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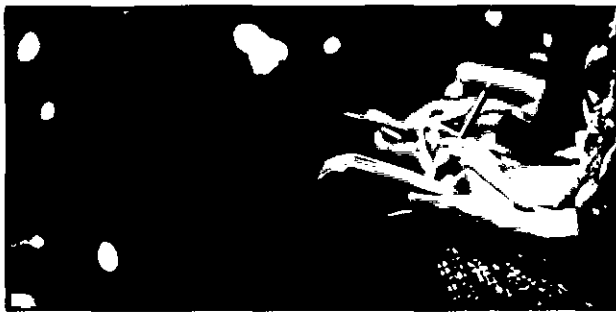



# The Pathways To Higher Studies

# Geography

## Class-XII

# GEOGRAPHY

# CLASS 12

Developed & Published by:
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# 1 NATURE OF GEOGRAPHY AS A DISCIPLINE

- Understand the concept of geography.
- Discuss the nature of geography.
- Describe the phases of geography.
- Discuss the scope of geography.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of geography so that the fundamentals of geography can be learned.

## Introduction

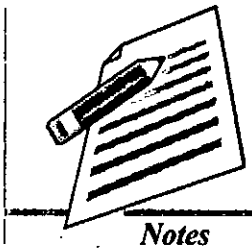
"The study of Geography is about more than just memorising places on a map. It is about understanding the complexity of our world, appreciating the diversity of cultures that exists across continents. And in the end, it is about using all that knowledge to help bridge divides and bring people together" - Barak Obama, Former President of USA.

The subject 'Geography' was considered as 'The Mother of all Sciences' as most streams of sciences took root from geography. It is a subject much needed in everyday life. Unfortunately, in the recent past it has been demoted to the back seat in most parts of the world, while certain other sciences hold prominent places in the society. Just as an intellectual understands the value of a library, a financier understands the value of money, a parent understands the value of their child a geographer understands the value of our planet earth and the wealth of resources it offers to us. A society that lacks sufficient geographic knowledge cannot be expected to exhibit its strength of resource potentials and empowerment to make decisions in real-world context. Therefore, the knowledge of geography is very much vital for the care and concern of the earth, growth and development of every country and for minimising the issues related to human activity. In this context, the National Geographic Society, USA defines geographic literacy as being equipped to understand the complexity of the world, how our decisions affect others (and vice versa), and the interconnectedness of this rich, diverse, and not-so-large world.

This unit introduces the student to the foundations over which the subject had developed in the past, the content it offers now and the changes that it had undergone. It also opens the door to the world of physical geography and the practical skills to be acquired to understand geography which are explained in the units following this.

## Defining Geography

Geography is one of the oldest earth sciences and its roots date back to the works of the early Greek scholars. The term '**Geography**' was coined by the Greek scholar **Eratosthenes** who combined two Greek words 'Geo' (The Earth) and 'Graphien' (to describe). Therefore, in the literary sense, geography is the description of the Earth. Over the ages, geography has





become the art and science of studying the physical characteristics of the earth and man's role in adapting to and modifying the environment.

Geography was born through explorations and discoveries. Earlier, the aim of geography was to discover new lands, sea routes, prepare maps and describe them. Later, its emphasis had shifted to scientific investigation of earth's landforms, oceans and atmosphere, as well as the interactions with human beings and the environment.

In essence, geography can be defined as a multifaceted discipline studying intra and inter relationships of various spheres of the earth, collects and analyses relevant data, applies the latest tools and methods to prepare maps and visuals and provides sustainable solutions to human and environmental issues of the earth.

### Evolution of Geography

Geography had evolved over a long period of time. Some of the earliest geographical studies go back about four thousand years ago through explorations. The early explorers travelled and tried to map the new places. The evidences of such explorations come from the archaeological discovery of a Babylonian clay tablet map that dates back to 600 BCE. During this time, Phoenician, Chinese and Egyptian civilisations were in the beginning to explore places outside their homelands. It was the ancient Greek scholars who laid the foundations and gave a solid form to geographic studies and on these foundations, the pillars of modern geography were erected by others in the subsequent ages. The Romans, the Arabs, the Indians, the Chinese, the Germans, the French, the British and the American geographers have contributed to the development and enrichment of the subject.

The Greek philosophers and scientist focused on the spatial nature of human and physical features of the Earth. The first Greek geographer was Herodotus (484 - 425 BCE) who wrote a number of volumes on the human and physical geography of the Persian Empire. The other early Greek contributors to geography are, Thales, Aristotle and Eratosthenes (276 - 194 BCE).

The earlier geographers were descriptive geographers concerned with answering questions like 'what is where' on the earth and the question like 'why it is there' came later. Geographers study the location of the activities, carefully identify patterns using maps and find out the reasons for these patterns. The areas are then described based on the distribution of land forms, population, housing and agriculture. They discover the linkages and movements between places and are able to infer the spatial processes that are working in these areas.

The development of geography can be summarised in three phases namely (1) The age of discovery (1400-1800), (2) The period between 1800 and 1950 and (3) The period after 1950.

## The age of discovery between 1400-1800

The period between 1400 and 1800 was when the subject matter and the methodology of geography were not fully developed. The discipline was in an embryonic stage. This period was characterised by exploration, discovery and conquest through the voyages of Vasco da Gama and Christopher Columbus. Numerous journeys of geographical exploration were commissioned by a number of Nations in Europe (Figure. 1.1, 1.2, 1.3 and 1.4). Most of these voyages were financed because of the potential commercial returns from resource exploitation. The voyages also provided an opportunity for scientific investigation and discovery. Making of maps (cartography) was important in the discipline of geography due to the emphasis on location of phenomena on the earth surface, e.g., location of trade routes, relief features and settlements.

Figure 1.1 Ptolemy's World Map

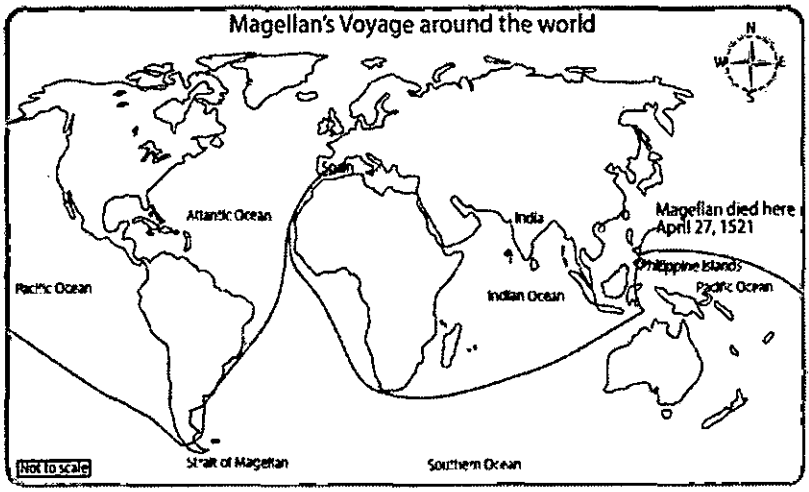



Figure 1.2 Magellen's Voyage around the World

Figure 1.3 Vosco da Gama

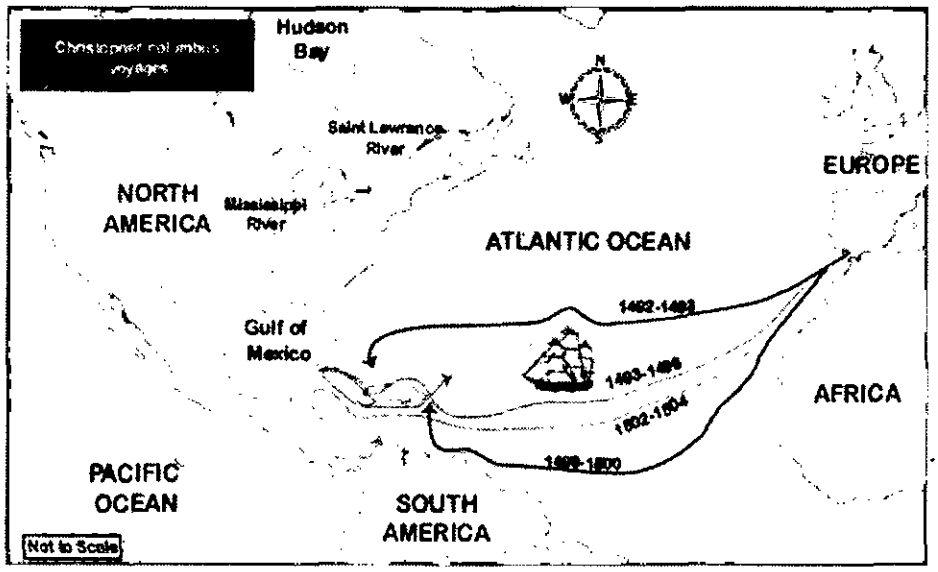



Figure 1.4 Christopher Columbus's Voyages to America

## The period between 1800 -1950

The period between 1800 and 1950 was characterised by the work of various individual philosophers who helped to expand the scope of geography. The discipline of geography became more distinct as a subject matter. Geographic knowledge saw strong growth in Europe and the United States in the 1800s. This period also saw the emergence of a number of societies interested in geographic issues. In Germany, Alexander Von Humboldt, Carl Ritter and Friedrich Ratzel made substantial contributions to human and physical geography. Humboldt's publication 'Kosmos' in 1844, examines the geology and physical geography of the earth. This work is still considered by many academics as a milestone contribution to geography.

There are two schools of thought that emerged during this period as an attempt to explain the relationship between human beings and their environment. These were environmental determinism and possibilism. Proponents of environmental deterministic school of thought such as Mackinder, Ellen Semple and Huntington believed that human actions and activities were moulded by the physical (natural) conditions. In several developing countries, human beings are susceptible to natural disasters such as drought, famine, floods and earthquakes. Human beings under such natural conditions usually surrender to nature. A good example of environmental determinism is the influence of the natural environment on human activities such as nomadic pastoralism. Nomadic pastoralism is so much dependent on the natural environment. Pastoralists do very little to modify their environment.


Ratzel


La Blache



The proponents of possibilistic school of thought, such as Vidal de la Blache saw the environment as a limiting factor rather than as a deterministic force. According to the possibilism school of thought, human beings have several alternatives in their environment and their actions are influenced by the decisions they make in the environment. For instance, humans can survive in hot or extremely cold conditions due to their ability to modify the environment to suit them. A good example is that in many arid countries such as Israel, humans have overcome the constraints set by the natural environment such as low rainfall, high temperatures and poor soils.

## The period after 1950

Until 1950s, geography was more of an art subject where facts were established by casual observation in the field rather than by careful measurement and hypothesis testing. In the 1950s there was a new development in the discipline and several laws were established to explain geographical phenomena. Using the laws, it is possible to predict what will happen in the future. If we can predict successfully, we can plan and limit the extreme possibilities.

One of the important developments in this period was the use of quantitative techniques in physical and human geography. These techniques refer to various statistical tools that are used to synthesise the data from maps, field, laboratories and questionnaires. Quantification came about as a result of the expanding scope of the discipline as well the need to understand the processes that were becoming more diversified and complicated.

This quantitative revolution was referred to as a revolution because it marked a new beginning in the way the subject matter of geography was to be studied. The quantitative revolution involves the use of statistics, mathematical equations and the use of deterministic models. Many geographers believed that numbers are more precise, and therefore perceived as more scientific compared to words. The map, both as graphic language and visual representation, continues to be used as a geographical tool and at present with the valuable assistance of remote sensing and Geographical Information Systems, map making has become digital and easier especially due to advances in computer and software technologies.

## Themes of Geography

In any subject there will be certain themes, around which the scholars work and contribute. In this way, geography subject also has certain traditional themes. Let us look at them carefully. *In 1963,* ***William D. Pattison*** *identified the core themes of geographic studies as* **'The Four Traditions** of Geography'.

These distinct, but related, traditions, of the discipline are: Spatial tradition (areal distributions and spatial patterns, Examples: Population movement) Area studies tradition, (hierarchy of areas, small to large) Main-land tradition (relationship between man and his physical environment) and Earth science tradition (processes of the earth).

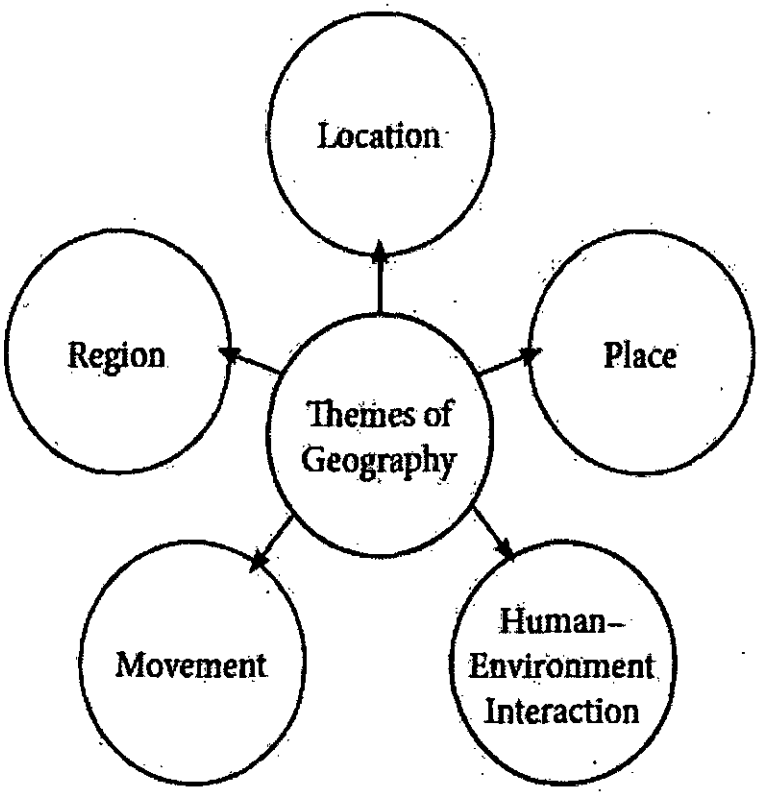



**Figure 1.5 Themes of Geography**

## HOTS

How might the ship that Columbus travelled have sailed at the time when no engine and power fuel available?

## Five Themes in Geography

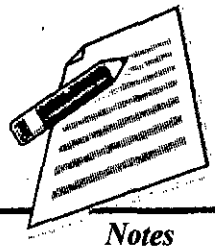
Themes of Geogra- phy are the educational tools for understanding the geography subject in detail. It was adopted in the year 1984 by the Association of American Geographers and these five themes were published in the National Council for Geo-graphic Education/Association of Ameri-can Geographers' publication Guidelines for Geographic Education.

Like the major traditions identified in geography, the significant themes of the subject are also identified. The Association of American Geographers put forward the 'Five themes of Geography' and it has been widely accepted by geographers worldwide (Figure1.5). The themes are location, place, human – environment interaction, movement and regions.

## Location

Every point on earth has a location. The location can be described in two different ways:

Absolute location is a location as described by its latitude and longitude on the earth. For example, the coordinates of Chennai Central Railway station are 13°04'56" N latitude and 80°16'32" E longitude.





Relative location is the position of a place in relation to another well-known landmark. For example, Kallanai Dam or Grand Anicut is located roughly 350 km south –southwest of Chennai City. The absolute and relative location related surveys and studies fall under this category.

