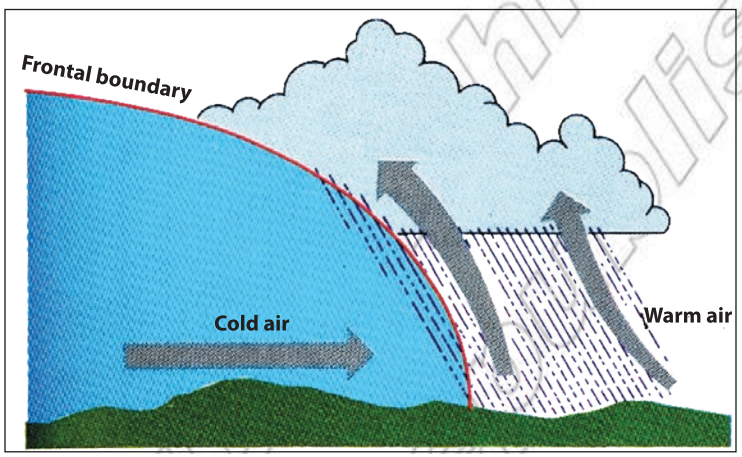


Figure 2.35 **Cyclonic/frontal rainfall**

Measuring and Recording Rainfall

Rainfall is measured using an instrument called **rain gauge**. A rain gauge consists of a wide-mouthed funnel placed over a cylindrical container. Rain water passes through the funnel into the container below. The water in the container is poured into a measuring cylinder, and then the amount of rainfall is measured in millimeters and is recorded.

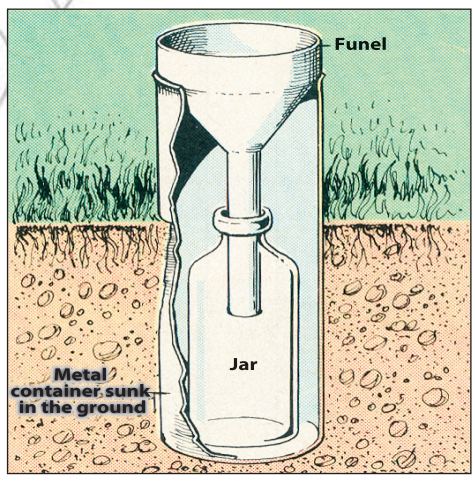


Figure 2.36 **A rain gauge**

Activity 2.13

Table 2.6: **Rainfall data for Debre Markos**

Months	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall (mm)	18.3	12.1	57.5	55.1	173.1	113	256.5	293.8	210.8	12	91	9.4

Using the preceding rainfall data for the Debre Markos station, perform the following tasks.

1 Calculate the total annual rainfall
2 Identify the season of heaviest rainfall.
3 Draw a line graph to illustrate each monthly total rainfall.

Air Pressure

What is air pressure? Explain how to record and measure pressure?

The air around us has weight. This weight exerts pressure on the surface of the earth. We call this atmospheric pressure. Atmospheric pressure is not the same all over the earth, and it is not the same even in one place all the time.

Pressure is measured by a mercury barometer. Normal pressure, at sea level, is about 760 mm/1013 mb.

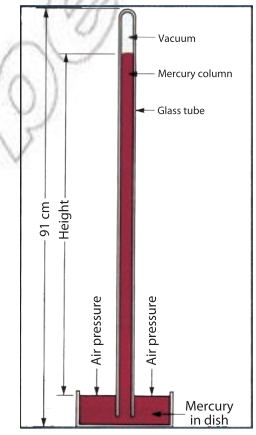


Figure 2.37 **Mercury Barometer**

The distribution of pressure over the earth's surface depends on (1) the **altitude** of places above sea level and, (2) most importantly, on **temperature**.

Pressure decreases with an increase in altitude. This explains why air pressure is highest at sea level and decreases with increasing altitude.

High temperature makes air expand, so that it has a lower density and pressure. Low temperature makes the air to contract, resulting in a higher density and creating an area of high pressure.

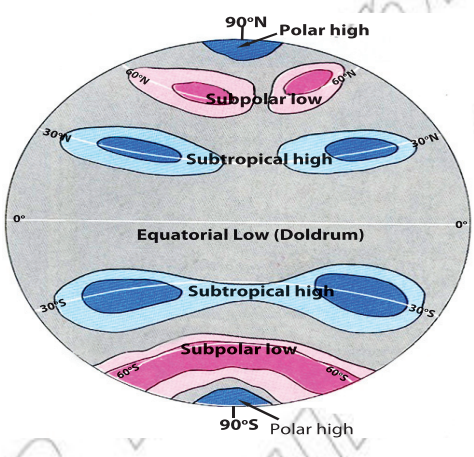


Figure 2.38 **Air pressure belts**

The distribution of air pressure over the globe is known as the *horizontal distribution of pressure*. Pressure distribution can be shown on a map. Lines connecting all places that have the same pressure are called **isobars**.

Focus

Global Pressure Belts:

1 Equatorial low pressure belt (Doldrums):

⇨ *Located from 5° North to 5° South.*

⇨ *There is tremendous heat, and thus warm air, creating low pressure. Also, the centrifugal force is very high at the equator, because the earth's velocity of rotation is high. Hence, the air masses tend to be thrown outwards, resulting in low pressure.*

⇨ *Wind speed is low, that is why this pressure belt is called the doldrums (Belt of Calm).*

2 Tropical high pressure belt (Horse Latitude):

⇨ *Located from 30° to 35° North and South.*

⇨ *Except for two months, temperature is usually high.*

⇨ *Here the pressure is high, because pressure depends on the rotation and movement of air (as winds from the Doldrums rise up and accumulate here. Also winds from the sub-polar low pressure belt accumulate here).*

3 Sub-polar low pressure belt:

⇨ *Located from 60° to 65°, North and South.*

➪ *Here the low pressure is created because of intense high pressure at the poles.*

4 Polar Highs

➪ *Located near the north and south poles.*

➪ *The polar zones have permanent centers of high pressure known as polar highs.*

The pressure distribution over the earth's surface is not a continuous belt. Except in the higher latitude of the southern hemisphere, they form belts due to the small land areas which do not affect the free flow of the atmosphere. However the position of the pressure belts and cells does not remain fixed in one position. They move north or south with the apparent movement of the sun.

During the northern hemisphere's summer, the sun is overhead north of the equator. The pressure belts then shift northward by a few degrees from their average position. During the southern hemisphere's summer, the sun is overhead south of the equator. As a result, the pressure belts move southward by a few degrees from their average position.

Activity 2.14

In your geography work group, answer the following questions.

1 What is atmospheric pressure?
2 Why does pressure decrease as there is an increase in altitude?
3 What effect does temperature have on atmospheric pressure?

Wind

What is wind?

Wind is air in horizontal motion. Winds have **speed** and **direction**. Wind force (speed) and wind direction are affected by

➪ *Pressure gradient*

➪ *Frictional force*

➪ *Coriolis force*

On weather maps, pressure is indicated by drawing isolines of pressure, called isobars. The difference in distance between *Isobars* is called the pressure gradient. If the isobars are closely spaced, we can expect the pressure gradient force to be

great, and wind speed to be high. In areas where the isobars are spaced widely apart the pressure gradient is low and light winds normally exist. High speed winds develop in areas where isobars are closer.

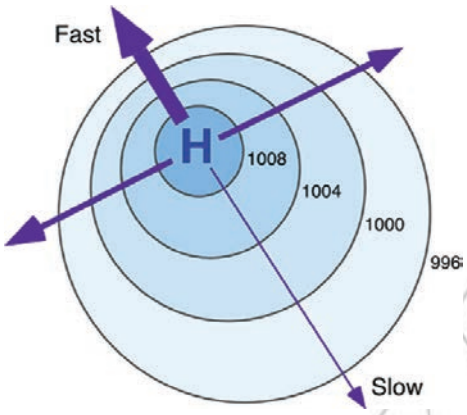


Figure 2.39 **Association between wind speed and distance between isobars**

Figure 2.39 shows that, thicker arrows represent relatively faster winds. Wind speed is often measured with animometer.

Winds are named according to the compass direction of their source. Wind direction is measured as the direction from where wind comes. For example, a southerly wind comes from the south and blows to the north. Direction is measured by an instrument called wind vane.

Strong winds are danger for aviation, sailors, and tall structures such as towers, masts and cranes. Winds also affect different homes in different ways depending on their design and location. The wind can collapse windows and doors, rip off roof sheeting and destroy gables and walls.

Regarding wind erosion, the speed and direction of the wind are directly related to the extent of soil erosion. Soil moisture levels can be very low at the surface of excessively drained soils, thus releasing soil particles to be transported by wind. This condition negatively affects the fertility of the soil, which reduced the yield of crop production.

Deflection of Winds Due to the Earth's Rotation

Because of the earth's rotation, the direction of wind blow may not be at right angles to wind isobars, but rather at slanting angles to them. This deflection is caused by friction. The speed of wind also affects the amount of deflection. The force which affects the direction of movements of winds is called the "**Coriolis force**." The deflection is to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

Near the ground, where the winds are slowed by friction, the air blows at an acute angle toward areas of low pressure, forming great gyres creating **cyclones** and

anticyclones. In the Northern Hemisphere, the **Coriolis** force causes air in low-pressure areas to spiral counter clockwise and inward, forming a cyclone, whereas air in high-pressure areas spirals clockwise and outward, forming an anticyclone. In the Southern Hemisphere, cyclones turn clockwise and anticyclones, counter clockwise.

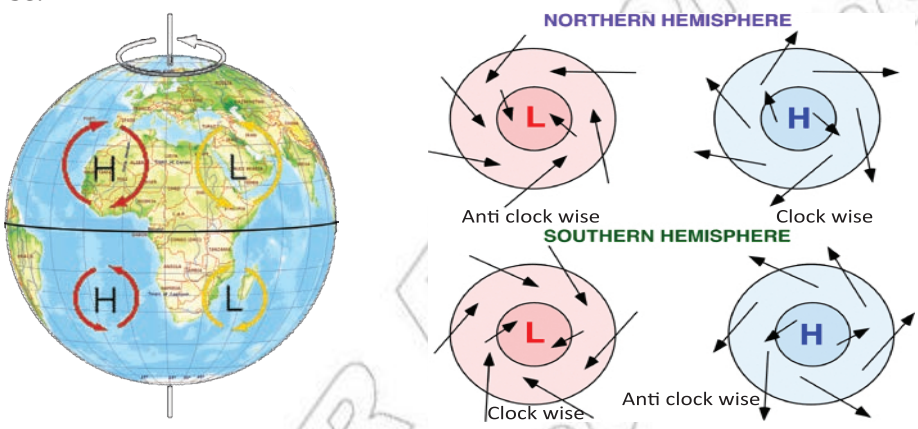


Figure 2.40 **Cyclones and anticyclones**

Focus

Cyclones are atmospheric disturbances which involve a closed circulation about a low-pressure center. They move inward, anticlockwise, in the Northern Hemisphere and clockwise in the Southern Hemisphere. Cyclones are commonly known as **lows** or **low pressure areas**.

Anti-cyclones are vast areas of high pressure which have a diverging system of surface winds. The winds in anti-cyclones blow outward in the anti-clockwise direction in the Southern Hemisphere and in the clockwise direction in the Northern Hemisphere.

Anticyclones are commonly called **highs** or **high pressure areas**.

Types of Winds

There are three types of surface winds. They are:

- ⇨ *planetary*
- ⇨ *monsoon*
- ⇨ *local winds.*

Planetary winds and their relationship with pressure belts: Planetary winds blow over large areas of the earth's surface. They are closely associated with

the world pressure belts. Winds blow from areas of high pressure to areas of low pressure. The most common planetary winds are **trade winds, westerlies** and **polar easterlies**. They have wide influence over the earth's surface (see Figure 2.41).

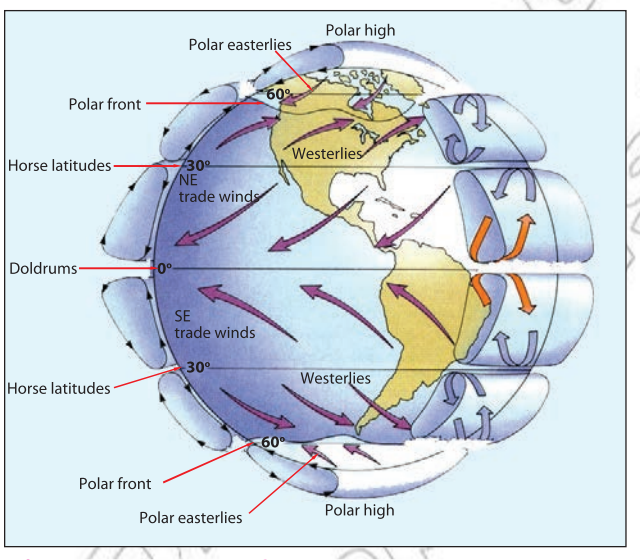


Figure 2.41 **Pattern of global wind belts**

Monsoon winds: They are seasonal winds whose movements are controlled by pressure that differs during different seasons.

Monsoon winds are very common in South and South East Asia. Seasonal changes in the direction of these winds are caused by the unequal heating of land and water surfaces. The direction of monsoon winds changes between summer and winter.

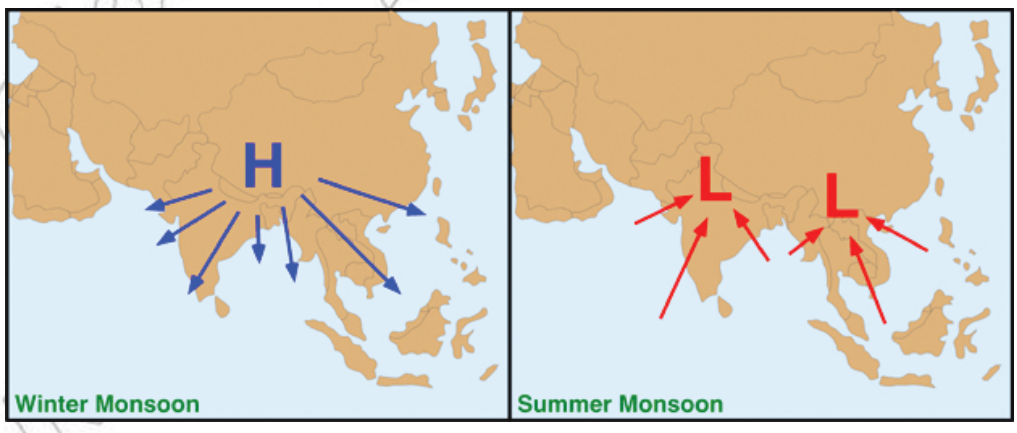


Figure 2.42 **Monsoon winds**

Local winds: They affect only limited areas and blow for a short period of time. They affect climate conditions on a small scale. Local winds are caused by the nature of the physical features of the area. The main local winds are:

- Land and sea breezes
- Mountain and valley breezes

1 **Land and sea breezes:** These winds are common along coastal areas. These winds change their directions daily and affect very small areas. During the daytime, temperature on the land is higher than on the water/sea. So low pressure is formed on the land, while it is relatively high on the sea. Wind blows from the sea towards the land. This is known as a **sea breeze**. At night the land is colder than the sea. So low pressure develops over the sea. The wind blows from land towards the sea. This is known as a **land breeze**.

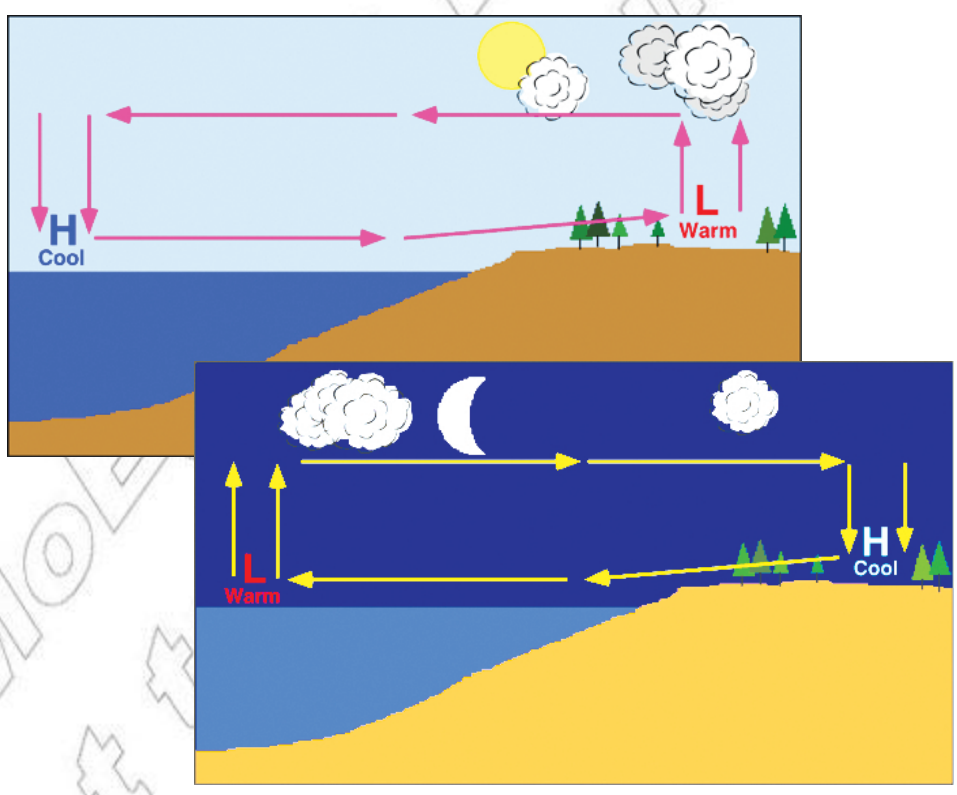


Figure 2.43 **Daytime and nighttime development of sea breeze and land breezes**

2 **Mountain and valley breezes:** Mountain and valley breezes arise from contrasts in temperature between a valley floor and mountain slopes. During the day the air at the bottom of the valley becomes warmer. As a

result it expands and rises along the mountain slopes. This is known as a **valley breeze**.

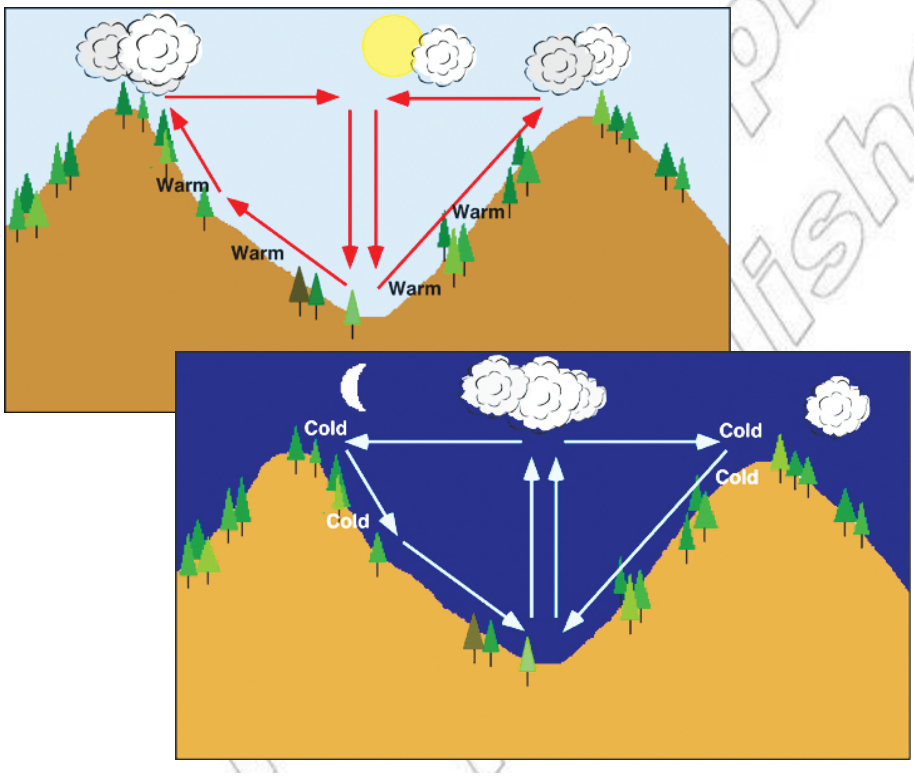


Figure 2.44 **Daytime and nighttime development of valley breezes and mountain breezes**

At night the wind over the slope of the mountain becomes cool. Then this cooler and heavier mountain air slides down slopes towards the valley. This is called a **mountain breeze**.

Clouds

What are clouds? How are clouds formed? What are the major types of clouds?

A cloud is a dense concentration of very fine invisible water droplets, sleet or ice crystals. Clouds are formed by the condensation of water vapour below the dew point in the atmosphere. There are varieties of clouds, based on their height, appearance and shape.

Table 2.7: **Types of clouds**

Group	Cloud type	Description
High clouds > 6000 m	Cirrostratus	Thin, wispy, appears in sheets.
	Cirrus	Thin, wispy, filamentous or curly, mostly composed of ice crystals.
	Cirrocumulus	Small, puffy, patchy and/or with a wave-like appearance.
Middle clouds 2000 – 6000 m	Alto cumulus	Medium-sized, puffy, patchy, scattered clouds – often in linear bands.
	Alto stratus	Thin and uniform.
Low clouds < 2000 m	Stratocumulus	Broad and flat on the bottom, puffy on the top.
	Stratus	Uniform, flat thick to thin layered clouds. Mostly composed of liquid droplets.
	Nimbostratus	Uniform, dark, flat, low clouds that produce precipitation. Mostly composed of liquid droplets.
Vertical clouds < 500 and > 18000 m	Cumulus	Puffy and piled up.
	Cumulonimbus	Can cause lightning, hail, strong rains, strong winds and tornados.

Source: *Focus on Earth science*

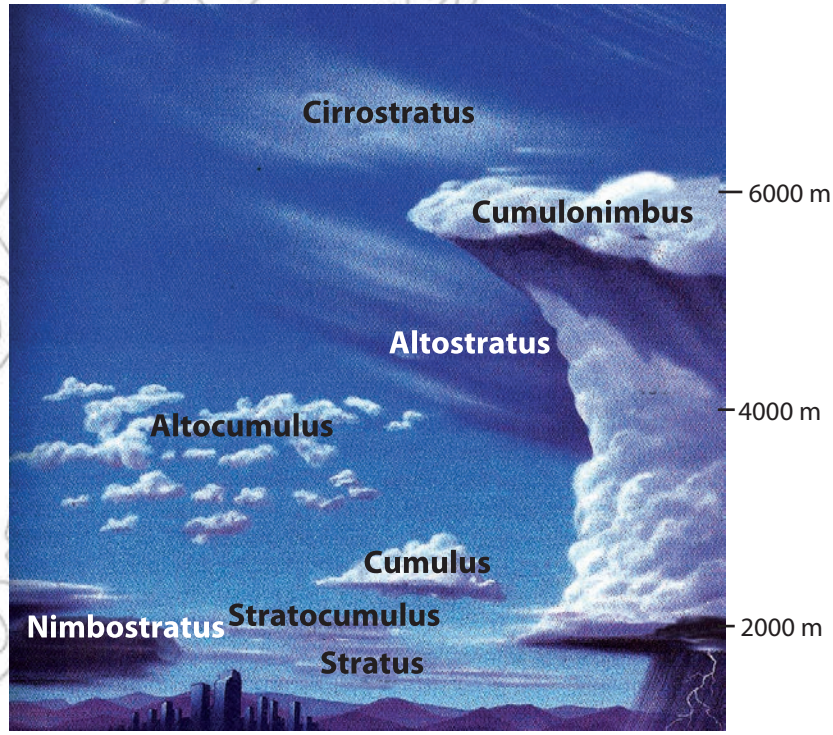


Figure 2.45 **Diagram of cloud types**

Activity 2.15

In your group, perform the following tasks and answer the following questions.

1. What are the major controlling factors responsible for the direction and speed of winds?
2. What is the difference between cyclones and anticyclones?
3. What are the effects of sea breezes and land breezes in a given locality?
4. Compare and contrast the characteristics and formation of monsoon winds and local winds.
5. Discuss the basic characteristics of planetary winds.

Controls of Weather and Climate

What are the major controls of weather and climate?