## Place

A place is an area that is defined by everything in it. All places have features that give them personality to distinguish them from other places. A number of place names in Tamil Nadu, like Redhills, Fort St. George, Mint, and George Town are examples to this theme.

Toponym: A place name, especially one derived from topographical feature.

Site: An area of ground on which a town, building, or monument is constructed.

Situation: The location and surroundings of a place.

## Human-Environment Interaction

The theme describes how people interact with the environment and how the environment responds. These are studied with reference to the following three key concepts:

Dependency: How humans depend on the environment (Example: For water, fresh air, sunlight etc.)

Adaptation: How humans adapt to the environment (Example: Life in polar or desert regions)

Modification: How humans modify the environment (Example: Construction of Underground Metro rail, Agriculture in Israel).

## Movement

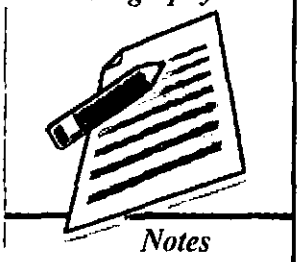
Movement is the network of travel of people, goods and ideas from one location to another. Examples: Rural-urban migration and metro train commuting in Chennai. **Air transport** which carries people and goods and the **internet** that allows access to ideas and knowledge across the world are also examples of this kind.

## Region

Regions are areas with distinct homogenous characteristics such as climate (Monsoon regions), natural vegetation (Tropical rain forests), crops (Corn Belt of USA), major landforms (Himalayan region), industries (Chota-Nagpur plateau) etc.

## Physical Geography

- **Geomorphology** is a branch of Geography dealing with the study of landforms, the formation of landforms, and associated courses.
- **Climatology** includes the study of atmosphere structure, elements of weather, climate, climatic types and climatic regions.
- **Hydrology** deals with the study of water present on the surface of the earth comprising oceans, rivers, lakes and other water bodies, its influence on various life forms on earth and allied activities.
- **Soil Geography** is to study the courses of soil formation, types of soil, fertility status of soils, soil distribution and utilization.





## 2. Human Geography

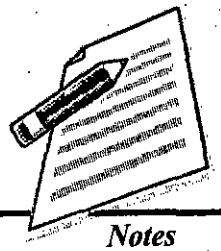
- **Social/Cultural Geography** covers the study of society and the spatial dynamics of society and the cultural aspects caused by society.
- **Population Geography** encompasses the population growth, density, distribution, migration, sex ratio and occupational structure, and so on.
- **Settlement Geography** deals with the features of urban and rural settlements.
- **Economic Geography** is related to people's economic activities comprising agriculture, industry, services, trade, transport, infrastructure, etc.
- **Historical Geography** deals with the historical processes by which space gets organised. The geographical features also go through temporal changes; these are the issues of historical geography.
- **Political Geography** is the study of the spatially unbalanced results of political courses and the various manners in which political processes are themselves influenced by spatial structures.

## 3. Biogeography

- The interface between human geography and physical geography has led to the progress of Biogeography which contains:
- **Ecology and Ecosystem** deal with the scientific study of the features of the habitat of species.
- **Plant Geography** which deals with the spatial structure and order of natural vegetation in their environments.
- **Zoo Geography** which is concerned with the spatial patterns as well as geographic features of various fauna and their habitats.

## SUMMARY

Geography is a science of space. Geography is both a natural and social science as it studies both environment and the people. It connects the physical and cultural world. Physical geography studies the earth systems that create natural environment. Human geography is concerned with the political, economic, social, cultural and demographic processes. It is concerned with the different ways in which resources are used. Earlier geography merely described places. Even though, this is still a part of geography, the pattern of description has changed a lot in recent years. Geographical phenomena and processes are generally described by two approaches viz. (i) regional and (ii) systematic. Regional approaches are characterized by understanding the formation and characteristic of regions. They try to focus on how and why areas are different from each other. Regions can be physical, social, economic, political, demographic etc. Systematic approach is organized in terms of particular phenomena of general geographic significance. Each phenomenon is studied in terms of the relations of its areal differentiations with the others. Now we understand the cause and impact of natural and human phenomena in creating physical and human landscapes. Geography has three main branches: Physical human and regional. Physical geography is further subdivided into several other branches namely. geomorphology, climatology, oceanography, soil and biogeography. Human Geography is also subdivided into other branches like, cultural, population, social, economic and political. Regional geography is subdivided in other branches like Macro, Meso and Micro. All these subjects are interrelated to each other.





## EXERCISE

### MCQ

1. Kalgoorlie and Coolgardie - places famous for gold mines are located in:
   A. Australia B. USA
   C. England D. South Africa
   **Answer:** Option A
2. Tadoba national park known for sheltering tiger, panther and bear is located in:
   A. Assam B. Chandrapur (Maharashtra)
   C. Karnataka D. Tamil Nadu
   **Answer:** Option B
3. In geography who propounded the theory of convectional current hypothesis?
   A. Arthur Holmes B. Carl Ritter
   C. Arnaldo Faustini D. Immanuel Kant
   **Answer:** Option A
4. Apatanis are the tribes found in:
   A. Himanchal Pradesh B. Nagaland
   C. Sikkim D. Arunachal Pradesh
   **Answer:** Option D
5. Genoa is leading seaport of:
   A. Spain B. Brazil
   C. Italy D. Canada
   **Answer:** Option C

### Review Questions

1 Answer the following questions in brief:
   (i) Define the term Geography.
   (ii) Why is geography called the mother of all sciences.
   (iii) What are the two basic approaches in geography?
   (iv) What are the four phases of development of geography?
   (v) Define the terms physical and human geography.
2. Distinguish between the following
   (i) Systematic and regional geography.
   (ii) Physical geography and biogeography.
   (iii) Population and economic geography.
3. Why is human geography an important part of geography. Explain with suitable explains.
4. Discuss the techniques of geographical studies.

# 2 EARTH'S INTERIOR AND ITS MATERIAL

- Understand the concept of earth.
- Discuss the nature of earth's interior.
- Describe the phases of earth.
- Discuss the material of earth's interior.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of earth's interior so that the material of earth's interior can be learned.

## Introduction

The interior of the earth is composed of many minerals both in the solid and liquid state. The temperature in general increases at the rate of 1 ° C for every 32 metres towards the earth's interior.

Look at the figure.3.4 the layers of the earth. Earth's interior can be divided into the crust, upper mantle, lower mantle, outer core, and inner core.

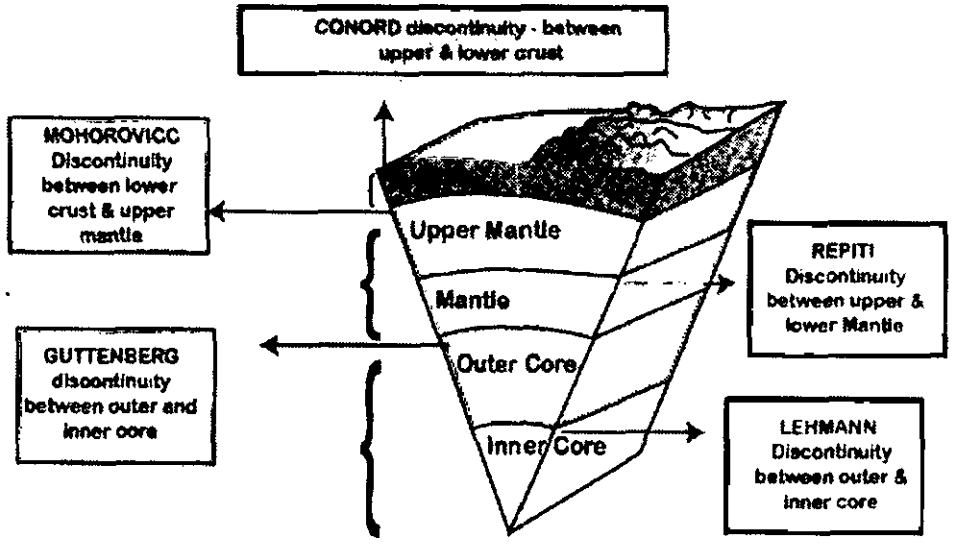
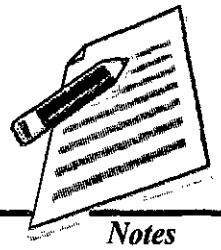



**Figure 3.4** Layers of the Earth

## The Crust

The crust is further divided into upper crust (continental crust), composed of silica and aluminium (sial) and the lower crust (oceanic crust) made up of silica and magnesium (sima).





The boundary between the upper crust and the lower crust is termed as 'Conorod boundary'. The thickness of the crust varies from oceanic areas to continental areas. Oceanic crust is thinner when compared to the continental crust. The mean thickness of oceanic crust is 5 km while the continental crust is around 30 km. The continental crust is thicker in the areas of major mountain systems. It is as much as 70 km thick in the Himalayan region. The density of the crust is less than 2.7 g/cm3.

## The Crust

- The crust is the outermost solid part of the earth.
- It is fragile.
- The thickness of the crust varies under the oceanic and continental areas.
- Oceanic crust is thinner as compared to the continental crust.
- The continental crust is thicker in the areas of major mountain systems.
- The crust is made up of heavier rocks having a density of 3 g/cm3.
- The kind of rock seen in the oceanic crust is basalt.
- The mean density of material in the oceanic crust is 2.7 g/cm3.
- Silica (Si) and Aluminium (Al) are major constituent minerals. Hence it is often termed as SIAL. Also, sometimes SIAL is used to refer to the Lithosphere.

## The mantle

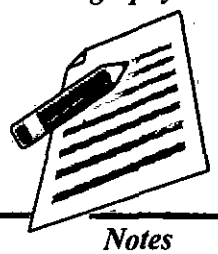
The mantle is composed of silica, magnesium and iron. It lies between the lower crust and the outer core. It extends for about 2,900 km. It is divided into upper mantle and lower mantle. The mantle generally is in a solid state. The upper part of the mantle is called asthenosphere. The word Asthen in Greek means weak. It extends up to 400 km and it is the main source of magma. The Mohorovicic is the boundary which divides the lower crust and the upper mantle. The density of the mantle is 3.9 g/cm3.

## The Mantle

- The portion of the interior beyond the crust is called the mantle.
- It is in a solid-state.
- It has a density higher than the crust portion.
- The thickness ranges from 10-200 km.
- The mantle extends from Moho's discontinuity to a depth of 2,900 km.
- The asthenosphere is the upper portion of Mantle.
- It is the chief source of magma that finds its way to the surface during volcanic eruptions.
- The crust and the uppermost part of the mantle are called the lithosphere.
- The major constituent elements of the mantle are Silicon and Magnesium and hence it is also termed as SIMA

## The core

The core forms the centre of the earth. Its density is 13.0 g/cm3. Its temperature is about 5500 ° C to 6000 ° C. The core has two parts namely the outer core and the inner core. The boundary between the lower mantle and the outer core is called Guttenberg margin.





The outer core and inner core are separated by **Lehmann boundary**. The outer core is in the liquid state while the inner core is in the solid state. Generally, the core is composed of Nickel and Ferrous (Iron) which is called NiFe (Barysphere). The core is extended from 2,900 km to 6,370 km from the surface of the earth.

## The Core

- The core-mantle boundary is positioned at the depth of 2,900 km.
- The inner core is in the solid-state whereas the outer core is in the liquid state.
- The core is made up of very heavy material mostly constituted by nickel and iron. Hence it is also called the "nife" layer.

## Continental Drift Theory

In 1912 Alfred Wegener (1880-1930) postulated that all the continents once were together forming a single continent. According to him, about 250 million years ago, the earth was made up of a single landmass called Pangaea (meaning «all lands»), and a single ocean surrounding it called as Panthalassa. Over a long period of time, probably 220 million years ago, they drifted apart and gradually moved to form their present position. First, Pangaea broke into two landmasses namely Laurasia in the north and Gondwana in the south.

Laurasia further split into Eurasia and North America. Gondwana land split into Africa, South America, Antarctica, Australia, and India.

Wegener put forward certain evidences to support the continental drift theory. Let us deal with it in detail.

## Evidences to support continental drift theory

The continental drift theory is supported by the following evidences.

- Certain identical rare fossils have been found in different continents.
- The fossils of Mesosaurus (a small Permian reptile), for example, have been found only in Africa and South America.
- The fossil of a Fern tree, about 360-million-year-old, has been found only in India and Antarctica.
- Rocks of similar type, formation, and age have been found in Africa and Brazil.
- Geological structure in Newfoundland matches with that of Ireland, Scotland and Scandinavia. Geological Structure of Appalachian Mountains matches with Morocco and Algeria in North Africa.
- The corresponding edges of the continents fit together. For example, the western side of Africa and the eastern side of South America fit together.

## Plate Tectonics

Have you heard about diving between two continents? It is possible in the Silfra rift of Iceland. Look at Figure.3.7. It is located in the Tingvellir National Park. It is in the boundary between the North American plate and the Eurasian plate. It is the visible boundary between these two plates.

Figure 3.7 Silfra rift, Tingvellir, Iceland

You have already learned the Continental drift theory. Now let us see what plate boundaries are.

## Rocks

Rock is the solid mineral material forming the surface of the earth. Petrology is the science of rocks. The age of the rock is determined based on Carbon-14 dating.

## Rock Types

Based on their origin, the rocks are classified as follows:

## 1. Igneous Rocks

Igneous rocks are formed out of magma and lava and they are known as primary rocks. If the magma cools slowly at great depths, mineral grains increase in their size. Sudden cooling (at the surface) results in small and smooth grains. The igneous rocks are the oldest of all the rocks. Granite, pegmatite, basalt, etc are some of the examples of igneous rocks. There are two types of igneous rocks: intrusive rocks (Granite) and extrusive rocks (Basalt-Deccan Traps).

Granite is less dense and is lighter in colour than basalt rocks.

## Intrusive Igneous rocks

Intrusive Igneous rocks are formed when magma rises and cools within the crust. The intrusive activity of volcanoes gives rise to various forms. We see them one by one as follow.

## 1. Batholiths

Batholiths are large rock masses formed due to cooling and solidification of hot magma inside the earth. It is granitic in origin.

## 2. Laccoliths

Laccoliths are large dome-shaped intrusive rock connected by a pipe-like conduit from below. These are basically intrusive counterparts of an exposed domelike batholiths. The Karnataka plateau is spotted with dome hills of granite rocks. Most of these, now exfoliated, are examples of laccoliths.

## 3. Lapoliths

When the magma moves upwards, a saucer shape, concave shaped body called Lapolith is formed.

## 4. Sill

Sill is a solidified sheet-like horizontal lava layer inside the earth. The near horizontal bodies of the intrusive igneous rocks are called sill or sheet, depending on the thickness of the material. The thinner ones are called sheets while the thick horizontal deposits are called sills.

## 5. Dyke

When the magma makes its way through cracks and the fissures developed in the land, it solidifies almost perpendicular to the ground. It gets cooled in the same position to develop a wall-like structure. Such structures are called dikes.

These are the most commonly found intrusive forms in the western Maharashtra area. These are considered the feeders for the eruptions that led to the development of the Deccan traps.

## 2. Sedimentary Rocks

Sedimentary rocks are also called as detrital rocks. They are formed as a result of denudation. These deposits through compaction turn into sedimentary rocks.

They occupy only 5 percent of the earth. They are layered or stratified of varying thickness. Example: sandstone, shale etc. Ice deposited sedimentary rocks is called Till. Wind-deposited sediments are called Loess.

1. Depending upon the mode of formation, sedimentary rocks are classified into Mechanically formed sedimentary rocks: sandstone, conglomerate, limestone, shale, loess, etc.
2. Organically formed sedimentary rocks: geyserites, chalk, limestone, coal etc.
3. Chemically formed: halite, potash, etc.

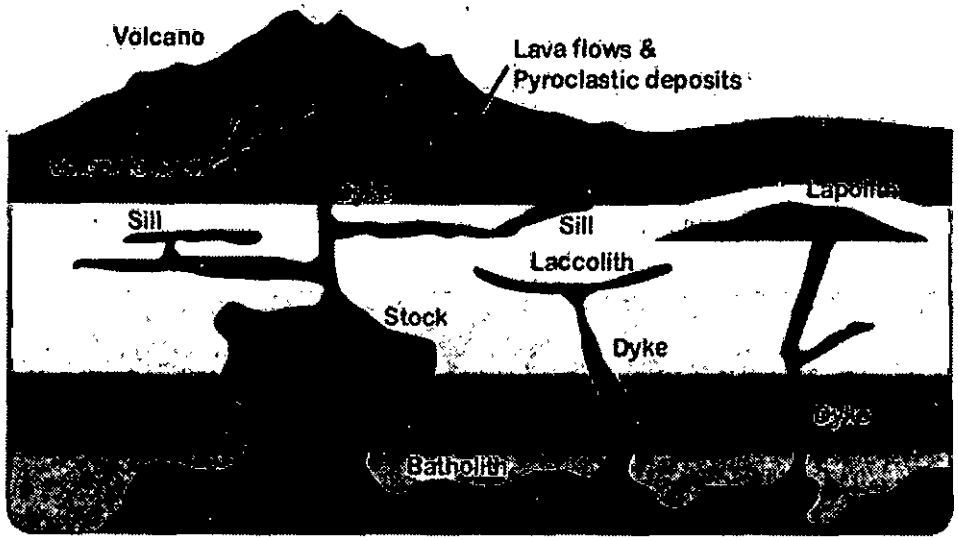
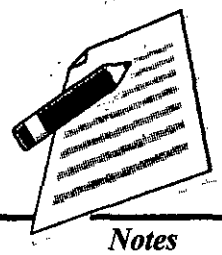



Figure 3.26 Intrusive Volcanic structure





## 3. Metamorphic Rocks

The word metamorphic means 'change of form'. The metamorphic rocks form under the action of pressure, volume and temperature (PVT) change.

Metamorphism is a process by which the already consolidated rocks undergo recrystallisation and reorganization of materials within original rocks. Gneiss, slate, schist, diamond, marble, quartzite etc. are some examples of metamorphic rocks. The igneous and metamorphic rocks together account for 95 percent of the earth.

**Table 3.2** Metamorphosis processes

| Igneous/ Sedimentary rock | Influence | Metamorphosed rock |
|---|---|---|
| Granite | Pressure | Gneiss |
| Clay, Shale | Pressure | Schist |
| Sandstone | Heat | Quartzite |
| Clay, Shale | Heat | Slate or Phyllite |
| Coal | Heat | Anthracite or Graphite |
| Coal | Heat and Pressure | Diamond |
| Limestone | Heat | Marble |

## Economic significance of rocks

Man has been interacting with the surface of the earth since long. With time and advancement in technology he is making different uses of rocks and minerals. The importance of rocks is given below:

(a) Soils: Soils are derived from rocks. Soils provide suitability for that agricultural products that provide food for mention and provide raw material for many industries.

(b) Building Material: Rocks are the source of types of building material directly or indirectly. Granite, gneiss, sandstone, marble and slates are extensively used in the construction of buildings. Taj mahal is made of white marble, Red Forts of Delhi and Agra, are made of red sandstone. Slates are used for roof purposes in different parts of India.

(c) Mineral Source: Minerals are the foundation of the modern civilization. Metallic minerals provide all metals ranging from very precious gold, plati- num, silver, copper to aluminium and iron. These metals are obtained from different rocks.

(d) Raw Material: Certain rocks and minerals are used as raw material for many industries. In cement industry and limestone kilns different type of rocks and minerals are used for production of finished goods. Graphite is used in crucible and pencil manufacturing as raw materials.

(e) Precious Stones: Precious stones and metals are obtained from different metamorphic or igneous rocks. Diamond is a precious stone used in jewellery and is a metamorphic rock. Similarly, other precious stones like gems, rubies and sapphires are obtained from different type of rocks.

(f) Fuel: Fuel in the form of coal, petroleum, natural gas and nuclear minerals are derived from different rocks.

(g) Fertilizer: Fertilizers are also derived from some rocks. Phosphatic fertilizers are obtained from phosphorite mineral found in abundance in some parts of the world.

## Weathering

Weathering is the process of disintegration and decomposition of rocks. It is due to the action of climate, plants, animals and other living organisms which cause the rocks to break down physically, chemically and biologically.

There are three types of weathering. They are physical weathering, chemical weathering and biological weathering.

## Physical weathering

**Physical Weathering** is the disintegration of rock mainly induced by elements of weather. It produces smaller, angular fragments of the same rock. It is caused by the change in temperature, pressure, water and wind. Physical weathering is further divided into different categories. They are thermal weathering, frost wedging and exfoliation.

## 1. Thermal weathering

In arid and semi-arid areas, the temperature increases, heat up and expand the rocks during the day and contract the rock materials when cooling at night. Under extreme temperature conditions, due to alternate expansion and contraction, the rocks crack and eventually split. The thermal weathering's are of two types. They are;

1. Granular disintegration and
2. Block disintegration

Alternate expansion and contraction of minerals of varying properties in the rocks due to temperature changes, makes the rocks break down into small pieces (Figure 4.2). Due to this, the breakup of rocks occurs, grain by grain. This is known as **granular disintegration.**

**Rock Exfoliated and Abraided**

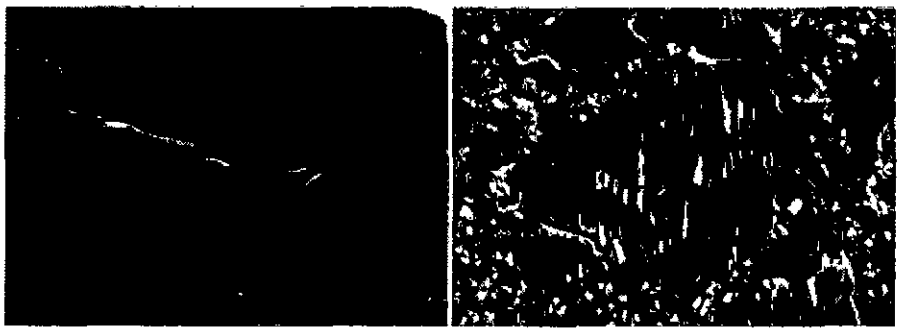


Figure 4.2 Exfoliated Rock( left) and Granular (right)

**Block disintegration** occurs in rocks such as granite rock. So, in the areas of jointed igneous or layered sedimentary rocks due to the great diurnal range of temperature, the rocks may break up along the joints and cracks into a large rectangular shaped block.

## 2. Frost Wedging

Almost all liquids contract when frozen, but when water freezes it becomes larger in size or takes up more space. As water expands it puts great pressure on rocks.

When water enters into the cracks of rocks and freezes, the pressure exerted on the rock is enough to wedge the walls of the crack farther apart, thus expanding and deepening the crack. Thus, frost wedging results in weathering of rock.

### 3. Exfoliation

Rocks generally heat or cool more on the surface layers. The alternate changes in temperature could cause their outer layers to peel off from the main mass of the rock in concentric layers just as the skin of an onion. The process by which curved layers of rock breakaway from the rock beneath them leaving behind dome shaped monoliths is called exfoliation (Figure 4.2). It is also called as 'onion weathering'. Exfoliation occurs commonly in the arid areas.

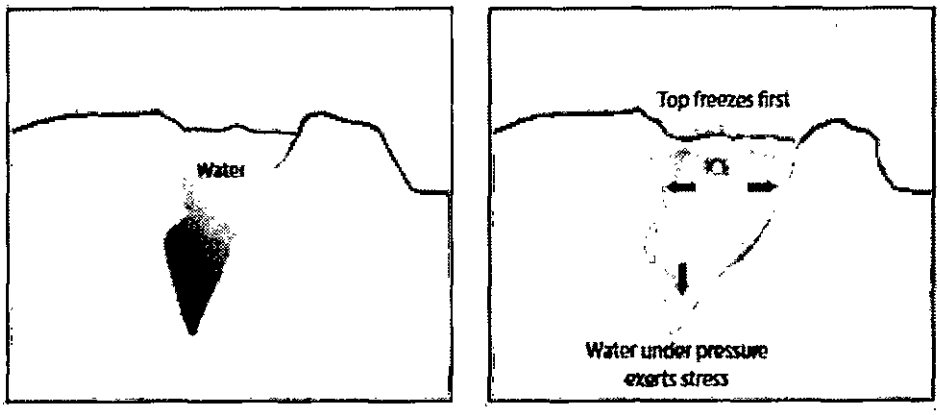



**Figure 4.3 Frost Wedging**

### Chemical Weathering

Chemical weathering is the decomposition of rock. For example, it creates altered rock substances, such as kaolinite (china clay) from granite. The types of chemical weathering are as follows:

1. **Solution:** Some soluble minerals in the rock get dissolved when come in contact with water. Over a long period, minerals get washed away from rock and sometimes leading to the formation of caves.
2. **Oxidation:** When oxygen combines with water and iron, it weakens the rock and breaks it. Example, rusting of iron.
3. **Hydrolysis:** It is the chemical breakdown of a rock substance when combined with water and forms an insoluble precipitate like clay mineral. The most common example of hydrolysis is feldspar found in granite changing to clay.
4. **Carbonation:** Carbonation is the mixing of water with carbon dioxide to make carbonic acid. This acid reacts with minerals in the rocks. This type of weathering is important in the formation of caves.
5. **Hydration:** *It is the absorption of water into the mineral structure of the rock.* Hydration expands volume and also results in rock deformation. A good example of hydration is the absorption of water by anhydrite, resulting in the formation of gypsum.

### Biological Weathering

Biological weathering is the alteration of rock by the action of plants, animals, and man. Burrowing and wedging by organisms like earthworms, termites, rodents, etc., help in exposing the rock surfaces to chemical changes with the penetration of moisture and air. Human beings by removing vegetation for agriculture and other activities also help in mixing

and creating new contacts between air, water, and minerals in the rock materials. Plant roots make a great pressure on the rock materials mechanically breaking them apart.

**Figure 4.4 biological weathering**

## Gradation

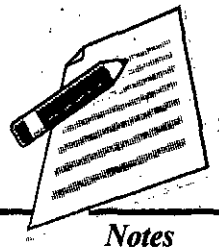
Exogenetic forces are constantly working to bring about levelling or the gradation of land. They attempt to achieve a condition of balance between erosion and deposition which mean a graded position. The above forces operate through the process called the process of gradation. Agents of gradation like rivers, glaciers winds, sea waves and underground water perform their task with the help of the triple action of weathering, erosion and deposition. The levelling down of elevated portions of the earth's surface is done by erosion. The filling up of depressions is done by deposition of the eroded material transported by the external agents of gradation as spoken earlier. We have studied that the endogenetic forces of the earth give rise to major landforms on the earth surface and the exogenetic forces level them down. The work of gradation has two components (a) degradation and (b) aggradation.

## (a) Degradation

When rocks are removed by scraping, scratching and cutting as a result of the process of erosion, thereby lowering the elevation of the land, it is called degradation. Degradation, first of all includes the work of weathering that is the movement of scarped and scratched material aided by the great force of gravity. It also includes the work of erosion implying the transportation of the rock material by an agent of gradation. The increase in the movement of rock- debris increases both its erosional and transportation capacities.

## (b) Aggradation

Filling up of low-lying areas of depression by eroded material is called deposition. Deposition starts when the agents of gradation lose their force or have obstruction in their way. As a result, eroded material is deposited in depressions which not only creates new landforms but also modifies the existing ones.





It explains the total process of gradation and its two components-degradation and aggradation. It shows the elevated portions continuously being lowered by weathering and erosion. The debris consisting of the eroded material is transported and deposited in the low-lying areas. The surface of the lower areas on the other hand is raised through deposition of this debris. Finally, the position of a uniform or near uniform level is achieved. The process of gradation is not performed by a single agent. It is rather a result of the work of all agents of gradation acting simultaneously. It is however possible for a single agent of gradation to be more active in particular area or at a particular time.

## Soil Formation

The outer layer of the earth is formed of soil. So, when we fall on the ground, our clothes get dirty because of soil. Its thickness varies from few millimetres to several meters. Soil formation occurs as a result of a gradual breakdown of rocks. Rocks are broken down into finer particles through many processes such as weathering and erosion. The geological components are mixed with organic materials to form soil. This implies that it is a mixture of rocks which are broken into smaller particles and the dead and decayed organic matter along with the little microbes.

Plants do not grow in the sand because pure sand is only rock particulate matter and it does not contain the minerals required for the proper growth of plants. Sand can be converted into soil by adding organic matter to it. There are two main components of soil, the rock particles and the organic matter. Soil also has a lifecycle of its own. Formation of soil starts with the disintegration of rocks under certain environmental conditions.

Rainwater sips in rocks and the fluctuation in temperature causes differential expansion and contraction of the rocks. Then the freezing and thawing of the water captured inside the rocks creates cracks inside the rocks and finally breaks them into finer particles.

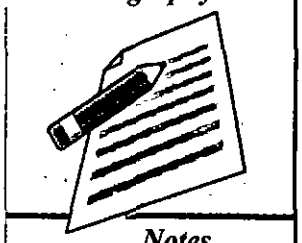
In the pioneering vegetations, if rocks are kept still for some day, lichens start growing on the surface of the rocks. During their growing period, lichens release certain substances which convert the rocks into powder form and slowly convert the powdery material into the soil. Small plants like moss can grow on these surfaces and their growing roots further loosen the rock particles. The decaying plants produce organic acids that attack the rocks. Organic matter and the rock particles are mixed with the minerals and forms soil.

It is considered as our life support system, without which human life will be difficult on earth. It provides plants with a foothold for roots, and it consists of necessary nutrients for plants. In this article, we have discussed soil and its constituents.

The soil is one of our essential natural resources. It is important for the growth of vegetation we feed on. It holds plants firmly and provides nutrition. It is home to many microorganisms such as earthworms, rats and several other subterranean species on earth.

## What is Soil?

It is the uppermost layer of Earth's crust, formed by the continuous weathering of mountains over thousands of years. It is made up of four basic constituents; minerals, organic materials, air, and water. The three main components responsible for its texture are; sand, silt, and clay. Depending upon these three constituents the mineral texture of the soil varies. Leaves and organic constituents decompose to form the upper organic layer, known as humus. The humus content in soils plays a very important role in its fertility.





## Soil Formation Process

Now let us look at the process of how soil formation happens.

## Parent Material

The mineral from which the soil is formed is termed as the parent material. Rocks are the source of all soil minerals. The parent material is chemically or physically weathered and transported which then deposits to form layers of soils. Usually, the bedrock is the parent material but there have been cases wherein soil gets transported due to factors like the wind and water.

## Image of a Parent Rock

Now the actual process of formation of soil is a cumulative combination of a number of processes. Soil formation also known as Pedogenesis is first kicked off by weathering and variations come according to the weather conditions.