The energy that the earth receives from the sun is not distributed evenly. Many factors affect the distribution. These include **latitude, altitude, distance from the sea, cloud cover, ocean current**, **planetary winds** and **pressure**.

Latitude

What is latitude? What is the effect of latitude on temperature?

On a global scale, latitude is the most important factor determining the strength of heat reaching the earth's surface. When the sun's rays are vertical (at a right angle) to the surface, the amount of heat received is the greatest. But when the sun's rays are slanting (oblique) the heat's strength decreases.

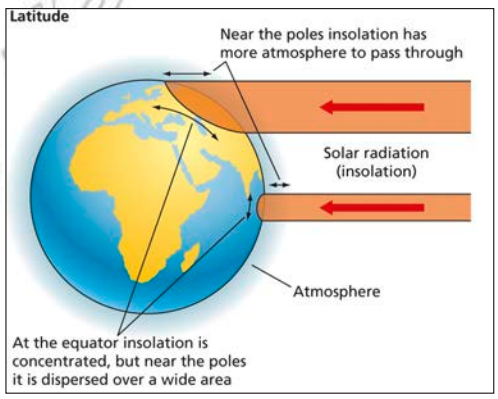


Figure 2.46 **Angle of the sun**

At the equator, the overhead sun is high and of high intensity insolation is received. At the poles, the overhead sun is low, so the amount of insolation is low. The sun is overhead at noon for six months between the equator and the Tropic of Cancer, and it is overhead for another six months between the equator and the Tropic of Capricorn.

The sun is directly overhead at the Tropic of Cancer on June 21 (the June solstice). The sun is directly overhead at the Tropic of Capricorn on December 21 (the December solstice). At March and September equinoxes, the sun is directly overhead at the equator. At times between solstices and equinoxes, the sun is

overhead in tropical areas in the zone between the Tropic of Cancer and the Tropic of Capricorn. The sun passes directly over every tropical place twice a year: once as the sun moves from being overhead at the equator to being overhead at the tropic and then again on the return from the tropic to the equator. The sun is never overhead outside of the tropics. The sun is closer to overhead in the middle and high latitudes on the day of their hemisphere's summer solstice.

Altitude

Do you know how to compute temperature change with altitude?

Air temperature decreases with increasing altitude. The normal decrease of temperature with height is 6.4°C per 1000 m. This is known as the normal lapse rate. The normal lapse rate is the average rate or proportion at which temperature changes per unit of altitudinal change. The highland areas of Ethiopia are good examples of places that demonstrate the effect of altitude on temperature.

Example: If the altitude of the given mountain is 4070 m above sea level and the temperature at sea level is 20°C. What will be the expected temperature at the top of the mountain?

Solution: At normal lapse rate temperature decreases 6.4°C per 1000 m

Altitude of mountain = 4070 m

1000 m = 6.4°C

4070 m = ?

$$\frac{4070\ \text{m} \times 6.4^{\circ}\text{C}}{1000\ \text{m}} = 26.048^{\circ}\text{C}$$

Therefore, the temperature at the top of the mountain = 20°C – 26.05°C = - 6.05°C

Distance from the Sea

How distance from the sea affects the distribution of temperature over the surface of the earth?

Land heats more quickly than water. But it loses its heat quicker than water. This is because of the transparency of water reflections from water surfaces, evaporation, mixing and currents in water. All these conditions result in greater and more rapid temperature changes on land than in the seas. Therefore coastal regions are cooler than inland regions.

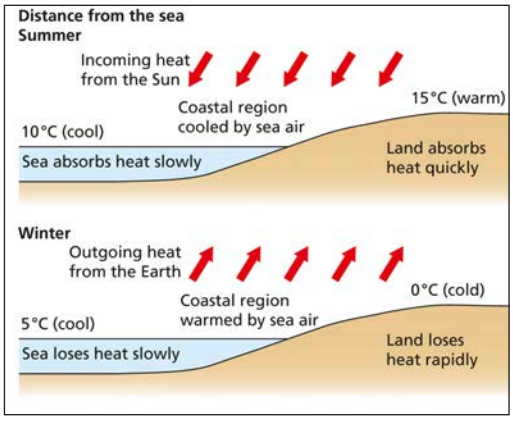


Figure 2.47: **Distance from the sea**

In winter in mid latitudes, the ocean surface is much warmer than land areas. So onshore wind brings heat to coastal lands. During the summer, coastal areas remain much cooler than inland sites.

Cloud Cover

What is cloud? How cloud affects temperature?

Cloud reduces the amount of solar radiation reaching the earth's surface and the amount of radiation reflected from the earth's surface. When there are no clouds both types of radiation will be at a maximum level.

Ocean Current

What is ocean current? How ocean current affects the distribution of temperature?

Ocean current is the horizontal movement of ocean waters caused by winds and differences in temperature. The effect of ocean currents on temperatures depends upon whether the current is **cold** or **warm**.

The water at the equator is warmer and less dense than that in polar areas. Convection currents in the oceans result in a pole ward flow of warm, light,surface water. Compensating heavy cold water flows through the ocean depths towards the equator.

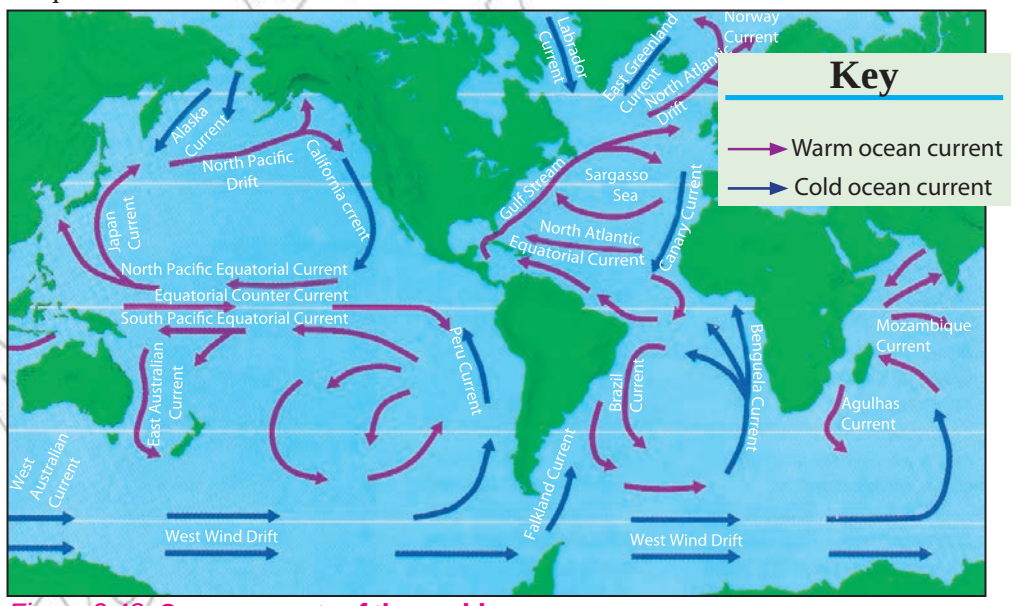


Figure 2.48: **Ocean currents of the world**

Ocean currents are the source of temperature regulation on the earth. Ocean currents change the temperature of a particular region. A warm ocean current makes the weather of the nearby regions to go up in temperature, whereas cold

ocean currents reduce the surrounding temperature. For instance, the European coasts get warmth from the ocean current of the Mexican Gulf stream, and southwestern Africa's Namib Desert is cooled by the Benguela current off the continent's western coast.

The currents also play major roles in determining the global geography of precipitation. The sun can more easily evaporate warm water than cold water and thereby produce the atmospheric vapor that results in rain. Therefore, land impacted by warm currents tends to have abundant precipitation in addition to a comparatively warm climate. In contrast, land impacted by cold currents tends to receive very little precipitation in addition to having a comparatively cool climate.

Winds

What is wind? What is the effect of wind on temperature?

Winds indirectly change the temperature of places near the sea according to the areas from which they blow. There are two ways by which distribution of temperature is influenced by winds.

1 Winds carry the temperature from one place to another.
2 Winds blow the surface layers of a body of water in the direction of their flow.

In this way, the winds have the effect of raising the temperature of the shore towards which the wind is blowing and lowering the temperature of the opposite shore.

Note

In temperate zones, winds that blow from the land lower winter temperatures, but raise summer temperatures. Winds blowing from the sea lower summer temperatures, but raise winter temperatures.

Activity 2.16

In your group, perform the following task and answer the following questions.

1 Which area of the world receives the overhead sun (the sun's rays at a right angle)?
2 Why does temperature decrease with increase in altitude?
3 In what ways do ocean currents change temperature?
4 Why do average temperatures fall as you move from the tropics to the poles?
5 What would be the temperature be at the top of mountain Ras Dashen assuming that the temperature at sea level is 30°C?

Exercise 2.2

I *Determine whether each of the sentences below is True or False.*

1 Air pressure increases with altitude.

2 Compared to warm air, cold air is more dense for a given volume.

3 Winds blow away from the center of high pressure.

4 Winds that blow in opposite directions in different seasons because of the differential heating of the land and oceans are called monsoons.

II *Choose the correct answer.*

5 Almost all of the energy reaching the earth from the sun is in the form of _____.

A gamma rays
B ultraviolet ray
C atomic particles
D electromagnetic waves

6 The process by which ice changes directly into water vapor is referred to as

A Conduction
B Sublimation
C Condensation
D All

7 The instrument used to measure wind speed is _____.

A Barometer
B Windvane
C Animometer
D Thermometer

8 Ocean currents influence temperature by

A eroding shorelines
B washing warm, dry sediments out to sea
C heating or cooling the air
D dispersing the rays of the sun

9 At the equator, the sun's rays always strike the earth

A at a low angle
B 18 hours each day
C at nearly 90° angle
D no more than 8 hours each day

III *Complete each of the following sentences with the correct word or phrase.*

10 Atmospheric pressure is measured with a _____.

11 Ozone within the atmosphere protects us from _____.

12 Jet streams occur in the layer of the atmosphere called the _____.

13 We live in the layer of the atmosphere called the _____.

14 The abundant gases in the atmosphere are _____ and _____.

2.3 NATURAL REGIONS OF THE EARTH

At the end of this section, you will be able to:

- analyse the concept of region and regional study;
- demonstrate temperature zones of the world;
- discuss the major characteristics of a tropical zone;
- state the general characteristics of the equatorial rainforest and hot deserts;
- distinguish the major sub regions of the tropical zone;
- explain the major relief features of Ethiopia;
- assess the major characteristics of the temperate zone and sub-regions;
- describe the general characteristics of the Mediterranean region;
- explain the general characteristics of a coniferous region;
- recognize the major characteristics of the frigid zone; and
- differentiate the general characteristics of tundra and the polar ice caps.

Key Terms

- Altitude
- Conifer
- Deserts
- Environment
- Forest
- Laterite
- Latitude
- Liana
- Rayon
- Relief
- Region
- Savanna
- Tundra
- Twilight
- Xerophyte

The Concept of Region and Regional Studies

What is a region? What are the major human activities in your locality? Can you identify the natural features of your locality?

A region is a part of the earth's surface which has similar physical elements and to some extent similar human activities. The earth provides many environments that vary in natural elements, such as relief, climate, vegetation, soil, etc. A region can be natural or human-made, can be small or large, and does not have a clear boundary.

To study the different ways of life of all the peoples of the world, one by one, would be very difficult. We have a method by which we can study the different geographical environments of the earth through peoples' social and economic activities. This is what we call a **regional study**.

The regions we are going to learn about are based on the physical elements of climate, vegetation, human activities, etc.

Major Natural Regions of the Earth

What is a natural region? Are all environments similar? What makes them different?

Different environments result in differences in human activities, population distribution and economic development. Mostly, natural regions are named after the dominant vegetation found in them. But their division is based on climate. The earth can be divided into three major temperature zones. These are:

- Tropical (hot) zone.
- Temperate zone.
- Frigid (cold) zone.