## Carriers or Weathering Agents

- Glacier:

  As glaciers move from one part to another, they push the soil further with them. The drifted material gets deposited miles away from the place of its formation. When the glaciers melt, huge mounds of soil are left behind, a part of which is carried by the stream.

- Water:

  As rivers flow, the soil particles are transported along with the water. The smallest particles travel the farthest. Heavier particles, such as sand and rock get settled earlier. Soils deposited along the river banks are termed as alluvial soil, which is very rich in mineral content. Rainfall also plays an important role. Rainfall washes off the soils in exposed lands.

- Wind:

  Air plays the most important role as it transports a huge amount of soil from one place to another. Loose soils are carried away by the wind from one place to another.

## Weathering Processes

- Freezing and Melting:

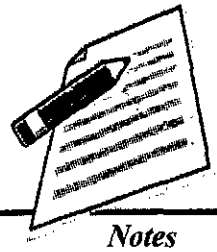
  Repeated freezing and melting results in the formation of cracks and crevices in rocks. In the presence of the sun, the surface of rock expands. Upon coming in contact with a water body, these pores get filled with water. As we know, water expands when frozen, which pushes the particles further apart, breaking it down. When ice melts again, the rock breaks into loose soil particles

- Heating and Cooling:

  In places with extreme climatic conditions, such as the arctic circle or the arid region, the rocks are subjected to sudden expansion and contraction, which results in the loosening of their particles and increase in the air content. Over time, the effect significantly reduces a rock to loosen soil.

- Wetting and Drying:

  The rocks swell when they are wet and shrink back when dry. Regular wetting and drying of rocks result in the loosening of its grains.





- Grinding or Rubbing:

  As the sea waves pound to the rocks along the seashore, abrasion of the uppermost layer occurs along with its fragmentation into smaller rocks and further into smaller particles.

- Organisms:

  The organisms such as earthworm live in the soil. They churn their way through it by eating it. This results in the production of nutrient-rich manure in the form of their excreta. Their movement in the soil helps in its mixing and aeration.

## 6. Soil erosion

Soil erosion is the process of removal of superficial layer of the soil from one place to another.

## Harmful effects of soil erosion

- Soil fertility is lost because of loss of top soil layer.
- Loss of its ability to hold water and sediment.
- Sediment runoff can pollute water and kill aquatic life.

## Types of soil erosion

## (i)Normal erosion

Gradual removal of top soil by the **natural process.** The rate of erosion is slower.

## (ii)Accelerated erosion

Caused by man-made activities the rate of erosion is much faster than the rate of formation of soil.

## Man induced landslides

Various anthropogenic activities like hydroelectric projects, large dams, reservoirs, construction of roads and railway lines, construction of buildings, mining etc are responsible for clearing of large forested areas.

Earlier there were few reports of landslides between Rishikesh and Byasi on Badrinath Highway area. But, after the highway was constructed, 15 landslides occurred in a single year.

During the construction of roads, mining activities etc. huge portions of fragile mountainous areas are cut or destroyed by dynamite and thrown into adjacent valleys and streams.

These land masses weaken the already fragile mountain slopes and lead to landslides.

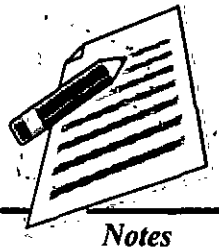
They also increase the turbidity of various nearby streams, thereby reducing their productivity.

## Causes of soil erosion (i)Water

Affects soil erosion in the form of rain, run-off, rapid flow, wave action.

**Sheet erosion:** When there is uniform removal of a thin layer of soil from a large surface area, it is called sheet erosion.

**Rill erosion:** when there is rainfall and rapidly running water produces finger-shaped grooves or rills over the area, it is called rill erosion.





**Gully erosion:** When the rainfall is very heavy, deeper cavities or gullies are formed, which may be U or V shaped.

**Slip erosion:** This occurs due to heavy rainfall on slopes of hills and mountains.

**Stream bank erosion:** During the rainy season, when fast running streams take a turn in some other direction, they cut the soil and make caves in the bank.

## (ii)Wind

Wind is the important climatic agent, who carry away the fine particles of soil and creates soil erosion. **Saltation:** This occurs under the influence of direct pressure of stormy wind and the soil particles of 1-3.5 mm diameter move up in vertical direction.

**Suspension:** Here fine soil particles (less than 1mm diameter) which are suspended on the air are kicked up and taken away to distant places.

**Surface creep:** Here the large particles (5-10 mm diameter) creep over the soil surface along with wind.

## (iii)Biotic agents

Overgrazing, mining and deforestation are the major biotic agents, cause soil erosion. Deforestation without reforestation, overgrazing by cattle, surface mining without land reclamation, irrigation techniques that lead to salt build- up, water logged soil, make the top soil vulnerable to erosion.

35% of world soil erosion is due to overgrazing.

30% of world soil erosion is due to deforestation.

## (iv) Landslides

-Causes soil erosion.

## (v)Construction

-Construction of dams, buildings, roads remove the protective vegetal cover and leads to soil erosion.

## Control of soil erosion (or) soil conservation practices

## 3. Conservational till farming (or) no-till-farming

In tradition method, the land is ploughed and soil is broken up and levelled to make a planting surface. This disturbs the soil and makes it susceptible to erosion

However, no-till-farming causes minimum disturbance to the top soil

Here the tilling machines make slits in the unploughed soil and inject seeds, fertilizers and water in the slit. So, the seed germinates and the crop grows.

## 2. Contour farming

It involves **planting crops** in rows across the contour of **gently sloped land.**

Each row acts as a small dam to hold soil and to slow water runoff.

Fig. 3.22 Contour farming

### 3. *Terracing*

It involves conversion of **steep slopes into broad terraces**, which run across the contour. This retains water for crops and reduces soil erosion by controlling runoff.

Fig. 3.23 Terracing

### 4. Alley cropping (or) Agro forestry

It involves **planting crops in strips** or **alleys between rows** of **trees of shrubs** that can provide fruits and fuel wood.

Even when the crop is harvested, the soil will not be eroded because trees and shrubs still remain on the soil and hold the soil particles.

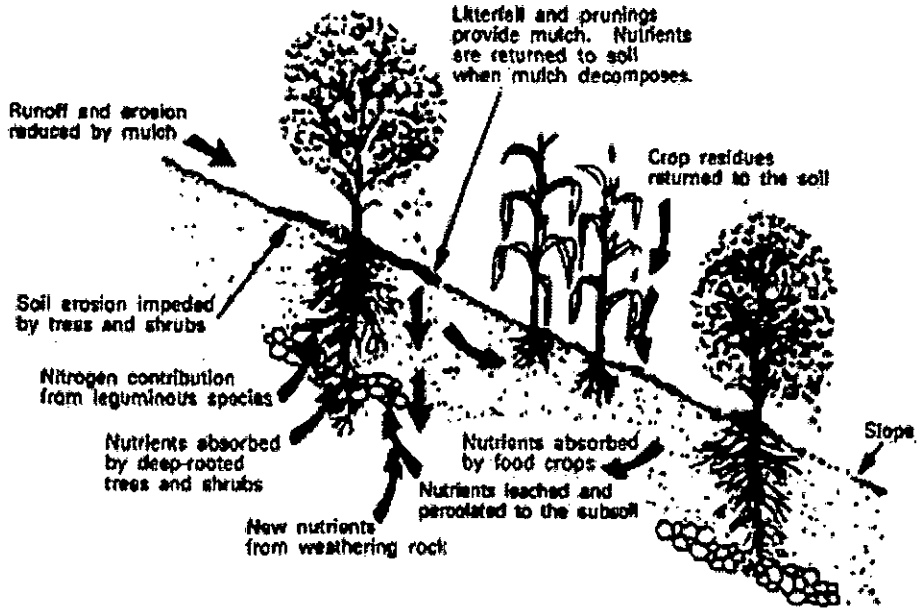



Fig. 3.24 Alley cropping

## 5. Wind breaks or shelter belts

The **trees** are planted in long rows along the boundary of cultivated lands, which **block the wind** and **reduce soil erosion**.

Wind breaks help in retaining soil moisture, supply of some wood for fuel and provide habitats for birds.

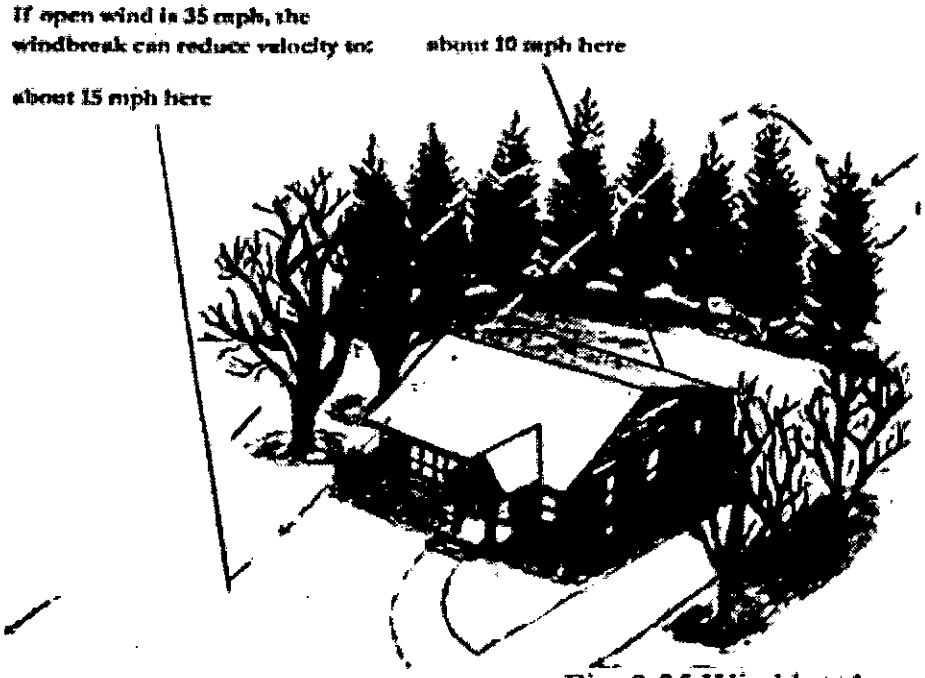
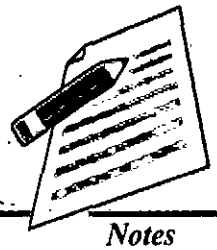



Fig. 3.25 Wind breaks





## SUMMARY

Earth is a spherical body. The direct observations into its interior are limited to a depth of a few kilometres. Temperature, pressure and density increase from the earth's surface to its centre. Earth's interior is divided into three concentric layers; Crust, mantle and core. Crust is the thinnest and outermost layer, mantle middle one whereas core is the innermost and the densest layer of the earth. The material of the crust is composed of rocks. Rock is composed of one or more minerals. Minerals have a definite chemical composition. On the basis of their mode of formation, rocks are classified into three types - igneous, sedimentary and metamorphic. Igneous rocks are formed by the solidification of molten lava or magma. Granite, basalt and gabbro are examples of igneous rocks. The exogenetic forces act upon them to make the surface level. The rocks undergo various types of changes in their own location under the process of weathering. Plants, animals, insects and men are the agents of biotic weathering and they contribute to both mechanical and chemical weathering. Erosion of soils takes place in four ways viz., wind erosion, sheet erosion, rill erosion and gully erosion. Removal of soil cover depends on velocity and speed of water, nature of slope, texture and structure of soils, frequency of dust storms and nature of precipitation. Man through his misdeeds, has also helped natural forces in increasing the problem of soil erosion. Methods to prevent soils from being eroded constitute soil conservation. These methods are protection of forests, afforestation, contour ploughing, terrace and strip farming, bunding, flood control, etc.

## EXERCISE

### MCQ

1. Which is the closest star to Earth?
   a. Sun
   b. Alpha Centauri A
   c. Moon
   d. Proxima Centauri

2. The gas in most abundance on the Earth is
   a. Hydrogen
   b. Oxygen
   c. Nitrogen
   d. Carbon Dioxide

3. _____ is composed of molten rocks that comes out during a volcanic eruption.
   a. Magma
   b. Lava
   c. Crust
   d. Core

4. Earth completes one rotation in approximately _____ hours.
   a. 6
   b. 12
   c. 24
   d. 36

5. _____ of Earth results in day and night.
   a. Rotation
   b. Revolution
   c. The orbit of the Earth
   d. When the Moon blocks the Sun

6. _____ of Earth results in the change of seasons.
   a. Rotation
   b. Revolution
   c. The orbit of the Earth
   d. When the Moon blocks the Sun

7. The Rotation of Earth happens when
   a. The Earth orbits around the Sun
   b. The Earth spins on its own axis
   c. The Earth orbits around the Moon
   d. The Sun orbits around the Earth

8. In the _____ season, the Earth is closest to the Sun.
   a. Summer
   b. Winter
   c. Spring
   d. Autumn

9. Alteration in the length of the shadows is caused due to
   a. Earth's Revolution
   b. Blockage of Earth by the Moon
   c. Earth's Rotation
   d. Movement of Sun

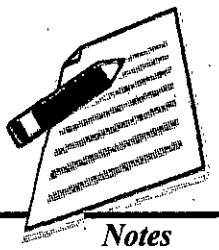
10. Our Solar System is a part of which Galaxy?
   a. Whirlpool Galaxy
   b. Black Eye Galaxy
   c. Andromeda Galaxy
   d. Milky Way

## Answers:

1. (a) Sun
2. (c) Nitrogen
3. (b) Lava
4. (c) 24
5. (a) Rotation
6. (b) Revolution
7. (b) The Earth spins on its own axis
8. (a) Summer
9. (c) Earth's Rotation
10. (d) Milky Way

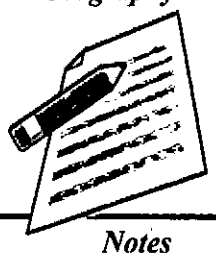
## Review Questions

1. What are the limitations of direct methods in the determination of the earth's interior?
2. Draw and label a diagram showing earth's interior and its density and depth of each layer.
3. Distinguish between a rock and a mineral with suitable examples.
4. Discuss the classification of various types of rocks on the basis of their mode of formation. Support your answer with examples.



*Notes*

5. Explain in brief the economic significance of rocks and minerals.
6. Compare the processes of formation of metamorphic and sedimentary rocks.
7. What is weathering? Name the different types of weathering.
8. How does chemical weathering take place?
9. Differentiate between (a) Disintegration and Decomposition (b) Degradation and Aggradation (c) Oxidation and Solution.





# 3 DYNAMIC SURFACE OF THE EARTH

- Understand the concept of earth.
- Discuss the dynamic surface of earth.
- Describe the concept of **Isostasy**.
- Discuss the Airy hypothesis.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of dynamic surface of earth so that the various hypothesis and theories of earth surface can be learned.

## Introduction

**Isostasy,** ideal theoretical balance of all large portions of Earth's lithosphere as though they were floating on the denser underlying layer, the asthenosphere, a section of the upper mantle composed of weak, plastic rock that is about 110 km (70 miles) below the surface. Isostasy controls the regional elevations of continents and ocean floors in accordance with the densities of their underlying rocks. Imaginary columns of equal cross-sectional area that rise from the asthenosphere to the surface are assumed to have equal weights everywhere on Earth, even though their constituents and the elevations of their upper surfaces are significantly different. This means that an excess of mass seen as material above sea level, as in a mountain system, is due to a deficit of mass, or low-density roots, below sea level. Therefore, high mountains have low-density roots that extend deep into the underlying mantle. The concept of isostasy played an important role in the development of the theory of plate tectonics.

In the theory of isostasy, a mass above sea level is supported below sea level, and there is thus a certain depth at which the total weight per unit area is equal all around the Earth; this is known as the depth of compensation. The depth of compensation was taken to be 113 km (70 miles) according to the Hayford-Bowie concept, named for American geodesists John Fillmore Hayford and William Bowie. Owing to changing tectonic environments, however, perfect isostasy is approached but rarely attained, and some regions, such as oceanic trenches and high plateaus, are not isostatically compensated.

The Airy hypothesis says that Earth's crust is a more rigid shell floating on a more liquid substratum of greater density. Sir George Biddell Airy, an English mathematician and astronomer, assumed that the crust has a uniform density throughout. The thickness of the crustal layer is not uniform, however, and so this theory supposes that the thicker parts of the crust sink deeper into the substratum, while the thinner parts are buoyed up by it. According to this hypothesis, mountains have roots below the surface that are much larger than their surface expression. This is analogous to an iceberg floating on water, in which the greater part of the iceberg is underwater.

The Pratt hypothesis, developed by John Henry Pratt, English mathematician and Anglican missionary, supposes that Earth's crust has a uniform thickness below sea level with its base everywhere supporting an equal weight per unit area at a depth of compensation. In essence, this says that areas of the Earth of lesser density, such as mountain ranges, project higher above sea level than do those of greater density. The explanation for this was that the mountains resulted from the upward expansion of locally heated crustal material, which had a larger volume but a lower density after it had cooled.

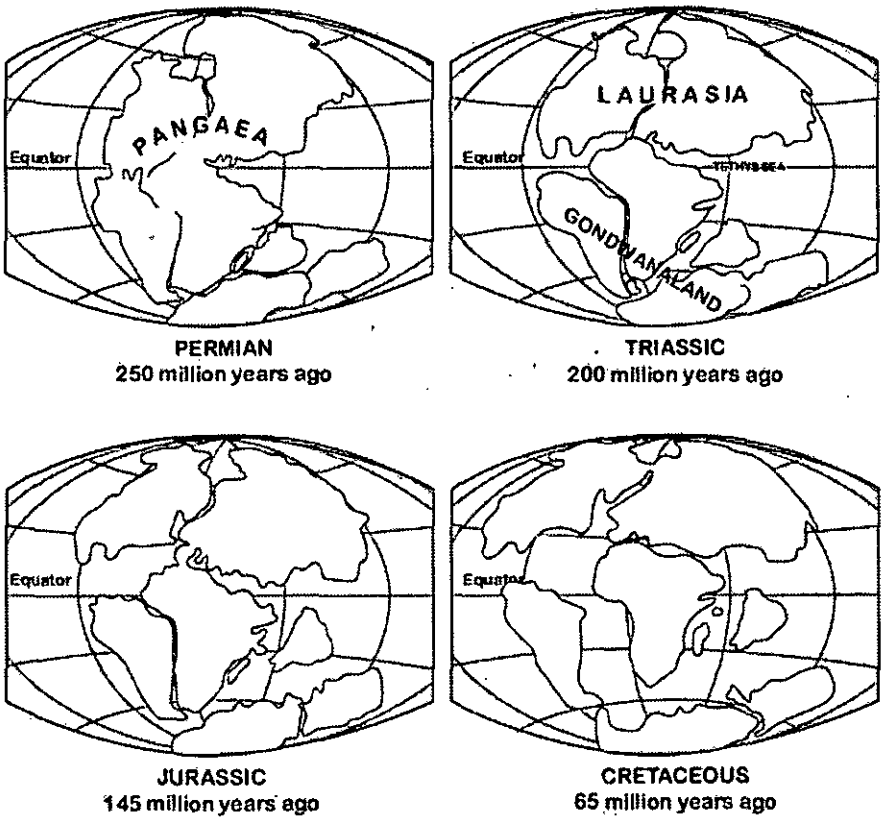
The Heiskanen hypothesis, developed by Finnish geodesist Weikko Aleksanteri Heiskanen, is an intermediate, or compromise, hypothesis between Airy's and Pratt's. This hypothesis says that approximately two-thirds of the topography is compensated by the root formation (the Airy model) and one-third by Earth's crust above the boundary between the crust and the substratum (the Pratt model).

## Continental Drift Theory

In 1912 Alfred Wegener (1880-1930) postulated that all the continents once were together forming a single continent. According to him, about 250 million years ago, the earth was made up of a single landmass called Pangaea (meaning «all lands»), and a single ocean surrounding it called as Panthalassa. Over a long period of time, probably 220 million years ago, they drifted apart and gradually moved to form their present position. First, Pangaea broke into two landmasses namely Laurasia in the north and Gondwana in the south.

Laurasia further split into Eurasia and North America. Gondwana land split into Africa, South America, Antarctica, Australia, and India.

Wegener put forward certain evidences to support the continental drift theory. Let us deal with it in detail.




PERMIAN
250 million years ago

TRIASSIC
200 million years ago

JURASSIC
145 million years ago

CRETACEOUS
65 million years ago

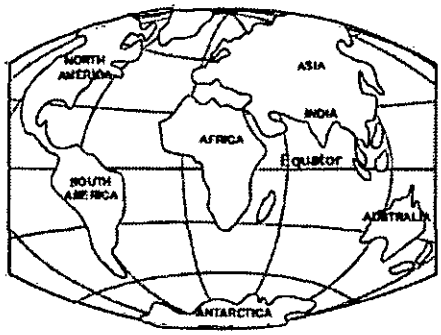



Figure 3.5 Continental Drift

## Evidences to support continental drift theory

The continental drift theory is supported by the following evidences.

- Certain identical rare fossils have been found in different continents.
- The fossils of Mesosaurus (a small Permian reptile), for example, have been found only in Africa and South America.
- The fossil of a Fern tree, about 360-million-year-old, has been found only in India and Antarctica.
- Rocks of similar type, formation, and age have been found in Africa and Brazil.
- Geological structure in Newfoundland matches with that of Ireland, Scotland and Scandinavia. Geological Structure of Appalachian Mountains matches with Morocco and Algeria in North Africa.
- The corresponding edges of the continents fit together. For example, the western side of Africa and the eastern side of South America fit together.

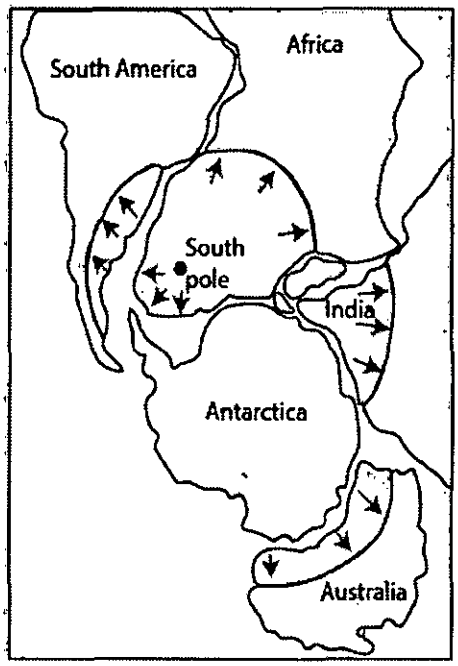



Figure 3.6 Evidence of continents split from the same land mass

## Plate Tectonics

Have you heard about diving between two continents? It is possible in the Silfra rift of Iceland. Look at Figure.3.7. It is located in the Tingvellir National Park. It is in the boundary between the North American plate and the Eurasian plate. It is the visible boundary between these two plates.

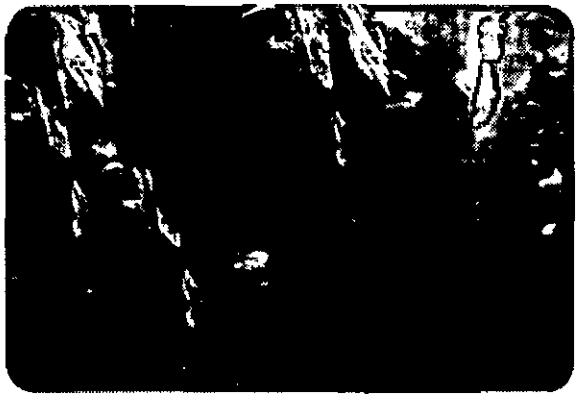


Figure 3.7 Silfra rift, Tingvellir, Iceland

You have already learned the Continental drift theory. Now let us see what plate boundaries are.

## Plate boundaries

Plate boundaries are the zones where two or more plates move about. Plate tectonics describes the distribution and motion of the plates. The earth's surface is composed of rigid lithospheric slabs technically called "plates". The word **tectonic** is derived from the Greek word ***tekton*** meaning builders.

Lithospheric plates are sometimes called as crustal plates or tectonic plates. Earth's lithosphere is divided into a series of major and minor mobile plates. Eurasian plate, Indo-Australian plate, North American plate, South American plate, Pacific plate, African plate and Antarctic plate are the major plates. Arabian plate, Caribbean plate, Cocas plate and Scotia plate are the examples of minor plates. Plates move at the rate of 2 to 3 centimetres per year.

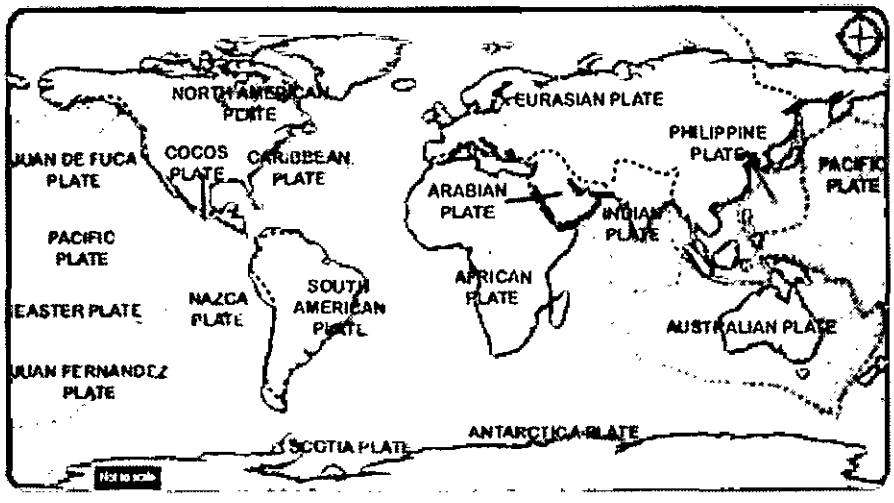



Figure 3.8 Distribution of tectonic plates

Plates are composed of the continental or oceanic landmass. The subduction of the oceanic plates results in the occurrence of earthquakes and volcanoes adjacent to trenches.

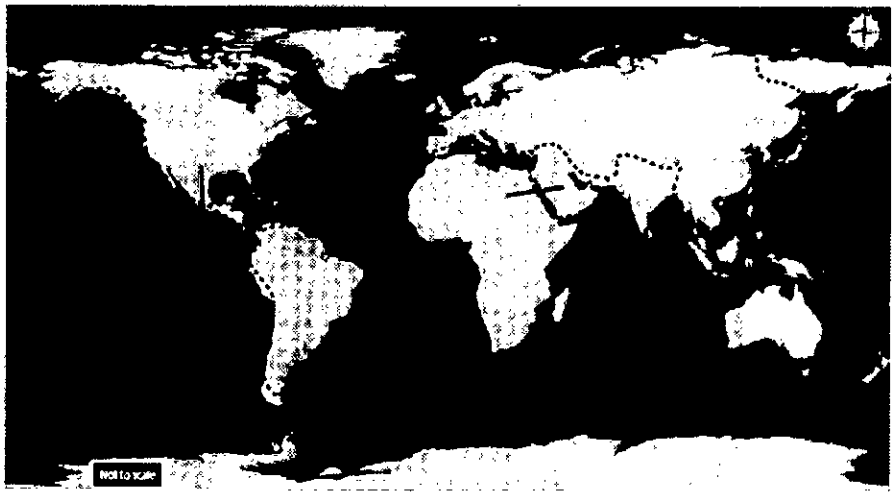


**Figure 3.9** Tectonic plates

Plate margins mark the occurrence of the most significant landforms, including volcanoes, fold mountains, island arcs and deep-sea trenches. There are three principal types of plate boundaries. They are divergent, convergent, and transform boundaries.

## Divergent plate boundaries

Divergent plate boundary is the margin where two plates move apart. For instance, the African plate and South American plate move apart and form a divergent plate boundary. Narrow oceans represent young divergent boundaries and wide oceans are indications of old ocean basins. Ocean ridges are the boundaries between plates of the lithosphere.

A fissure is created when oceanic lithosphere separates along the oceanic plate boundary. The gap is filled by magma that rises from the asthenosphere. The magma cools and solidifies to create a new oceanic crust. Hence, the divergent plate boundary is termed as the constructive plate boundary. It is also called as accreting plate margin.

Let us see what happens in the divergent plate boundary. Firstly, submarine mountain ridge is formed through the fissures in the oceanic crust when the plates move apart.

The Mid-Atlantic Ridge is an ideal example of a submarine mountain ridge in the Atlantic Ocean. It is the longest mountain ridge in the world.

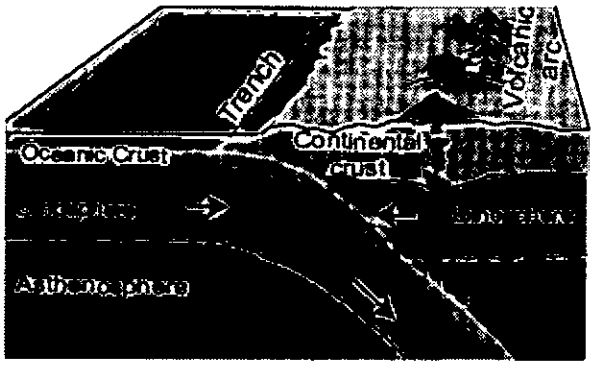



**Figure 3.10** Divergent margin

It extends for about 16,000 km, in a 'S' shaped path, between Iceland in the north and Bouvet Island in the south. It is about 80 to 120 km wide. It reaches above the sea level in some places thus forming the islands such as the Azores, Ascension, St. Helena and Tristan da Cunha.

Secondly, rift valley is formed when two plates move apart. If a divergent boundary runs through the continent, the continent splits apart and rift valley is formed. The African *Rift Valley of East Africa is an example.*

## Convergent plate boundary

Convergent plate boundary is the margin where two plates collide with one another. For instance, the South American plate and Nazca plate collide with each other. There are two kinds of surface features associated with the convergent margin. The first is the ocean trench that forms a line between the two colliding plates.

A trench is a narrow and deep depression of the ocean floor. It is formed when the oceanic plate slides down underneath continental plate as the oceanic plate is denser than the continental plate. For instance, Mariana Trench in the Pacific Ocean, is the deepest trench in the world. It is formed when the Pacific plate sinks down the Eurasian plate. It is about *10,994 metres (10.99 km) deep. Mariana Trench stretches for more than 2,540 km with a* width of 69 km.

You could take Mount Everest and sink it in the Mariana Trench, the deepest point in the ocean, and still, you have a km of depth to reach the surface of the ocean.

When a continental plate and an oceanic plate collide with each other, denser oceanic plate sinks below the lighter continental plate, subduction zone is formed.