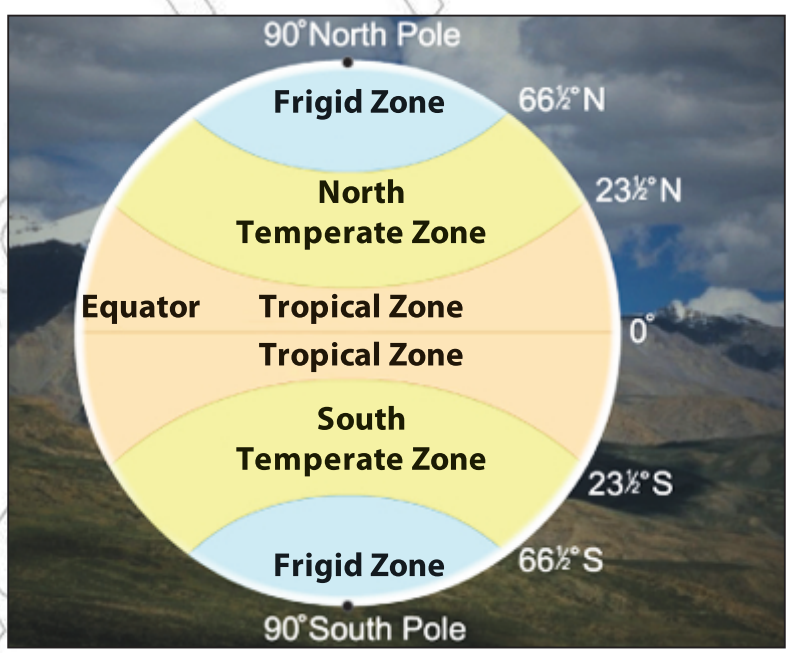


Figure 2.49 **Temperature zones of the earth**

Within each zone, there is a great deal of variation. Each zone can be divided into a number of sub-regions.

I Tropical (Hot) Zone

What is the location of Tropical zone? Explain the general characteristics of temperature?

The tropical or hot zone is the zone between the Tropic of Cancer (23½°N) and Tropic of Capricorn (23½°S).

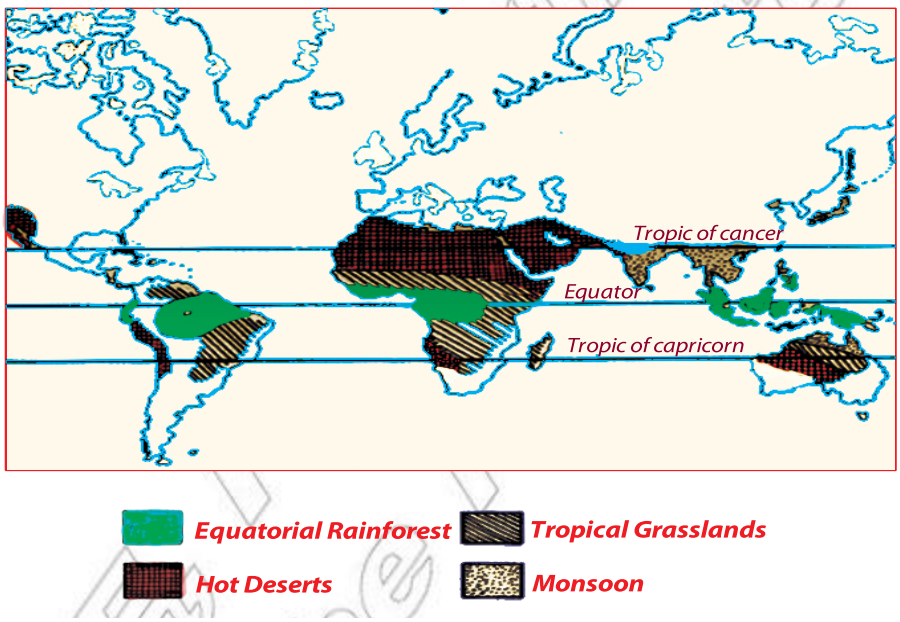


Figure 2.50 **Natural regions of the tropical zone**

The tropical zone is characterized by high temperature throughout the year. The annual average temperature is above 20°C, which decreases polewards from the equator. Rainfall decreases and becomes seasonal as one moves away from the equator. Along the equator there is dense forest which gradually changes with distance from the equator, to savanna grassland, semi-desert vegetation and true desert vegetation. Agriculture and mining are the major economic activities of the zone.

The tropical zone is divided into four sub-regions. These are:

- *the equatorial rainforest region*
- *the savanna grassland region*
- *the desert region*
- *the tropical monsoon land.*

Activity 2.17

Study Figure 2.50 and then perform the following tasks and answer the questions below.

1 List countries where equatorial rainforests are found.
2 Which continent has the largest desert?
3 What countries have the largest areas of tropical grassland or savanna?

Two sample sub regions are treated in detail below.

A *The Equatorial Rainforest Region*

What is the location of equatorial rainforest region? What are the major areas of the equatorial rain forest region?

Location

They are found in the lowland areas within 6° north and south of the equator. The main areas in the world include.

- *The Amazon Basin*
- *The Congo Basin*
- *Southern Malaysia and some Indonesian islands*

The equatorial rainforest region does not form a continuous belt around the earth. It is broken by high altitudes in East Africa and South America. The Amazon Basin is the most extensive area.

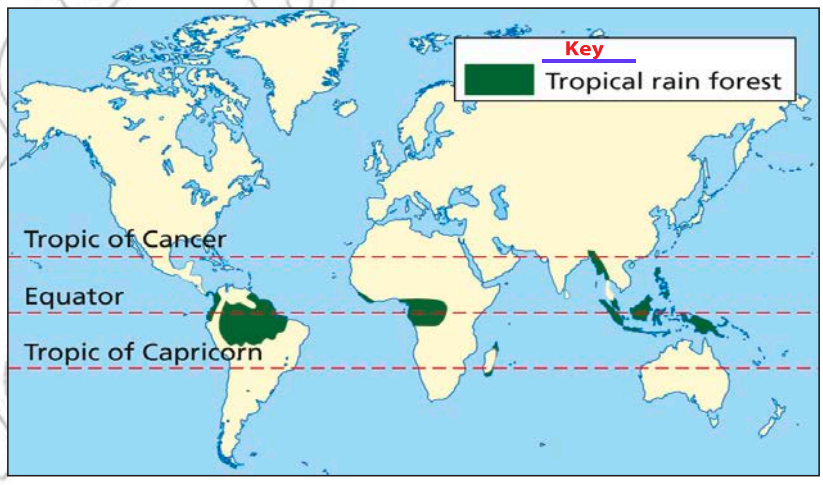


Figure 2.51 **Distribution of Equatorial rainforest Region**

Climate

Equatorial rainforest region has uniformly high temperature and heavy rainfall throughout the year. The mean annual temperature is about 27°C, and the annual range of temperature is less than 3°C. But the daily range is greater than the annual range of temperature. Rainfall in this region is mainly of a **convectional** type which falls every day, usually in the afternoon. The total annual rainfall is very high, usually between 1500 mm and 2500 mm. All months have rainfall with a small variation in amount.

Activity 2.18

Study Table 2.8 and answer the questions and perform the task that follow it.

Table 2.8: **Mean monthly temperatures and mean monthly rainfall of Singapore**

Month	J	F	M	A	M	J	J	A	S	O	N	D
Temp °C	27	27	27	28	28	27	27	27	27	27	27	27
R.F (cm)	251	188	188	193	170	173	173	201	173	206	251	269

Singapore is located 1° north of the equator.

1. What is the mean annual temperature of Singapore?
2. What is the annual range of temperature of Singapore?
3. What is the total annual rainfall of Singapore?
4. In which month is the highest rainfall received?
5. Plot line and bar graphs showing temperature and rainfall of Singapore respectively.

Natural Vegetation

The region has dense, tall, broad-leafed and evergreen trees. The high temperature and abundant moisture of this region makes plants growth continuous. The ground is covered with tropical rainforest, the most luxuriant type of natural vegetation in the world. Most of the trees are hardwood, such as rosewood, ebony, and mahogany, which are valuable for making durable furniture.

There are three layers in the forest:

1 **The top layer:** This is made of giant trees, often over 50 m high. They do not grow close together. They have very few branches except at the top.

2 **The middle layer:** This is made of the trees that are from 20 m to 40 m high. It is the main part of the forest.

3 **The lower layer:** This is made of the smaller, younger trees. In time, these grow and take the place of the larger trees.

Trees are closely spaced and interlaced with climbing vines called *lianas*. There are as many as about 3,000 species within a few square kilometres.

Figure 2.52 **Vertical stratification of a rainforest**

Wild Animals

The Equatorial rainforest is inhabited by varieties of animals, such as insects, birds, reptiles, mammals. Most mammals are arboreal. They are small in size and are tree climbing, example apes, monkeys, bats, squirrels, etc.

Water body animals, such as crocodiles, alligators, hippopotamuses, fish, etc, are also available.

Activity 2.19

In pairs, discuss the following questions.

1 Why is the equatorial rainforest covered with thick evergreen forest?

2 What are the major characteristics of the climate of the equatorial rainforest?

3 What are the major animals in equatorial rainforest?

Human Activities

What are the major economic activities in the equatorial rain forest region?

The human activities found in equatorial rainforests include primitive hunting and gathering, shifting cultivation, plantation agriculture, and mining.

Hunting and gathering: Many of the people of the equatorial rainforest region lead a simple and primitive way of life. The forest vegetation provides them with food in variety, if not in abundance. They also hunt animals and fish from the rivers.

Shifting cultivation: This is more advanced than hunting and gathering, and it provides people with a continuous food supply. An area of forest is cleared to create a small plot of land which is cultivated until the soil becomes exhausted. The plot is then abandoned and a new area is cleared. This is a threat for this region in the long run. Frequently the cultivators work in a circular pattern, returning to previously used land once the natural fertility of the soil has been renewed.

Shifting cultivation is, a simple form of agriculture based on the shifting of plots after two or more years.

This type of agriculture is practiced in equatorial rainforests because of the nature of the soil. The soil of the region lacks valuable mineral nutrients which resulted from excessive leaching. Such leached soil is called **laterite**.

Activity 2.20

1 In a small groups work the following. Find and read articles written in newspapers or magazines about:
   a plantation
   b mining in Ethiopia; and share the information with your group.

In pairs, discuss the following questions.

2 What is the advantage of the practice of shifting cultivation?

3 What is the threat in the long run caused by shifting cultivation?

Plantation agriculture: is a large scale production of one or two crops for sale. It is based on modern techniques of production. It was first introduced to the region by Europeans during the colonial period. Plantation agriculture is characterized by:

- ⇨ *Large-scale holdings, which draw most of their labor supply from the local inhabitants.*
- ⇨ *The production of a single crop (mono culture)*
- ⇨ *Heavy investment in processing plant, railway, shipment facilities, etc.*

The most important crops grown in the plantations of the equatorial rainforest region include rubber, palm oil, jute, bananas, pineapples, cocoa, sugarcane, etc.

There are a number of areas that produce commodities for export. For example, nearly half of the world cacao production comes from Ghana.

Rubber is one of the main plantation crops in Malaysia, Indonesia and Congo. The Amazon basin supplies only a very small amount of the world's rubber.

Mining: is the extraction of mineral-bearing substances from the earth's crust. The equatorial rainforest region is a source of useful minerals. Bauxite (an ore of aluminium) is found in Ghana, Guyana and Venezuela. Petroleum is found in Nigeria, Venezuela, and Indonesia. Iron ore is found in Liberia.

B *Tropical Deserts*

What is a desert? Where are the major tropical hot deserts? How were tropical deserts formed? What are the major characteristics of hot deserts?

Location

Deserts are almost barren lands. The tropical hot deserts are located between 15° to 30° north and south latitudes of the equator. The largest hot desert is the Sahara

Desert. There are also other important deserts such as the Kalahari, Atacama, Colorado, Arabia, Thar and Australian deserts. Deserts are formed due to their location

- *in the trade-wind belts*
- *on the leeward side of high mountains*
- *in the interior of continents*
- *along cool ocean currents*

Most deserts arise due to atmospheric wind conditions. Warm air masses create two belts of desert, one along the Tropic of Cancer and the other along the Tropic of Capricorn. Other deserts result from the effects of ocean currents on land masses, where cool air masses carry fog and moist, but little rain, along coastal regions.

Figure 2.53 **Tropical desert regions**

Deserts are located on the western margins of continents, except for the Sahara Desert, which is in North Africa and extends to the northeastern coast of the African continent.