A subduction zone is a boundary where one plate sinks under the other plate. It was first identified by Kiyoo Wadati and Benioff.

Secondly fold mountain is formed when two plates collide each other. For instance, the Himalayas were formed when the Indian plate collided with the Eurasian plate. The zone marking the boundary of the two colliding plates is known as suture line.

As the crust is less dense than the mantle, the newly formed magma will tend to rise to the Earth's surface, where it may form volcanoes. The area in the subduction zone where most earthquakes occur is known as the Benioff zone.

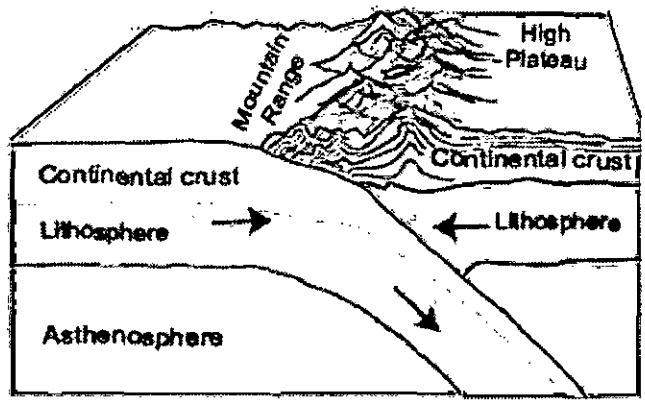



**Figure 3.11 Convergent plate boundaries**

## Transform plate boundaries

Transform plate boundary is the margin where two plates move side by side. The lithosphere is neither destroyed nor created by the transform plate boundary. Hence it is called as the Conservative or passive plate boundary. The San Andreas Fault, California, is a transform boundary that separates the North American plate and Pacific Plates.

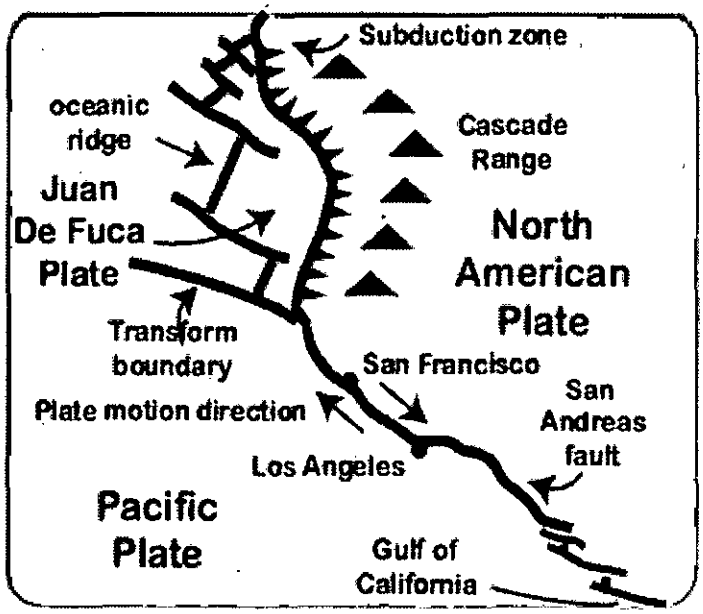



**Figure 3.12 Transform plate boundary**

## SUMMARY

The surface of the earth is dynamic. This dynamism is due to the forces operating from inside the surface (endogenetic forces) as well as on the surface/atmospheric forces (exogenetic forces). It is existing on the earth while itself is rotating and revolving. The surface is irregular. Hence, a sort of dynamic equilibrium is always in operation which is termed as isostasy. Apart from many scholars the views of Airy and Pratt are more distinct. Airy propounded the idea of uniform density of all rocks on the surface but has its roots depending upon the height of the column. A greater root will be found beneath the higher and lofy body of mountains and having smaller root under lower columns like plateau or plain. Pratt accepted that the rocks found on the earth have different densities. At a particular's depth, the weight of all columns of varying height will be compensated. Hence, higher column of mass will have lower density and lower column will have higher density. Therefore, both of them are explaining the same problem of isostatic balance, but with different perspective. The distribution of land and water on earth surface is not static. It has changed, it is changing and it will change in future too. This changed position is said to be continental drift in crude way which was conceived by Wegener, but the mechanism explained by him was not scientific. First, two adjacent plates move away (divergent) and where a new zone is constructed. Second, two adjacent plates come closer (convergent) and get subducted and where a zone is destroyed. Third, in which two adjacent plates slide past each other (fracture) where the margins of both plates are preserved. Because of these different tectonic activities, earthquakes and volcanoes are associated with plate margins.

## EXERCISE

### MCQ

**Q.1.** Which of the following are reasons for uneven surface of earth?

1. Earth moves vertically and horizontally.
2. Earth's crust is dynamic.
3. Earth is continuously subjected to external forces originating within the earth's atmosphere

Select the correct answer from the following codes

a. only 1 b. 1 and 3 only
c. 2 and 3 only d. 1,2 and 3

**Answer:** d

**Q.2.** Consider the following statements

1. Earth crust moved a bit faster in the past than the rate at which it is moving now.
2. The endogenic forces are mainly land wearing forces and the exogenic processes are mainly land building forces.

Select the correct statements using following codes

a. Only 1 b. Only 2
c. Both 1 and 2 d. Neither 1 nor 2

**Answer:** c

**Q.3.** Which of the following force contribute to endogenic geomorphic processes?

1. primordial heat from the origin of the earth
2. radioactivity
3. rotational and tidal frictionSelect the correct statements using following codes

a. Only 1 b. Only 1 and 3
c. Only 1 and 2 d. 1,2 and 3

**Answer:** a

**Q.4.** Consider the following statements

1. All processes that elevate earth's crust come under diastrophism
2. Earthquakes involving local relatively minor movements also come under diastrophism

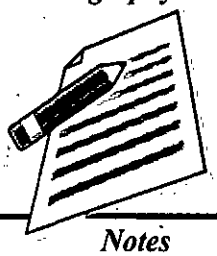
Select the correct statements using following codes

a. Only 1 b. Only 2
c. Both 1 and 2 d. Neither 1 nor 2

**Answer:** d

**Q.5.** Which of the following is true about exogenic geomorphic forces?

1. Exogenic geomorphic processes vary from region to region.
2. Besides the gravitational stress earth materials become subjected to molecular stressesSelect the correct answer from the following codes



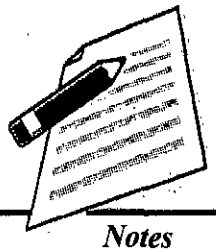


a. Only 1
b. Only 2
c. Both 1 and 2
d. Neither 1 nor 2

**Answer:** c

## Review Questions

1. What is isostasy?
2. Explain the concept of isostasy according to Airy.
3. Explain the isostatic balance of the earth as proposed by Pratt.
4. Differentiate the ideas between Airy and Pratt.
5. Discuss the isostatic balance at global level.
6. Discuss the evidences of continental drift.
7. What is plate? Explain the mechanism of plate movement.
8. Discuss the activities at plate margins.
9. Describe the distribution of earthquakes and volcanoes with the help of plate boundaries.





# 4 EVOLUTION OF LAND FORMS DUE TO INTERNAL FORCES

- Understand the concept of land.
- Discuss the internal forces of land.
- Describe the concept of **land forms**.
- Discuss the evolution of land forms.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of land so that the evolution of land forms due to internal forces can be learned.

## Introduction

We come across so many landforms such as mountains, plateau, plain, etc. But do you know how these landforms are formed? Let's find out more about Landforms of the Earth and Internal Forces.

## Internal Forces That Cause Landform

The thing that causes a change in the Earth's landforms is plate tectonics. Tectonic plates are huge slabs of rock and underneath all of the world's landmasses and seas. These plates move occasionally. These movements may be undetectable or may cause natural disasters such as earthquakes and volcanoes. Over the years, the amalgamation of these shifts reshapes the Earth's surface, altering existing landforms and creating entirely new ones.

## Earthquakes

The earth's plate responsible for causing earthquakes is the crust of the changing earth. Most earthquakes occur along the edge of the oceanic and continental plates. The earth's crust (the outer layer of the planet) is made up of several pieces, called **plates**. The plates under the oceans are called as oceanic plates and the rest are continental plates.

The plates are moved around by the motion of a deeper part of the earth (the mantle) that lies underneath the crust. These plates are always bumping into each other, pulling away from each other, or past each other. The plates usually move at about the same speed that your fingernails grow. Earthquakes usually occur where two plates are running into each other or sliding past each other. Earthquakes affect the landforms of the earth.

## Forces That Cause Landforms

### *By Veronica Ouellette*

Landforms are defined as specific features that appear on the Earth's surface. Some examples are mountains, plains, plateaus, valleys and hills. What causes these landforms are different forces that work internally and externally on the Earth's surface and core to form some of Earth's natural features.

### Layers of the Earth

Earth is made up of four layers: the inner core, the outer core, the mantle and the crust. Moving from the inner core to the crust, temperatures go from extreme heat to about room temperature. The inner core is a hot ball of mostly iron under extremely high pressure. The outer core is made up of mostly melted iron. The mantle is a thick liquid made up of iron, magnesium, aluminium, silicon and oxygen. The crust is made up of a mixture of solid minerals and is breakable.

### Tectonic Plates

The Earth's crust is broken into plates that lie over the mantle. Because the mantle is hotter toward the interior and cooler toward the exterior, convection currents occur, which causes the plates to move above them. The edges of the plates are called plate boundaries. Volcanoes, earthquakes and mountain building or orogeny are found along plate boundaries.

### Plate Boundaries

There are three different plate boundaries: divergent, convergent and transform. Divergent boundaries are where plates pull apart and lava pushes up into the space created. This forms most of the Earth's new crust. Plates are pushed together along the convergent boundaries and plates slide past one another along transform boundaries.

## Faults

Faults are a kind of transform boundary. Faults are a fracture or break in the Earth's crust along a line of weakness. Faulting can be caused by tensional or compressional forces put on rocks either laterally or vertically. An example of a fault is the San Andreas Fault in California. A block mountain, or horst, is another example of a fault. A block mountain has a flat surface and overhanging cliff and is formed when faulting in the crust causes a block of the crust to be lifted.

## External or Internal Processes

Landforms can also be shaped by external or internal processes, which work on the crust of the Earth. External processes work on the surface of the crust through weathering, denudation (or removal of the surface), erosion and deposition (or the raising of land). Some of these works are caused by rivers, glaciers, winds and waves. Internal processes work on the interior layers of the Earth. Forces gradually build up and the crust will undergo movements in the Earth such as earthquakes, volcanic activity or mountain buildings.

## Folding

Folding is a type of internal process on the Earth. Folding happens when forces on the Earth's crust push toward each other from opposite directions, which bends and folds the rock layers in different ways.

## Plate Tectonics

Plate tectonics is the movement of the Earth's crust through convection currents that occur in the mantle. Divergent plate boundaries occur where hot magma rises to the surface, pushing the plates apart. The mid-ocean ridges form at divergent plate boundaries. Convergent plate boundaries occur where cooled rock becomes denser than the rocks around it and sinks back into the mantle. Oceanic trenches, folded mountains and volcanic mountains occur at convergent plate boundaries. Sliding plate boundaries occur when one plate slides past another plate through a twisting force. The San Andreas Fault is an example of a sliding plate boundary.

## Igneous Rocks and Plate Tectonics

Igneous rocks form from the cooling of magma or lava. At diverging plate boundaries, convection currents bring hot magma to the surface. This hot magma flows out onto the ocean floor, forming extrusive, finely grained igneous rocks. At convergent plate boundaries, sedimentary rock from the ocean floor gets pushed down into the mantle. The crust increases in temperature as it dives deeper into the mantle. Eventually, the crust melts and rises to the surface causing a volcanic eruption, creating igneous rocks. Sometimes, magma that gets pushed up at plate boundaries cools before it gets there. It fills in cracks and voids in the bedrock. When it cools, it creates igneous rock formations, such as dikes and batholiths.

## Metamorphic Rocks and Plate Tectonics

Metamorphic rocks form when rocks change after undergoing extreme pressure or temperature increase. These temperature changes must be hot enough to reorganize matter within the rock but not hot enough to melt it. Hot magma pushes itself to the surface at both divergent plate boundaries and convergent plate boundaries. This magma comes in contact with rocks

as it rises to the surface. The magma is hot, heating the rocks around it. As the rocks heat, they change and become metamorphic rocks. This process is called contact metamorphism. Regional metamorphism occurs at convergent plate boundaries, due to intense pressure. As two plates collide, the Earth's crust folds and faults. The intense pressure changes large areas of the Earth's crust into metamorphic rock. Mountain ranges are typically metamorphic rock due to plate tectonic processes.

The earth's surface is being continuously reshaped by both the internal (Endogenic forces) and external forces (Exogenic forces). The changes that the endogenic and exogenic forces bring about in the appearance of the surface of the earth are collectively known as geomorphic processes. (figure. 3.3)

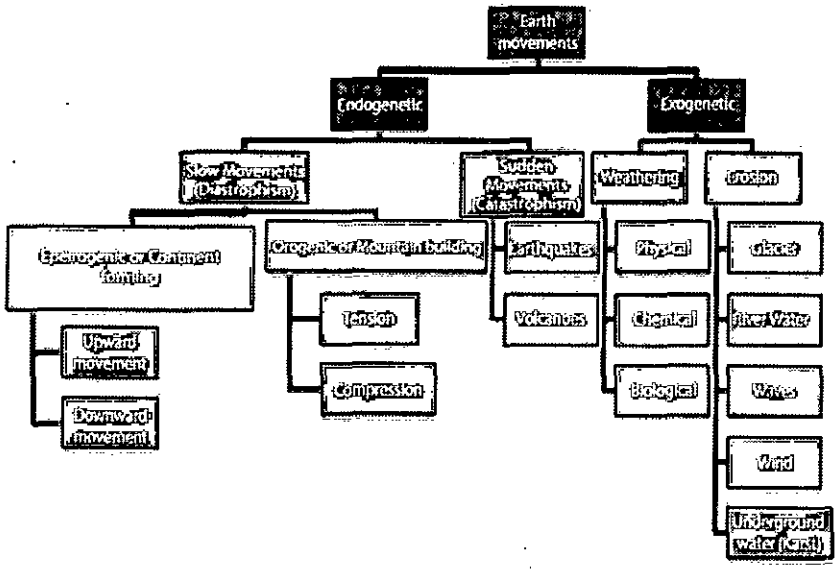



Figure 3.3 Earth's Forces

The process by which the earth's surface is reshaped through rock movements and displacement is termed as diastrophism. Diastrophism includes both orogenic and epeirogenic processes.

Our knowledge of the earth is mostly limited to its surface. But the earth has a complicated interior. The earth is composed of lithosphere, atmosphere, hydrosphere, and biosphere.

The lithosphere is the outermost rigid rocky shell of the earth. It comprises the crust and the upper portion of the mantle. The word lithosphere is derived from the Greek words ***lithos*** meaning rocky and ***sphaira*** meaning sphere. The term **lithosphere** was introduced by Joseph Barrel, an American Geologist.

## Motions of the earth

The earth has two basic movements:

1. Rotation
2. Revolution.

## Galactic movement:

This is the movement of the earth with the sun and the rest of the solar system in an orbit around the centre of the Milky Way Galaxy. This, however, has little effect upon the changing

environment of the earth.

**1. Rotation:** The spinning of the earth around its axis is called the rotation of the earth. The axis is the imaginary line passing through the centre of the earth. The earth completes one rotation in 23 hours, 56 minutes and 4.09 seconds.