Climate

The main characteristics of desert is that the climate is hot throughout the year, and there is very low and unreliable rainfall (not more than 250 mm per year).

Temperature ranges from 25°C to 40°C or above during the daytime, and they can fall even below 0°C during the night, due to the absence of clouds. The winds are warm and dry.

The following graph for Baghdad, Iraq shows the annual average weather condition readings covering rain, monthly average, maximum and minimum temperatures.

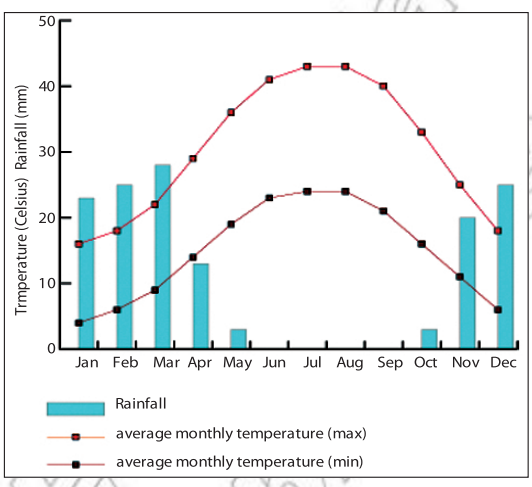


Figure 2.54 **Climate graph for Baghdad (example of hot desert climate)**

Vegetation

The climate of the hot desert is not favourable for plant growth. However, there are some plants that have a special way of behaving or special features (adaptations) which enable them to survive. Plants in deserts have long roots, few or no leaves, hard bark and an oily leaf surface. These features help the plants to extract every drop of moisture from the soil and reduce the loss of water by evapotranspiration. These are called *xerophytes*. Xerophytes are woody and thorny plants, grasses and herbs, for example cacti.

Animal life

Animals such as gazelle, hare, fox, snakes, lizards, etc are commonly available in the desert region. For the desert people camel is their best companion. It has special adaptations, which helps it to survive the desert.

Human Activities:

The major economic activities found in the hot deserts are pastoralism, crop cultivation and mining.

Pastoralism is the grazing of animals. Many of the desert people practice a nomadic way of life. Nomads do not live in one area. They move with their animals from place to place looking for water and pasture. They keep animals like camels, sheep, goats, cattle, etc. Small-scale crop cultivation is possible along wadis (small streams) and in the oases; dates, vegetables, fruits and cereals are grown. In areas where the deserts are crossed by rivers, irrigation on a large scale is possible. The waters of the Nile, Tigris-Euphrates and Indus have made possible the cultivation of crops in desert areas.

Most deserts are important sources of minerals. The most important mineral is oil. The Middle East alone accounts for about 60% of the world's total oil reserve.

Other minerals produced in hot deserts are nitrates and copper in the Atacama Desert, gold in the Australia Desert, diamond in the Kalahari, natural gas in the Sahara Desert and the Middle East, phosphate and iron ore in the northwest Sahara Desert. Therefore, mining is an important occupation in deserts.

Activity 2.21

In your group, discuss the following questions and perform the following tasks:

1 Why do deserts have very cold night and hot days?
2 Explain the three ways in which deserts are formed.
3 How plants have adapted to survive in deserts.
4 Why it is difficult to live in a hot deserts?

Case Study 1

Vertical Distribution of Climate in Ethiopia

Ethiopia lies within the tropics (3°N to 15°N latitude). It lies in a zone of maximum insolation where every place has overhead sun twice a year. However, as it is a highland country, tropical temperature conditions are not experienced everywhere. They are limited to the lowlands in the peripheries.

The traditional classification of climatic zones of Ethiopia is divided into five:

1 **Bereha (hot arid)**: found below 500 m a.s.l., where the average annual temperature range is between 30°C and 40°C or higher.
2 **Kola (warm to hot semiarid):** It is a climate of hot lands with altitudinal ranges of 500 - 1,500 m a.s.l. Average temperature is between 20°C – 30°C.
3 **Weina dega (warm to cool semi-humid)**: This is a zone which covers the temperate highlands that fall in altitudinal ranges of 1,500 – 2,300 m a.s.l. Its average annual temperatures are between 15°C and 20°C.
4 **Dega (cool to cold humid):** This describes the cool temperate highlands with an altitude ranging from 2,300 – 3,300 m a.s.l. and average temperatures between 10°C to 15°C.
5 **Wurch (cold moist temperature):** It coincides with the Afro-alpine areas on the highest areas of the plateaus. The lower limit of the wurch

zone, generally, coincides with the transition from coniferous forest to the vegetation dominated by Asta. This happens above 3,300 m.a.s.l. where Average temperature is below 10°C.

⇨ *Though Ethiopia is a tropical country, its climate types range from desert to hot steppe, and from tropical savanna and rainforest to warm temperate cool highlands. Ethiopia is a multifaceted tropical country, because of the influence of altitude.*

Case Study 2

Altitudinal Condition and Temperature Distribution of the Central African Republic

The Central African Republic (C.A.R.) is a landlocked country which lies in the heart of equatorial Africa. Most of its land is plateau that ranges with altititude from about 610 m to 792 m. Two ranges of hills in the north and northeast rise to maximum heights of about 1,402 m.

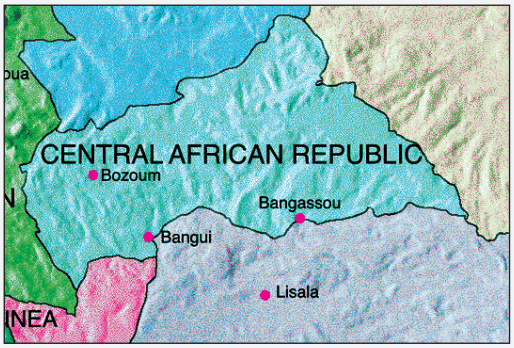


Figure 2.55 **Central African Republic**

The Central African Republic is characterized by the tropical climate with hot dry winters and mild-to-hot wet summers. The average annual temperature is about 26°C. The average annual temperature ranges in Bangui are from 21°C to 29°C, in July or August, to 21°C to 34°C in February. The northern part has a drier climate with temperatures reaching as high as 40°C, and it is prone to harmattan (hot dusty) winds, and even to desertification. The temperature in the south is lower, as 30°C during the day and 20°C at night. These conditions are similar to those in Ethiopia's western lowlands.

Though the C.A.R. gets a lot of rainfall (mostly in May-October), because of its altitude, it is not as hot and humid as many equatorial countries.

Activity 2.22

In your group, perform the following tasks.

1 Describe the differences and similarities in temperature distribution and altitudinal conditions between Ethiopia and the Central African Republic.

2 Examine the important factors that determine temperature distribution in Ethiopia and in the Central African Republic.

C *Ethiopia, a Mountainous Tropical Country in Eastern Africa*

Location of Ethiopia

What is location? Where is your region located? Describe the location of Ethiopia.

Location refers to the position or site that a place occupies. It is understood in two ways, **relative location** and **absolute location**.

Relative Location: Location of a place in relation to water bodies or land masses. It is also known as **vicinal location**. It can also be explained in terms of compass points such as North, East, South and West etc.

Ethiopia is located in the Horn of Africa. It shares common boundaries with five neighbouring countries.

Table 2.9: **Ethiopia's borderlines, shared with neighbouring countries**

Country	Location	Boundary lines in (km)
Sudan	West	1750
Somalia	South East	1600
Eritrea	North	840
Kenya	South	760
Djibouti	East	310

- *Size of Ethiopia is 1,106,000 sq. km*
- *In terms of land-area size Ethiopia is 10th in Africa and 25th in the world*

Absolute location is the position obtained in reference to the parallels of latitudes and meridians of longitude. The latitudes and longitudes are measured in degrees, which are expressed in numbers. Ethiopia has four extreme points. These are the

southern most tip, northern most tip, western most tip and eastern most tip. Thus, Ethiopia's absolute location is 3° N to 15° N and 33°E to 48°E.

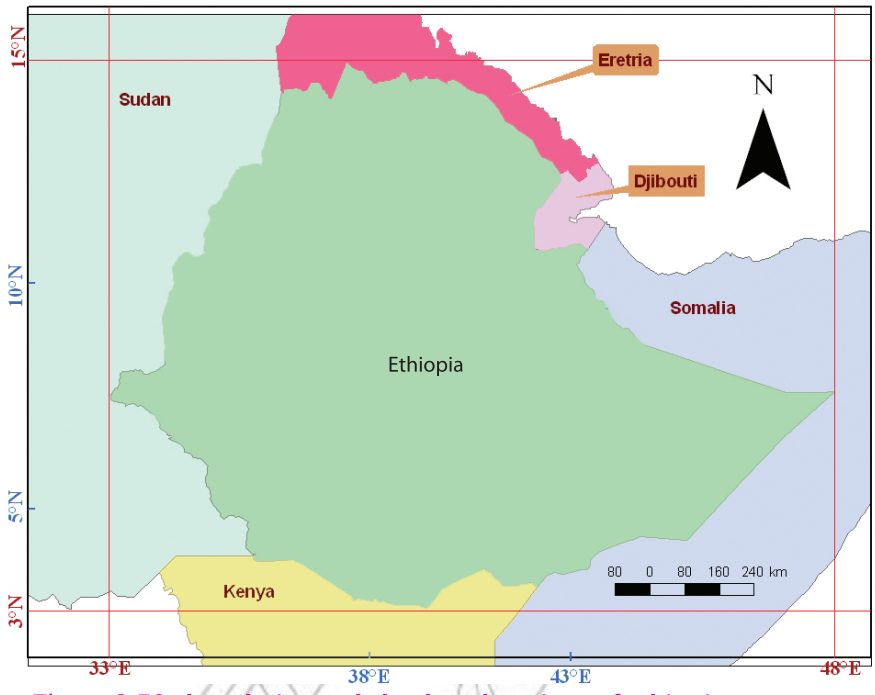


Figure 2.56 **The relative and absolute locations of Ethiopia**

- *The north – south extent of Ethiopia is 12°*
- *The east – west extent of Ethiopia is 15°*

Activity 2.23

Using Figure 2.56, perform the following task and answer the following question.

1 Explain the relative location of Ethiopia.

2 What is the influence of the south–north extent of Ethiopia on its climate? Discuss.

The Relief of Ethiopia

What does relief mean? What are the major relief features of Ethiopia?

Relief means the differences in altitude and surface structure of any part of the earth.

Ethiopia is characterized by a variety of landforms, such as mountains, plains, depressions, and valleys. The major landforms of Ethiopia can be classified into

- Highlands
- Lowlands

The point at an altitude of 1000 meters above sea level is generally considered to be the division between highlands and lowlands.

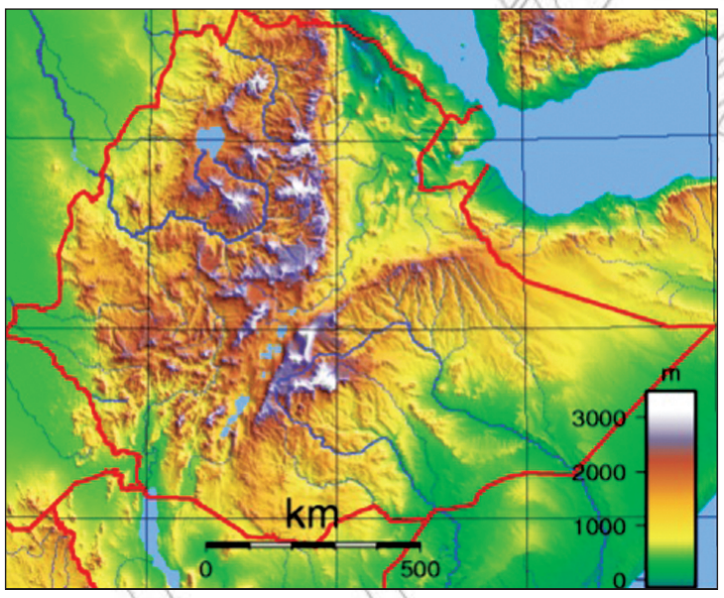


Figure 2.57 **Major relief of Ethiopia**

I *Highlands*

What is highland? What are the major highland areas of Ethiopia?