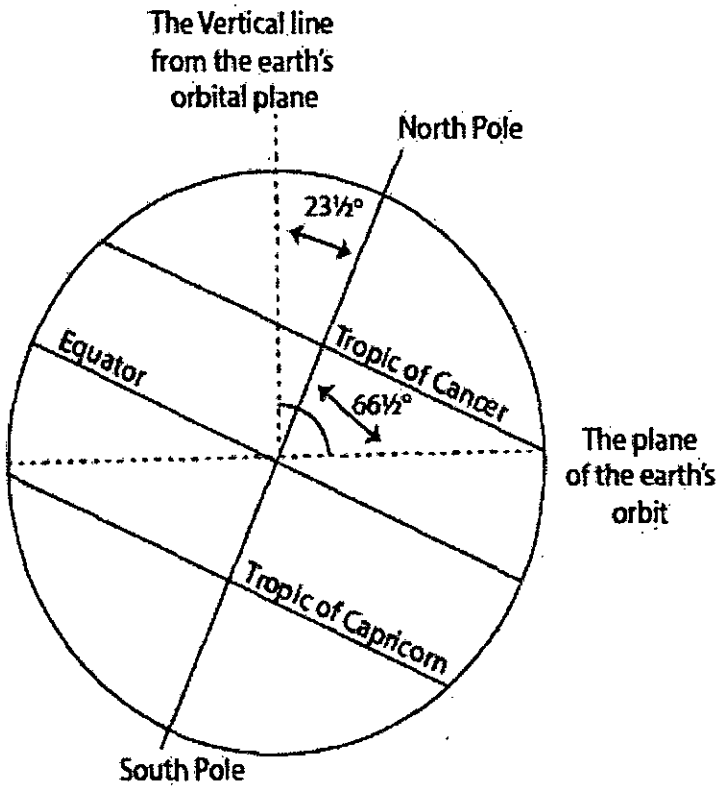



**Figure 2.10 Tilt of the Earth's axis**

It rotates in an eastward direction opposite to the apparent movement of the sun. The earth's axis is inclined at an angle of 66½q to the orbital plane as it moves around the sun. We can say, the earth's axis is tilted at an angle of 23½q (Figure 2.10) from a perpendicular to the elliptic plane. The velocity of earth's rotation varies depending on the distance of a given place from the equator. The rotational velocity at the poles is nearly zero. The greatest velocity of the rotation is found at the equator. The velocity of rotation at the equator is 1,670 km per hour.

**Effects of earth's rotation:** The rotation of the earth causes the following effects:

1. The apparent rising and setting of the sun is actually caused by the earth's rotation which results in the alternate occurrence of day and night everywhere on the earth's surface.
2. Rotation of the earth is also responsible for the difference in time between different places on the earth. A 24-hour period divided by 360 degrees gives a difference of 4 minutes for every degree of longitude that passes the sun. The hour (60 minutes) is thus 1/24 of a day.
3. When you observe through a moving train, trees, houses and fields on the other side of the track appear to move in the direction opposite to that of the speeding train. The apparent movement of the sun and the other heavenly bodies in relation to the rotating earth is similar. As the earth rotates from west to east, the sun, moon, planets and stars appear to rise in the east and set in the west.

4. Rotation causes the working of the Coriolis force which results in the deflection of the winds and the ocean currents from their normal path.
5. Tide is caused by the rotation of the earth apart from the gravitational pull of the sun and the moon.

Rotation causes a flattening of Earth at the two poles and bulging at the Equator. Hence, there is a difference in diameter at the poles and equator.

**Circle of Illumination:** The line around the earth separating the light and dark is known as the circle of illumination (Figure 2.11).

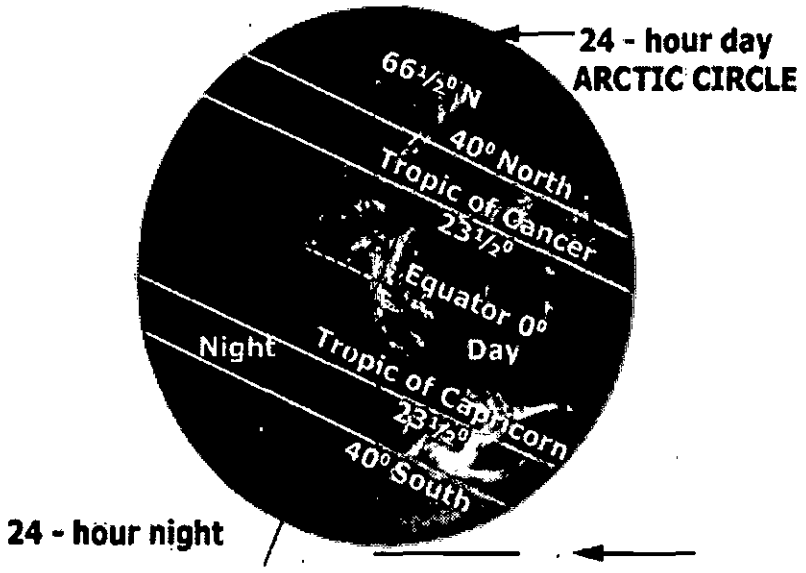



**Figure 2.11** Circle of Illumination

It passes through the poles and allows the entire earth to have an equal amount of time during the daylight and night time hours. This line can be seen from space, and the exact location of the line is dependent on the various seasons.

## Revolution of the Earth

The movement of the earth in its orbit around the sun in an anti-clockwise direction, that is, from west to east is called revolution of the earth. The earth revolves in an orbit at an average distance of 150 million km.

The distance of the earth from sun varies time to time due to the elliptical shape of the orbit. About January 3rd the earth is closest to the sun and it is said to be at Perihelion ('peri' means close to and Helios means sun). At Perihelion, the distance is 147 million km.

Around July 4th the earth is farthest from the sun and it is said to be at Aphelion (Ap means away and Helios means sun). At Aphelion the distance of the earth is 152 million km away from the sun.

The period taken by the earth to complete one revolution around the sun is 365 days and 6 hours (5 hours, 48 minutes and 45 seconds) or 365¼ days. The speed of the revolution is 1,07,000 km per hour. The speed is 30 km per second. The bullet from a gun travels with a speed of 9 km per second.

## Period of Revolution and Leap year

The period of time the earth takes to make one revolution around the sun determines the length of one year. The earth takes 365 days and 6 hours to complete one revolution. Earth takes 365.25 days to complete one trip around the Sun. That extra quarter of a day presents a challenge to our calendar system, which has one year as 365 days. To keep our yearly calendars consistent with our orbit around the Sun once in, every four years we add one day.

The extra day added to is called a leap day, and the year the extra day is added to is called a leap year. The extra day is added to the month of February which has 29 days in a leap year.

## Brain storming

How many birth days a person, whose life span supposed to be 60 years, would have seen in his/ her life time, if born on 29th February?

## Effects of revolution of the earth

The revolution of the earth around the sun results in the following

- Cycle of seasons,
- Variation in length of days and nights,
- Variation in distribution of solar energy over the earth and the temperature zones.

## Volcano

A volcano is an opening in the earth's crust through which magma, gases and ash are released to the earth's surface. The molten rock material found in the interior of the earth is called magma. It can be noted that when magma reaches the earth's surface, it is known as lava (Figure. 3.25). Vent is an opening or mouth of a volcano. Fumaroles are the gushing fumes through the gap in the volcano. Crater is a saucer shaped depression in the mouth of a volcano. When the crater is widened, it is called as Earthquake, Iran-Iraq border, 2017 Caldera. Volcanic ash consists of fragments of pulverized rock, minerals and volcanic glass, created during volcanic eruptions. Volcano generally erupts either through the vent (E.g., Mt. Fujiyama, Japan) or fissure (The Deccan Plateau, India).

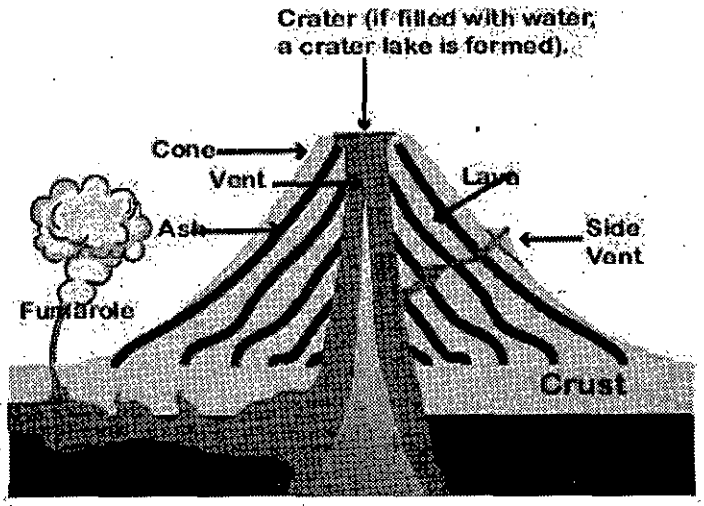
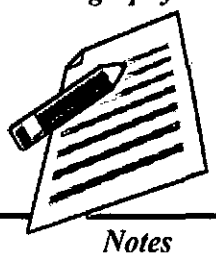



Figure 3.25 Volcano





**Pumice** is a volcanic rock produced when lava with a very high content of water and gases is discharged from a volcano.

## Causes of Volcanic Eruptions

The following are the causes of volcanic eruptions:

1. **Weak Zones in the Earth Crust:** The parts of the earth where two tectonic plates collide against or drift apart from each other are considered very weak. Volcanoes may erupt in such zones, for example, African and Eurasian plates.
2. **Magma Saturated with Gases:** The magma, in the interior of the earth, is often found saturated with gases like carbon dioxide, and hydrogen sulphide. These gases together with water vapour make the magma highly explosive. Magma is forced out as lava on the surface of the earth due to the pressure exerted by these gases.

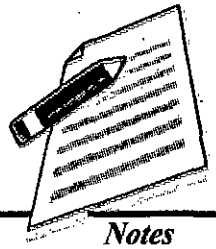
## Types of Volcanoes

Based on the **frequency of eruption**, there are three types of volcanoes:

1. **Active Volcanoes:** Volcanoes which erupt frequently are called active volcanoes. Generally, their vent remains open. Mount Etna of Italy, Cotopaxi in Ecuador are some examples.
2. **Dormant Volcanoes:** These volcanoes may not have erupted in the recent past but there is a possibility of eruption at any time. In other words, they may lie dormant awaiting active eruption anytime. Sometimes gases and steam come out of them. They cause great destruction to life and property once they become active again. Mt. Vesuvius of Italy and Mt. Fujiyama of Japan are examples.
3. **Extinct Volcanoes:** These volcanoes have exhausted their energy and have not erupted during the known geological period. The vent of these volcanoes remains closed with solidified lava. The formations such as craters may be filled with water and crater lakes may be formed. The slopes of these landforms may be covered with vegetation. Popa in Myanmar and Mt. Kenya in eastern Africa are the examples of extinct volcano.

On the **basis of nature of eruption and form** developed on the surface, they are classified into following types:

1. **Shield Volcanoes:** These are made up of basalt, a type of lava that is very fluid when erupted. They become explosive when water gets into the vent. They develop into a cinder cone. Hawaiian volcano is an example of this category.
2. **Composite cone volcanoes:** They are also called 'strato volcanoes'. They are cone-shaped volcanoes composed of layers of lava, ash and rock debris. Mount Vesuvius and Mount St. Helens are examples of composite volcanoes.
3. **Cinder Cone Volcano:** It forms when magma is thrown out to the surface, cooled in to ash and cinders and settled around the mouth of volcano. It is less dangerous than other volcanoes.
4. **Lava Dome:** Unlike composite and shield volcanoes, lava domes are of significantly smaller structure. They are formed when the lava is too viscous to flow to a great distance. As the lava dome slowly grows, the outer surface cools and hardens as the lava continues to pile within. Eventually, the internal pressure can shatter the outer surface, causing loose fragments to spill down its sides.





## Fact File

The greatest volcanic explosion known to humans is perhaps Mt. Krakatau in August 1883.

Krakatau is a small volcanic island in the Sunda Straits, between Java and Sumatra.

The explosion could be heard in Australia, almost 4,000 km away.

The vibration set up enormous waves over 30 m high which drowned 36,000 people in the coastal districts of Indonesia.

## Effects of Volcanic Activities

### Destructive effects of volcano

Showers of cinders and bombs can cause damage to life and properties. Sometimes ash can precipitate under the influence of rain and completely cover large areas.

The volcanic gases pose potential hazard to people, animals; agriculture, while sulphur dioxide gas can lead to acid rain and air pollution.

### Positive Effects of Volcanoes

Volcanism creates new landforms. Volcanic rocks yield very fertile soil upon weathering and decomposition.

The Kimberlite rock of South Africa, the source of diamonds, is the pipe of an ancient volcano.

In the vicinity of active volcanoes, waters in the depth are heated from contact with hot magma giving rise to springs and geysers. The Puga valley in Ladakh region and Manikaran (Himachal Pradesh) are promising spots in India for the generation of geothermal electricity.

## Distribution of Volcanoes across the World

Most known volcanic activity and the earthquakes occur along converging plate margins and mid-oceanic ridges. The major regions of volcanic distributions are as follows.

### 1. Pacific Ring of Fire

Circum-Pacific region, popularly termed the 'Pacific Ring of Fire', has the greatest concentration of active volcanoes. Volcanic belt and earthquake belt closely overlap along the 'Pacific Ring of Fire'. It is estimated to include two-thirds of the world's volcanoes.

### 2. Mid-Atlantic Region

The Mid-Atlantic Region coasts has comparatively fewer active volcanoes but many dormant or extinct volcanoes, example. St. Helena, Cape Verde Islands and the Canary Islands. But the volcanoes of Iceland and the Azores are active.

### 3. The Great Rift valley of Africa

In Africa some volcanoes are found along the East African Rift Valley. Kilimanjaro and Mt. Kenya are extinct volcanoes. The only active volcano in West Africa is Mt. Cameroon.

## 4. Mediterranean Region

Volcanoes of the Mediterranean region are mainly associated with the Alpine folds. Example, Mt. Vesuvius, Mt. Stromboli (known as the Light House of the Mediterranean Sea).

## 5. Other Regions

Elsewhere in the interiors of continents of Asia, North America and Europe active volcanoes are rare. There are no volcanoes in Australia.

## Volcanoes in India

There are no volcanoes in the Himalayan region of India. However, Barren Island, lying 135 km north-east of Port Blair became active in 1991 and 1995.

However, the other volcanic island in Indian Territory is Narcondam (Andaman and Nicobar Islands) It is probably extinct. Its crater wall has been completely destroyed.

## Earthquake

Earthquake is a sudden shaking of the earth's surface. **Focus** is the location inside the earth where the earthquake originates. **Epicentre** is the point on the earth›s surface vertically above the focus of an earthquake. Earthquake results from the sudden release of pressure which has slowly built up within the earth's crust. Energy is released in the form of shockwaves known as seismic waves. The seismic waves can broadly be classified into two types namely Body waves and surface waves.