***Highlands** of Ethiopia are grouped into three areas:*

1. **Northern highlands:** include Tigray, Wollo, Gojjam, Gonder and the Shewan plateaus.
2. The **Southwest Highlands:** include parts of Wellega, Illubabor, Keffa, Gamogoffa and Benishangul highlands.
3. The **Southeast Highlands:** They are separated from the northern and southwestern highlands by the Ethiopian Rift Valley. They include the Arsi-Bale Massif, Jemjem Plateaus and Hararghe Highlands.

The highlands of Ethiopia account for more than half of the total area of the country. They experience cool climate and adequate rainfall. Here altitude modifies the climatic condition of Ethiopia.

II Lowlands

What is low land? What are the major lowland areas of Ethiopia?

Lowlands of Ethiopia include the areas below 1000 meters in altitude, and they are mostly found in the peripheral parts of Ethiopia. They are grouped into three categories. These are:

1. **Western Lowlands:** They include the Tekeze-Setit lowland, the Abay-Dinder and the Baro Akobo lowlands.
2. **Southeastern Lowlands:** include the Borana, Elkerre and Ogaden lowlands.
3. **Awash-Afar Lowland:** occupies the floor of the Rift Valley.
   - ⇨ **The Awash Valley:** *extends from the south of Koka Dam to the mouth of the Awash River.*
   - ⇨ **Afar Depression:** *extends northwards within the floor of the Rift Valley. It is the lowest point of Ethiopia, and the Kobar sink (116 m below sea level) is part of it.*

Activity 2.24

In your group, answer the following question and perform the following tasks.

1. Can you name the basic physical features of Ethiopia?
2. Using the map in Figure 2.57, locate regions (kilil) where the lowlands of Ethiopia are mostly found.

II Temperate Zone

What does temperate zone mean? Where is the temperate zone located?

What are the climatic characteristics of the temperate zone?

Location

The temperate zone is located between 23½°, and 66½°, both north and south of the equator. The temperate zone is the transitional zone between the tropical zone and the frigid zone. It is also known as a mid-latitude region.

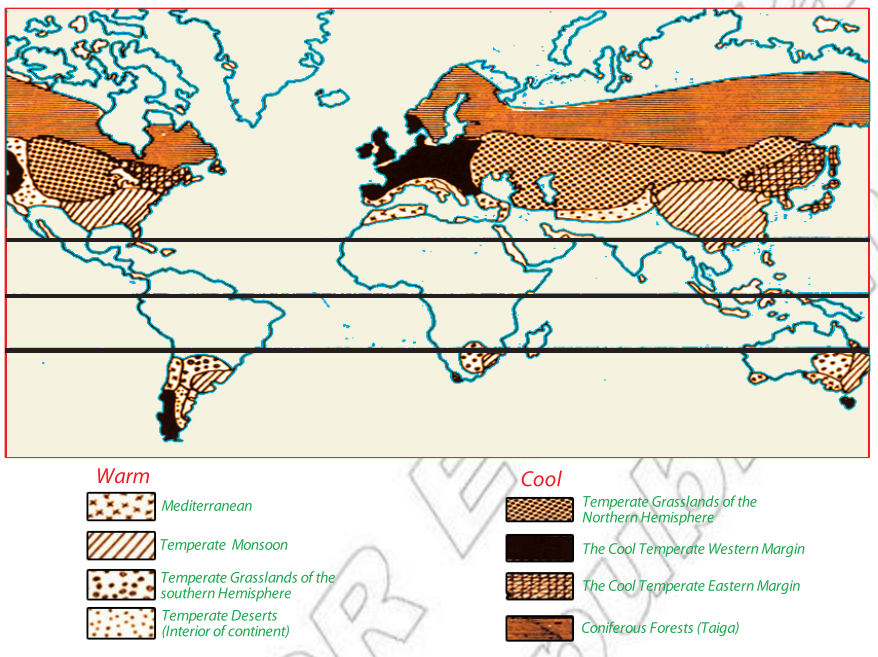


Figure 2.58 **Natural regions of the temperate zone**

Climate

Temperate regions usually have four distinct seasons. They are summer, winter, autumn and spring. Weather changes are observed in each season. Precipitation ranges from 750 mm to 1500 mm. Temperature ranges from below freezing point during the winter, to 30°C or more during the warmest days of summer. There are important factors that bring about frequent weather changes in the temperate zone. These are:

- **Convergence of tropical** *and* **polar air masses:** *This results in cyclonic storms and fronts.*
- **Angle of the sun:** *The sun is never overhead in the temperate zones. Therefore it does not heat the earth very much.*
- **Length of day:** *There is a big difference in the length of day between summer and winter. Days are longer in summer and shorter in winter.*
- **Effects of continents:** *This is more important in the northern hemisphere, where there are very large areas of land. In winter, the centres of the continents become very cold because they are far away from the sea. In this season, the angle of the sun is very oblique and it does not give much heat. During summer, the interiors of the continents become very hot. The annual range of temperature is therefore very great.*

Temperate region has coniferous forest, grasslands and shrublands. The region as a whole is generally more developed than the other regions. Most of the worlds industries are found in this region. Agriculture is also highly developed. Both growing of crops and rearing of animals are carried on modern and scientific basis. This is true with fishing and forestry, too.

The temperature region is, therefore, the most important producer of both agricultural and industrial productions in the world.

Sub-regions: The temperate zone is a very extensive zone. It contains many regions with different characteristics. But the two main divisions are the **warm temperate** and the **cool temperate regions.**

The warm temperate region includes:

- ⇨ *The **Mediterranean region areas**.*
- ⇨ *The **temperate monsoon lands**.*
- ⇨ *The **warm temperate grasslands** of the southern hemisphere.*
- ⇨ *The **temperate deserts** (in the interiors of the continents).*

The cool temperate region includes:

- ⇨ *The **temperate grasslands** of the northern hemisphere.*
- ⇨ *The **cool temperate western margins**.*
- ⇨ *The **cool temperate eastern margins**.*
- ⇨ *The **coniferous forest belts**.*

One sample area of each sub-region is discussed in detail below.

A *Mediterranean Region*

What is the location of the Mediterranean region? What are the climatic characteristics of the Mediterranean region?

Location

The Mediterranean region is located on the western coasts of the continents, particularly in the middle latitudes (30° to 45° north and 30° to 40° south of the equator). The major Mediterranean-region areas are:

- ⇨ *The surrounding area of (the shore of) Mediterranean sea*
- ⇨ *Southwestern part of South Africa*

- *Central Chile*
- *Central California.*
- *Southwest and Southern Australia (Adelaide to Melbourne).*
- *Northern New Zealand.*

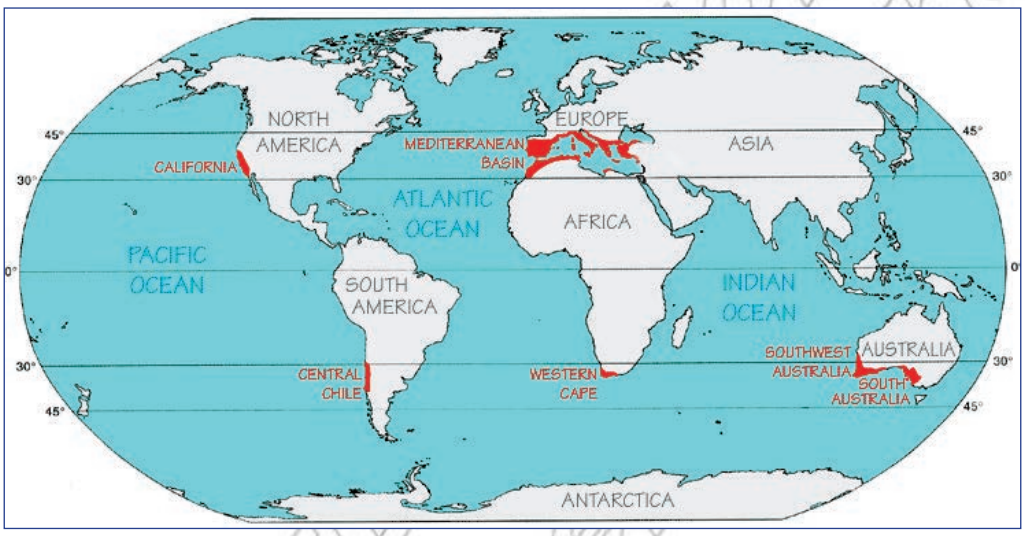


Figure 2.59 **Location of Mediterranean-region areas**

Climate

The climate is characterized by warm to hot, dry summers and mild to cool, wet winters. Summer has off shore dry winds. But winter has on shore wet westerly winds.

During the summer season, the Mediterranean lands are under the influence of sub-tropical (Horse Latitude) high pressure. This means the dry trade winds blow out from them and do not bring rain, but temperature is high. In winter, the winds that blow over these areas are the onshore westerlies. These winds blowing from the ocean bring rain to the Mediterranean-region areas, but the temperature is low.

Table 2.10: **Climate data for Algers 37°N**

Months	J	F	M	A	M	J	J	A	S	O	N	D
Temp. °C	10	11	13	15	18	22	24	25	23	19	15	12
Rainfall, in mm.	116	76	57	65	36	14	2	4	27	84	93	117

Activity 2.25

Study Table 2.10 and answer the following questions and perform the following tasks.

1 Which months of the year represent summer and winter?

2 List the months with the highest and lowest rainfall.

3 List the months with the highest and lowest temperatures.

Natural Vegetation

What is Natural vegetation?

Many years ago the Mediterranean region was covered with evergreen forests. However, in most areas the forests have been destroyed and replaced by a type of vegetation known as Maquis. The Maquis vegetation consists of small short trees with dense growth of **shrubs**. The olive tree is the most common. Almost all kinds of citrus fruits grow in the Mediterranean region.

Human Activities

Agriculture is highly diversified and specialized in the Mediterranean region areas. The most important crops grown in the Mediterranean lands are grapes, figs, oranges, apples, vegetables, olives, wheat and, in the wetter areas, rice. Because of the dry hot summer, agriculture in the Mediterranean region depends on **irrigation**.

Transhumance is also practiced in the area. This is the practice among pastoral farmers of moving their herds and flocks between two regions of different climates. In mountainous regions, the animals are driven from mountain to valley pastures for the winter and back again to mountain pastures for the summer.

Mining: Only a few areas have mineral deposits-such as gold and petroleum in California and copper in Chile. Italy is a major producer of mercury. Chrome and coal are mined in Turkey.

Manufacturing Industries: The existing industries process agricultural products. Wine making, extraction of olive oil and fruit drying are some of the industrial activities.

Activity 2.26

In your group, perform the following tasks and answer the following questions.

1 Why is irrigation important in the Mediterranean region areas?
2 The Mediterranean-region areas are scattered in different parts of the world. What common things do they share?
3 In most parts of the world, winter is cold and dry. But in Mediterranean region areas, it is rainy. Discuss why this happens.

B *Coniferous Forest Region/Taiga*

Where is the location of the coniferous region? What are the major areas of the coniferous region? What are the climatic characteristics of this region?

Location

This region lies approximately between 55° North and 70° North latitudes. The coniferous forests are found only in the northern hemisphere. The major coniferous forest areas are:

- *Northern America*
- *Northern Norway, Sweden and Finland*
- *Parts of Asia, South of the arctic circle and north of the temperate grassland.*

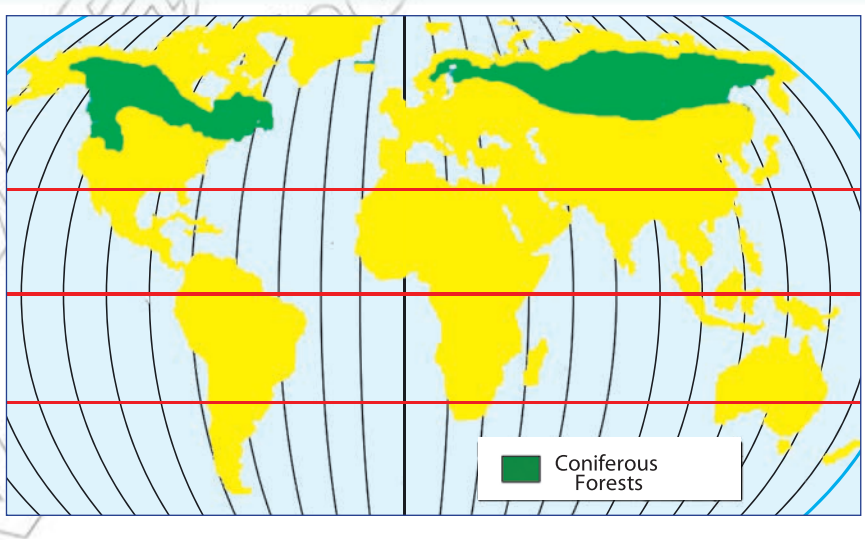


Figure 2.60 **The Coniferous forest belt (Taiga)**

Climate

The climate changes a lot from season to season. Winter is long and very cold. For over half of the year, the mean monthly temperature is below zero. The winter days are short, but the sky is clear. In winter, the northern hemisphere is tilted away from the sun. As a result these lands get only short periods of daylight.

When the summer season begins, the long days of bright sunshine make the temperature high. In summer, the northern hemisphere is tilted toward the sun, so these lands get long hours of daylight. Summer is also a season of maximum rainfall. The rainfall is mainly cyclonic. The total annual rainfall ranges between 300 mm and 750 mm. Even though the total rainfall is low, it is adequate for plant growth, as the rate of evaporation is low.

Table 2 11: **Climate table of Verkhoyansk, Siberia**

Months	J	F	M	A	M	J	J	A	S	O	N	D
Annual Max. Temp. °C	-43	-37	-20	-3	10	20	23	18	9	-9	-32	-40
Annual Min. Temp. °C	-49	-46	-39	-22	-3	6	9	4	-3	-19	-40	-47
Precipitation mm.	6	6	5	6	12	23	33	32	14	13	10	8

Source: *Pogoda. ru. net*

Activity 2.27

Using Table 2.11, answer the following questions.

1. From the table can you tell how many months have temperatures above zero?
2. What is the mean annual temperature of Verkhoyansk?
3. What is the annual range of temperature of Verkhoyansk?
4. Plot a line and bar graphs showing both temperature and rainfall of Verkhoyansk?

Natural vegetation

What type of natural vegetation can grow in this region?

The vegetation in the region consists of conifer trees. The coniferous forests have low species diversity. Single species of trees grow together in large stands where there is suitable soil. The trees have adapted to the harsh climate of the region. They get and save moisture through their long roots, spongy wood and

needle shaped-leaves. As the trees are evergreen, no moisture is lost in making new leaves each year.

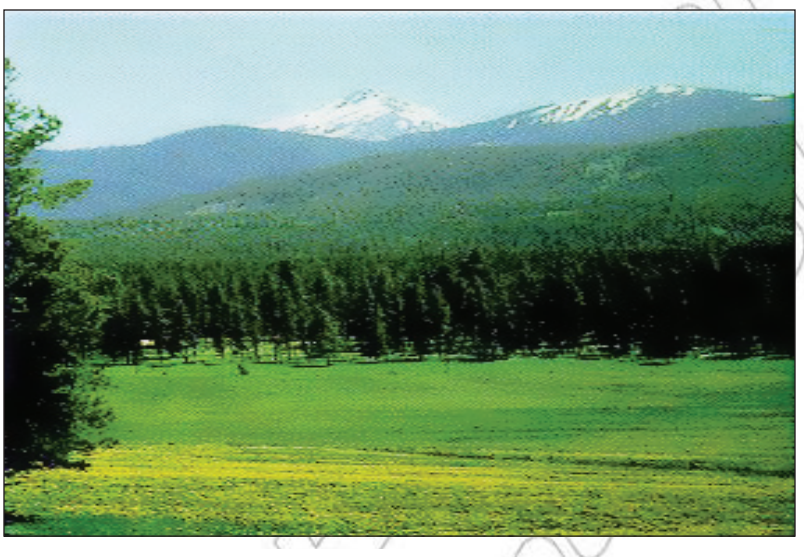


Figure 2.61 **Coniferous forest**

Human Activities

What type of economic activities are practised in this region?

The climate of the coniferous forests is not favourable for growing crops because the growing season of this region is too short. The soils are not usually fertile. As a result, agriculture is not an important activity in this region. But conditions are excellent for forestry, which is one of the most important economic activities in these areas.

The coniferous trees are softwood, which can be easily cut and shaped. The trees are long and straight, from which long and flat pieces of timber for building can be made. The logs of coniferous trees are good for making pulp, from which paper and rayon are made. The nature of the forest makes their exploitation easier. This is because the same kind of trees grow in dense stands.

Lumbering (the felling of trees) is usually done during winter because of two reasons.

- *There is little water inside the trees.*
- *The ground becomes hard and frozen. which makes movement easy.*

Nowadays, power machines that fell, trim, drag and load the logs are available. In order to get a continuous supply of timber for the woodwork industry, reforestation is carried out in the region.

Mining: The coniferous forest region is also rich in several mineral deposits. Iron ore, gold, cobalt, zinc, uranium, oil, copper and lead are the main minerals of the region. Sweden, Canada, and the Russian Federation have rich iron ore deposits. Siberia is well known for its coal, oil and gas deposits.

Generally, the coniferous forest region has a well-developed industrial base. This is supported by the availability of many mineral deposits, rich forest resources and cheap and abundant water power from rivers.

Activity 2.28

In your group, perform the following tasks and answer the following questions.

1 Describe the natural conditions that favour forestry in the coniferous forest region.
2 How does the vegetation withstand the harsh climate of the coniferous forest region?
3 What factors facilitated industrial development in the coniferous forest region?

III *Frigid (Cold) Zone*

Where is the location of frigid zone? Why is this region cold?

The frigid zone is located between 66½° to 90°, both N and S of the equator. In some areas natural conditions of this zone are not limited by latitudinal location. For example, in Canada, this zone bends southwards to about 55°N. The boundary between the cold temperate and the frigid zone is marked by 10°C isotherm of the warmest month. Common vegetations of this zone are lichens, mosses, grasses, cushion plants, and low shrubs which spring to life during the short summer season. They remain dormant for about ten months of the year. However on the ice bound areas, such as Antarctica, there is no vegetation because the temperature is not above the freezing point and there is no sufficient sunlight that serves as a source of energy for life.

The most widespread people in the region are the Inuit (Eskimos), Indians, Lapps, Chukchi, Koyaki, and Yakuts. They are found in Alaska, Canada, Greenland, Finland, Norway, Sweden and Siberia. They follow their traditional ways of life as hunters, reindeer herders, fishing, fur trapping, and they are being trained for more settled occupations, such as Farming and mining.

All of the native Arctic people have developed a unique ability to survive in their harsh environment by skillfully using the few materials available to them. From snow, ice and animal skins and bones they have fashioned a simple technology that enables them to build shelters, weapons, and forms of transportation such as sleds and kayaks (small, skin-covered boats). Land and sea animals and fish provide their main source of food. The frigid zone has two sub-regions. These are tundra and the polar ice caps.

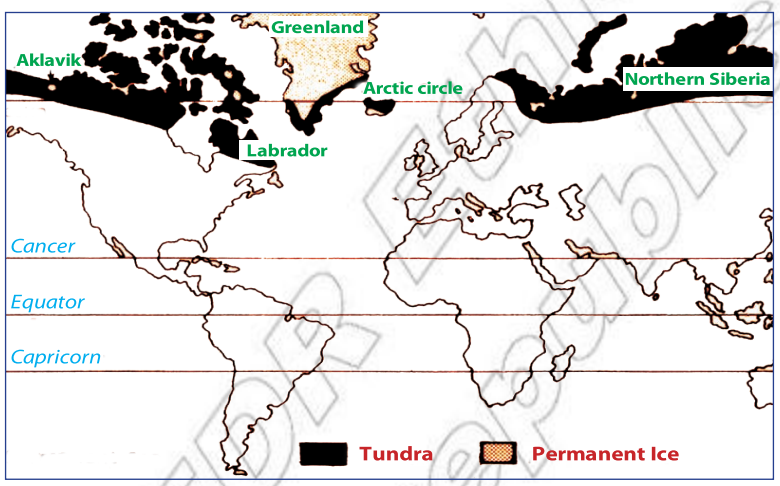


Figure 2.62 **Frigid zone**

A *Tundra Region*

What is tundra? Where are the areas of tundra located? What are the climatic characteristics of the tundra sub-region?

The word **tundra** refers to an area where the growth of trees is prevented due to low temperatures and short seasons that restrict growth.

The tundra is a transitional zone between the polar ice caps and the coniferous forest belt. Tundra is found only in the northern hemisphere. It extends along the northern Arctic shores of the continental land mass.

Climate

Tundra has two distinct seasons. These are the summer and winter seasons. During the summer season, there is long daily duration of sunshine, but the temperature is very low. Only three or four months have average temperatures above the freezing point. This is because the sun's rays are very slant, and therefore lack heat. Winter is cold and long. During the daytime, the sky is dark, and stars can be seen shining. There is twilight in the middle of the day.

The rainfall level in the tundra is low. The amount of annual total rainfall is below 250 mm.

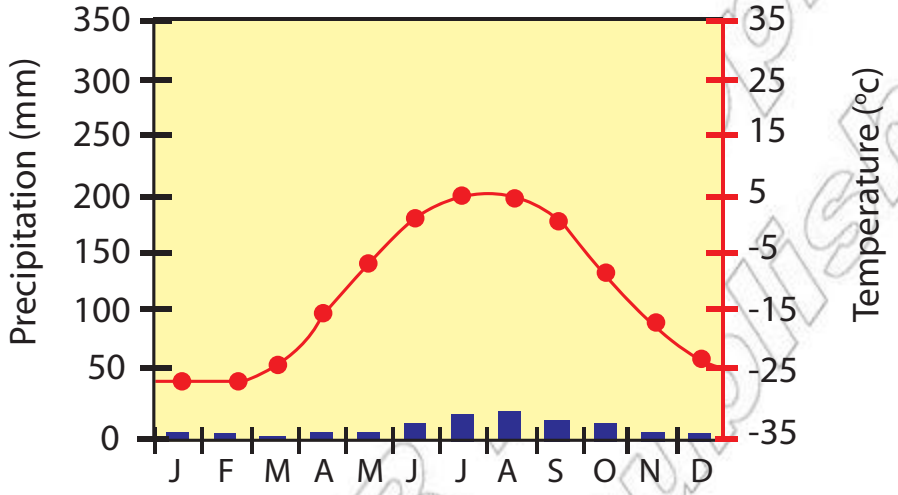


Figure 2.63 **The climate graph for Barrow, Alaska**

Activity 2.29

Using Figure 2.63,

1 List the months with the highest and the lowest precipitation.

2 List the months with the highest and the lowest temperature.

Natural Vegetation

Is the type of climate experienced in the tundra suitable for plant growth? Why? What kind of plants grow in the tundra?

As plants cannot grow in temperatures below 6°C, there is little or no vegetation in tundra areas. In places where the snow is not thick, low forms of plants such as lichens, mosses and sedges grow during the summer season. On the southern margins of the tundra lands, and in lower areas, there are short trees and flowering plants.

Human Activities

What are the main human activities in tundra?

The tundra is a sparsely populated region. There are a few scattered tribes such as Eskimos (Inuit), Lapps, Finns, Aleuts and Tunguses. These are primitive peoples who have adapted themselves to the cold and difficult environment of the tundra.

The people lead primitive ways of life and depend on hunting, fishing, and reindeer herding. In North America, the Eskimos settle along the seashores in igloos (houses made up of blocks of ice) in the cold winter. During the summer, the people move inland and live in tents which are made of animal skins.

Figure 2.64 **Eskimos (Inuit) building a snow house (Igloo)**

Activity 2.30

In pairs, perform the following tasks.

1. Compare the adaptations of tundra vegetation to its environment with the adaptations of desert vegetation.
2. Describe the way of life of the tundra people and explain how they have adapted themselves to the conditions of the tundra region.

B *Polar Ice Cap Region*

What is polar ice cap? Where is the location of polar ice cap?

A polar icecap is a high latitude region of the earth that is covered with ice. The two polar ice caps are located near the North and South poles. These natural regions include Greenland and the Arctic islands and Arctic Ocean in the northern hemisphere and the continent of Antarctica and the South Sea in the southern hemisphere.

Climate

Ice caps are generally characterized by negative temperatures. The average temperature for each month of the year is less than 0°C. The precipitation is very low and falls in the form of snow. In Greenland the total annual precipitation is about 80 to 100 mm. The whole of Antarctica receives an average precipitation of less than 150 mm per year.

Natural Vegetation

Plant growth is impossible as the regions are permanently covered by ice and snow. The soil of the region is permanently frozen. Except few areas the surface

is covered with ice. In those areas, a little vegetation, like mosses, lichens, and algae may grow with the help of the light of the very short summer.

Human Activities

There are no people living permanently in Antarctica. Only scientists and hunters visit this cold continent. At present, the only resource of Antarctica is whale oil. But it is believed to contain rich deposits of coal. The Arctic Ocean is rich in animals that can be used as sources of food and material for clothing. The Arctic region is also important for military strategies. For example, the USA has an air base at Thule in Greenland.

Activity 2.31

In your geography work group, answer the following questions.

1 Do people live on polar ice caps? If your answer is no, why not?

2 Explain the influence of climate on the vegetation of the polar ice caps and of the hot regions.

Exercise 2.3

I *Determine whether each of the following statements is true or false*

1 The equatorial rainforest region is the most advanced industrial region of the world.

2 Climate makes the tropical zone different from the frigid zone.

3 The longitudinal extension of Ethiopia results in a tropical climate.

4 Temperature decreases from the equator towards the poles.

5 Taiga is part of the polar zone.

II *Choose the correct answer.*

6 Tropical deserts exhibit all of the following characteristics except

A extremely dry conditions

B dense plant growth

C location between 20˚ and 30˚ latitude

D influenced by the subtropical highs

7 In regions with a Mediterranean climate, almost all the yearly precipitation falls

A in autumn
C in winter
B in spring
D in summer

8 The most important economic activity of the coniferous forest region is

A Plantation agriculture
C Crop cultivation
B Forestry
D All are correct

9 Identify the equatorial rainforest area that is the largest, after the Amazon Basin.

A Congo Basin
C South East Asia
B Indonesian islands
D Mehagreb region

10 The geographical criteria used to classify the whole world as in the tropical, temperate or frigid zone is

A Latitude
C Population
B Altitude
D Temperature

2.4 ECOSYSTEM

At the end of this section, you will be able to:

- define the term ecosystem;
- identify the components of ecosystem; and
- demonstrate interdependence in the ecosystem.

Key Terms

- Abiotic
- Biotic
- Carnivorous
- Consumers
- Decomposers
- Ecosystem
- Herbivorus
- Omnivorous
- Producers

What is an ecosystem? What are the components of an ecosystem?

An ecosystem is a community of living things and their non-living environment.

It is a basic functional unit of biosphere, consisting of organisms (plants and animals) and their environment (air, water, soil and rock). The non-living features of the environment are the *abiotic factors*, and the organisms in the environment

are the *biotic factors*. Populations and communities make up an ecosystem. An ecosystem may be small organisms in a drop of water, or even the whole earth as one system. There are many types of ecosystems, even within a relatively small area. Some are on land, others are aquatic. All components of an ecosystem function together as a closed unit of biological community or association.

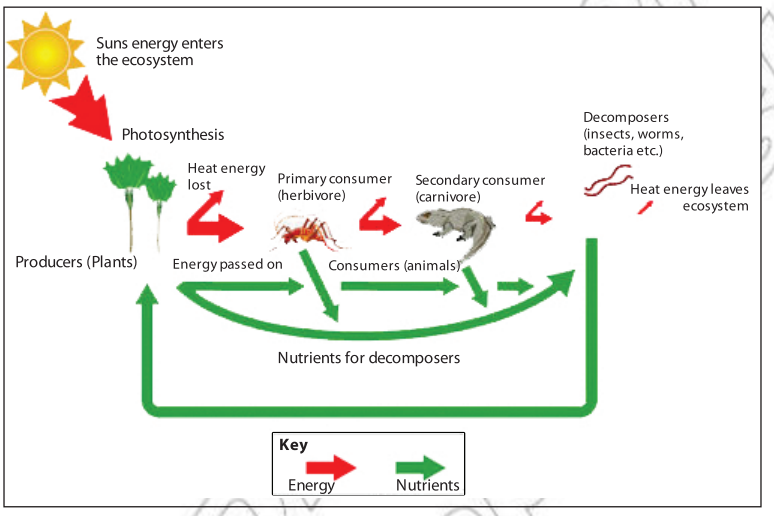


Figure 2.65 **All plants and animals are linked with the natural environment. This is an ecosystem**

All ecosystems require energy in order to exist. This is provided by sunlight, with only minor contributions from other sources. Energy from the sun reaches the earth's surface in two forms. These are **heat energy** and **light energy**. Heat energy cannot be used directly by plants and animals. Light energy can be captured only by green plants during the process of photosynthesis. Only about one percent of light energy falling on leaves is converted into food energy and stored as carbohydrate molecules.

Ecosystems have lots of different living organisms that interact with each other. The living organisms in an ecosystem can be divided into three categories: **producers**, **consumers** and **decomposers**. They are all important parts of the ecosystem.

- **Producers** *are the green plants. They make their own food by means of photosynthesis. Green plants are the primary passage from one organism to another along the food chain. A food chain is a simple way of showing how energy in the form of food passes from one organism to another.*
- **Consumers** *are animals, which get their energy from the producers or from organisms that eat producers.*

There are three types of consumers:

- **Herbivores** (primary consumers) are animals that eat plants.
- **Carnivores** (secondary consumers) are animals that eat herbivores and sometimes other carnivores.
- **Omnivores** are animals that eat both plants and other animals.

- **Decomposers** *are plants and animals that break down dead plants and animals into organic materials that go back into the soil. When organisms die, their bodies decompose and form a source of energy and nutrients for other organisms. Similarly, waste matter passed from the bodies of living organisms are also sources of energy and nutrients. These materials are not wasted by their ecosystems. They form the food for many other organisms, which are referred to as decomposers. Decomposers are micro organisms, mainly fungi and bacteria, which live on dead organic matter.*

Activity 2.32

In pairs, perform the following task and discuss the following questions.

1 Give an example of ecosystem and explain how it is self-supporting.

2 What is the difference between abiotic factors and biotic factors? Give five examples of each.

3 What is the food chain?

4 "Everything in the biosphere is connected." Do you agree or disagree? Discuss this question.

Exercise 2.4

I *Choose the correct answer.*

1 A community and its physical environment together is

A population C habitat

B an ecosystem D niche

2 An ecosystem is a community of plants and animals that depend upon one another and their surroundings for survival.

A True B False

3 Which of the following best explains why many kinds of plants and animals can live together in an ecosystem?

A plants and animals all care for each other and protect one another.

B plants and animals are all parts of a food chain and depend on each other to live.

C plants and animals have nothing to do with each other, so they can live together.

D plants and animals all feed on the same thing, so they compete with each other for food.

4 What name is given to all organisms that feed on other organisms?

A Carnivores

B Consumers

C Omnivores

D Producers

5 Deer and zebra feed on grasses and other plants. Leopards and lions feed on deer and zebra. Which of these is the role of the deer and zebra in this ecosystem?

A Producers

B Carnivores

C Consumers

D Decomposers

6 Which one of the following best describes the role of a producer in an ecosystem?

A A producer supplies energy for the consumers in the ecosystem.

B A producer supplies light for the consumers in the ecosystem.

C A producer supplies oxygen for the consumers in the ecosystem.

D A producer supplies water for the consumer in the ecosystem.

7 An ecosystem includes

A one type of organism

B two types of organisms

C at least one type of plant and one type of animal

D a wide variety of organisms

8 What kind of organisms can produce their own food?

A Carnivores

B Animals

C Green plants

D Herbivores

II *Complete each of the following statements with the correct word or term.*

9 The original source of energy in an ecosystem is _____.

10 A population and the environment in which its members interact form _____.

2.5 VILLAGIZATION OF THE WORLD THROUGH DISTANCE-TIME DECAY

At the end of this section, you will be able to:

- identify what developments of transport and communication technology has brought changes in location of economic activities.
- discuss how development of transport and communication technology has brought changes in location of economic activities.

Key Terms

- Communication
- Development
- Distance-time decay
- Globalization / Villagization
- Technology
- Transport

Villagization and Distance-Time Decay

What is villagization? What makes the world a global village ?

Villagization in this context refers to the time-space compression which has resulted from the increasing, rapid movement and interaction of people from all parts of the world. Today, due to advancements in transportation and other communications technologies, the world's population are much "closer" than ever before. These technological advancements have reduced the time needed to travel from one corner of the world to any other and to communicate over distances.

Distance-time decay: is a geographical term which describes the effects of distance and time on cultural or spatial interactions, the production of goods and the location of activities. The distance-time decay effect is the decline in interaction between two localities as the distance and time between them increases.

With the advent of faster travel, distance and time have less effect than they did in the past. Advances in communications and technological devices such as phones, radio and television broadcasts, and the internet, have further decreased the effects of distance and time.

The socio-economic impacts of world villagization

World villagization impacts many socio-economic and cultural features of our world. Although some of them operate primarily in the developed countries, their effects are increasingly evident in developing countries such as Ethiopia.

- **On production of goods and service delivery**: In the past, time and distance had a profound impact on the location of markets and the production of goods. Perishable goods, such as vegetables, fruits, and fresh milk, used to be primarily produced and sold close to urban centers in order to sell and consume them fresh. However, today any type of perishable good can reach its consumers within a short period of time without perishing or losing its freshness. Hence, today distance and time have little or no impact on the production and market of perishable goods.

  Fast communications such as the internet have improved the delivery of goods and services even without face-to-face contact. Today people can make a purchase or transfer money from one part of the world to another while sitting at home. Similarly, many people are working for companies located thousands of kilometers away from their homes, and do not need to be there physically.

- **On location of settlements and industries**: In the past, the distance-time-decay effect deeply affected the location of settlements and industries. They had to be located near resources and energy. Similarly, industrial workers needed to live near their work places. Now, advancements in transportation networks have allowed many industrial workers to commute daily from their homes to workplaces many kilometres away. In the same way, industrial components such as sources of energy and natural resources can now be transported to almost anywhere they are needed. In general, the time-distance-decay effect that used to profoundly affect our socio-economic and physical environments on local, regional, and global scales has been mostly overcome in many parts of the world. This has produced what we call the villagization of the world. Another term for this process is **globalization**. It has greatly affected the social, cultural, political and economic landscapes of our world.

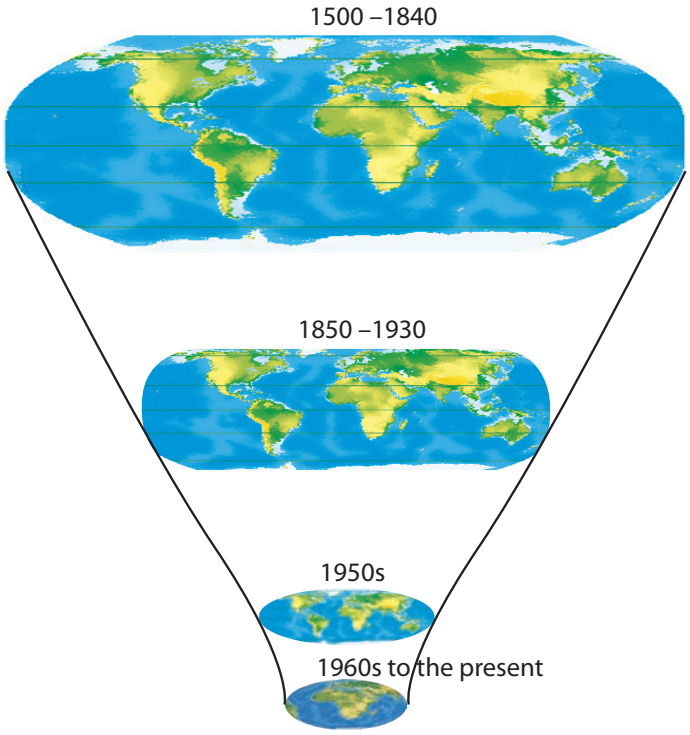


Figure 2.66 Villagization of the world through distance-time decay

Activity 2.33

Be in groups and give answers to the following questions.

1. The world is considered to be a "global village." What do you understand by this?
2. Why is the world called a global village?
3. What is the contribution of modern transport and communication technologies to connecting distant areas of the entire world?