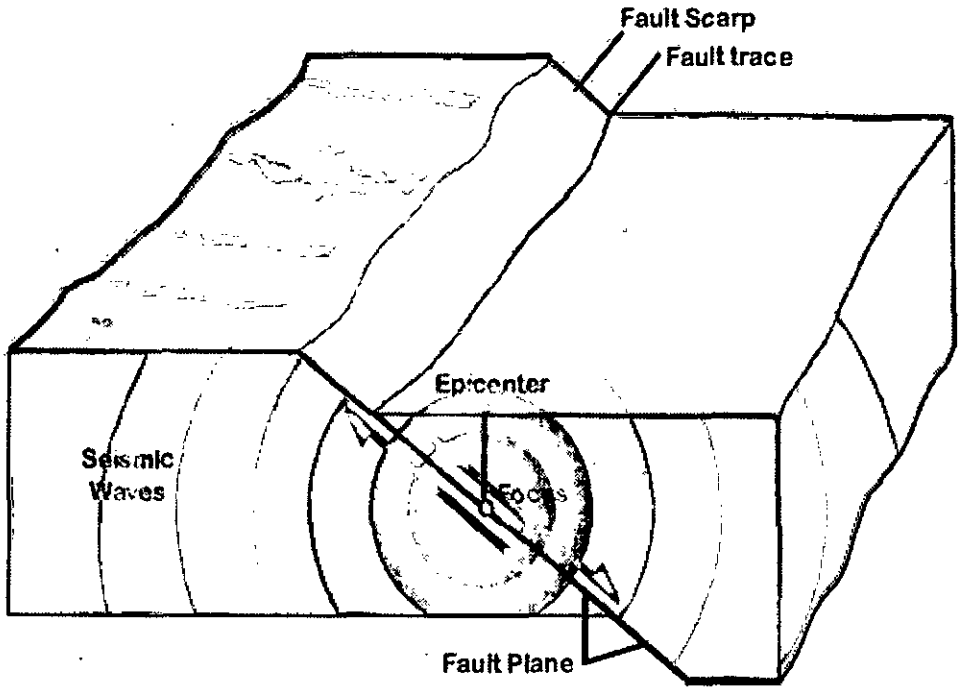



**Figure 3.22 Parts of an Earthquake**

1. **Body Waves** are the waves that travel through the interior of the earth. They are further divided into the following.
   a. **P or Primary or Compressional waves** are the fastest seismic waves (6 km/ sec. in the upper crust). They cause the matter to oscillate forward and backward, parallel

to the motion of the seismic wave front. P waves push (compress) and pull (dilate) the rock that they pass through. They pass through all medium.

b. **S or Secondary or Shear waves** are slower than the primary waves (3.5 km/sec. in the upper crust). They cause matter to oscillate side to side, perpendicular to the motion of the wave front. S waves shear the rock that they pass through. They pass through only solid medium.

II. **Surface Waves** are the waves that travel along the earth's surface. They are slower than body waves. They cause damage during earthquakes.

**Love waves** shake the ground side to side like S wave.

***Rayleigh waves*** displace the ground like rolling ocean waves. The ground rolls forward and up and then down and backwards. This is similar to a p wave but with the extra up-down motion.

## Measuring the earthquake

It is estimated that about 100,000 earthquakes occur but all cannot be felt. A few earthquakes may be severe causing huge damage to property. Earthquake magnitude is measured on the Richter scale (named after the seismologist who devised it), which rates them on a scale of 1 to 10. Earthquake intensity is measured on the modified Mercalli scale, which ranges from 1 to 12, depending upon the intensity. The seismograph is an instrument used to detect and record seismic waves created by the earthquakes.

## *Description of effects of earthquake in Richter scale*

| MODIFIED MERCALLI SCALE | RICHTER SCALE |
|---|---|
| I. Felt by almost no one.<br>II. Felt by very few people. | 2.5. Generally not felt, but recorded on seismometers. |
| III. Tremor noticed by many, but they often do not realize it is an earthquake.<br>IV. Felt indoors by many, Feels like a truck has struck the building.<br>V. Felt by nearly everyone: many people awakened. Swaying trees and poles may be observed. | 3.5. Felt by many people |
| VI. Felt by all; many people run outdoors. Furniture moved, slight damage occurs.<br>VII. Everyone runs outdoors. Poorly built Structures considerable damaged; Slight damage elsewhere. | 4.5. Some local damage may occur. |
| VIII. Specially designed structures damaged Slightly, others collapse.<br>IX. All buildings considerably damaged, many shift off foundations, Noticeable cracks in ground. | 6.0. A destructive earthquake. |
| X. Many structures destroyed. Ground is badly cracked. | 7.0. A major earthquake. |
| XI. Almost all structures fall. Very wide cracks in ground.<br>XII. Total destruction. Waves seen on ground surfaces, objects are tumbled and tossed. | 8.0. and up Great Earthquakes. |

Table 3.1 The Mercalli and Richter scales

## Causes of Earthquakes

There are many factors controlling the occurrence of the earthquake. Some of the major factors include:

1. Plate Tectonic Movements
2. Volcanic Eruptions.
3. Construction of large dams results in earthquake. Example. Koyna dam, Maharashtra.
4. Other Reasons: The nuclear explosions also release massive energy to cause tremors in the earth crust. When underground cave collapses, earthquake may occur.

## Effects of the Earthquakes

1. Damage to buildings, roads, rails, factories, dams, bridges etc.
2. Landslides caused by earthquakes damage infrastructure.
3. Fires in the forest and urban areas.
4. Flash floods.
5. Tsunami - The high amplitude oceanic waves caused by submarine earthquake (measuring more than 7 on Richter scale). The seismic waves travel through seawater generates high sea waves. They cause severe loss of life and property. For instance, on 26th December 2004, a tsunami originating from a magnitude 8.9 earthquake in northern Sumatra killed over 1,50,000 people in countries surrounding the Indian Ocean.

## Distribution of earthquakes

1. Circum-Pacific region: This region includes all the coastal areas around the Pacific Ocean. It extends through the coasts of Alaska, Aleutian Islands, Japan, Philippines, New Zealand, west coast of North and South America. This zone accounts for 68% of all earthquakes on the surface of the earth.
2. Mediterranean-Himalayan region: This region extends from Alps mountain to the Himalayan Mountains and Tibet to China. About 31% of world's earthquakes occur in this region.
3. Other Areas: These include Northern Africa and Rift Valley areas of the Red Sea and the Dead Sea.

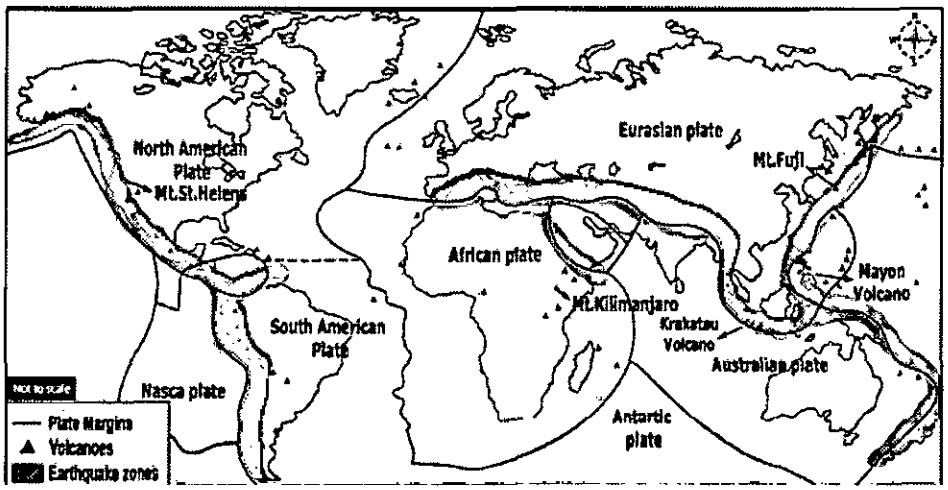



Figure 3.23 World Distribution of Earthquakes and Volcanoes

## SUMMARY OF THE CHAPTER

Land forms of different types present on the earth's surface are the result of continuous work of both internal and external forces. Internal forces are responsible for creating inequalities in altitudes of different relief features. These forces originate in the interior of the earth. They are also known as endogenetic forces. These forces cause movements of the earth's crust which are called earth movements. Slow movements bring slow and gradual changes in the relief features while sudden movements bring abrupt and rapid changes. Internal forces affect the earth into two way radially and horizontally. When they affect radially, they cause subsidence or upliftment of the earth's crust. Such earth movements are called vertical movements. Contrary to this; when these forces affect horizontally or side to side, they result in folding and faulting of the rock strata. These are called horizontal movements. Volcanoes are landforms marking the eruption of lava at the earth's surface. The shape and size of volcano depends on the frequency of eruption, fluidity of lava and type of eruption. Earthquakes are vibrations of the earth's crust cause by the operations of the tectonic forces and. volcanic activity. The volcanic activity is confined to three well defined belts of the world. The occurrence of earthquakes is also closely connected with two of these belts.

## EXERCISE

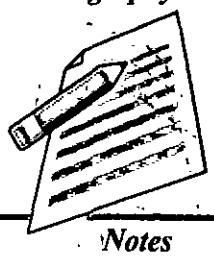
### MCQ

1. Which of the following is not categorised under geologic hazard?
   (A) Tropical cyclone (B) Earthquakes
   (C) Volcano (D) Floods

2. Which one is the 2nd large magnitude earthquake occurred during past 100 yrs.?
   (A) 2001, Bhuj earthquake
   (B) 2004, Sumatra earthquake
   (C) 2015, Nepal earthquake
   (D) 2005, Kashmir earthquake

3. New Zealand is an example of
   (A) Convergent plate boundary
   (B) Divergent plate boundary
   (C) Conservative plate boundary
   (D) Both convergent and conservative plate boundaries

4. Which one of the following is a secondary phenomenon during an earthquake?
   (A) Fault scarp
   (B) Terrace offset
   (C) Liquefaction
   (D) All of these



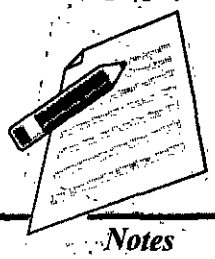


5. Which of the following is not categorised under the Himalayan earthquake?
   (A) Uttarkashi Earthquake
   (B) Kangra Earthquake
   (C) Gorkha Earthquake
   (D) Bhuj Earthquake

**Answers:** - 1.A 2. B 3.D 4. C 5.D

## Review Questions

1. What is meant by internal forces? List causes of the origin of these forces.
2. Give four examples to prove that the earth's crust is unstable.
3. Draw diagrams to show (i) Displacement of rock strata along a fault plane, (ii) Anticline and synclines of rock strata.
4. Differentiate between vertical and horizontal movements.
5. Distinguish between folding and faulting
6. What is a volcano? Describe different types of volcanoes with examples.
7. Distinguish between acid and basic lava and land forms developed by each of them.
8. What causes an earthquake?
9. List the effects of earthquakes on earth's surface.
10. Define the following terms: (a) Fault plane (b) Central type eruption (c) Fissure type eruption (d) Dormant volcano.





# 5 THE WORK OF RUNNING WATER AND UNDERGROUND WATER

- Understand the concept of running water.
- Discuss the uses of running water.
- Describe the concept of **underground water**.
- Discuss the uses of underground water.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of running water and underground water so that their uses and distribution can be learned.

## Introduction

## The River

The streams have a huge capacity to erode the rock over which they flow. In fact, the formation of the river channel is the result of the erosional capacity of the stream. The erosional capacity of the stream depends on its volume of water and velocity of flow. The river performs three types of work. They are erosion, transportation and deposition.

1. **Erosion:** The breaking of rocks by the river in along its course is called erosion. Erosional work of a river is performed mechanically and chemically. River erosion is carried out in the following ways:
   - **Hydraulic action:** It refers to the physical force of the moving water which breaks the rocks in its course.
   - **Corrasion (abrasion):** It refers to the breaking of rock in the bed and on the bank by fragments carried by the stream.
   - **Corrosion(solution):** It refers to the dissolving process of soluble minerals by the splashing of stream water.
   - **Attrition:** It refers to the eroded materials carried by the stream strike against each other.
2. **Transportation:** Stream carrying the fragmented materials broken by the stream is called transportation. After erosion, the eroded materials get transported along with the running water. This transportation of eroded materials is carried in four ways:
   - **Traction:** The heavier and larger rock fragments like gravels, pebbles etc are forced by the flow of the river to roll along its bed. These fragments can be seen rolling, slipping, bumping and being dragged. This process is called as traction and the load transported in this way are called traction load.

- **Saltation:** Some of the fragments of the rocks move along the bed of a stream by bouncing continuously. This process is called as saltation.
- **Suspension:** The holding up of small particles of sand, silt, and mud by the water as the stream flows is called suspension.
- **Solution:** Some parts of the rock fragments dissolve in the river water and transported. This type of transportation is called solution transportation.

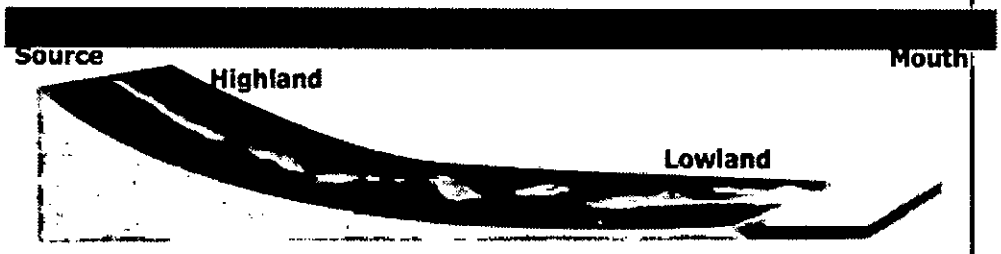
3. **Deposition:** When the velocity of the stream decreases, the stream deposits sand, silt and other fragments. It is called as the deposition. When a river moves in a gentle slope, its speed reduces and river begins to deposit its load. The river starts depositing larger materials first and smaller and finer materials are carried further down to the mouth of the river.

## Stages of the River

The course of a river includes the upper stage, the middle stage, and the final stage. Each stage of the river is dominated by a kind of work. Let's discuss the stages of a river, the main work and the landforms made in each stage.

## 1. The Upper Stage

The upper stage of a river is also called the youthful stage or mountain stage. The velocity and speed of the stream are very high because the slope here is steep. The vertical erosion is the most dominant work here. The valley is formed here. The place where a river starts is called a **source**. In the mountain stage, the number of small streams originates from different locations. They are called **Tributaries**.




| | Upper Stage | Middle Stage | Lower Stage |
|---|---|---|---|
| Gradient | | | |
| Velocity | | | |
| Volume | | | |

The place where two rivers join is called as **the confluence**. The mountain which has two river systems draining on either side of the slope is termed as **the water divide**.

## 2. The Middle Stage

Middle stage is the matured stage of a river. Vertical erosion or deepening of the valley is significantly reduced. Lateral erosion is the dominant work. Due to the lateral erosion of this

stage, the widening of the valley occurs. The volume of the river water increases and the slope of river is moderate. The depth of the river is deep here.

### 3. The Lower Stage

This is the final stage of a river where the valleys are extremely broad and it has generally gentle slope. The valley becomes almost flat which is called a peneplain. Most of the peneplain forms low residual hills with steep slopes which are called as Monadnocks.

## Landforms by the Erosional Work of River

The significant landforms resulting from erosion by rivers include gorge, canyon, V-Shaped Valley, waterfall, pothole, structural bench, river terrace, river meander, ox-bow lake, peneplain, etc.

**Gorges** are formed due to active down cutting of the valleys. So, a Gorge is a narrow and deep river valley which has steep slopes.

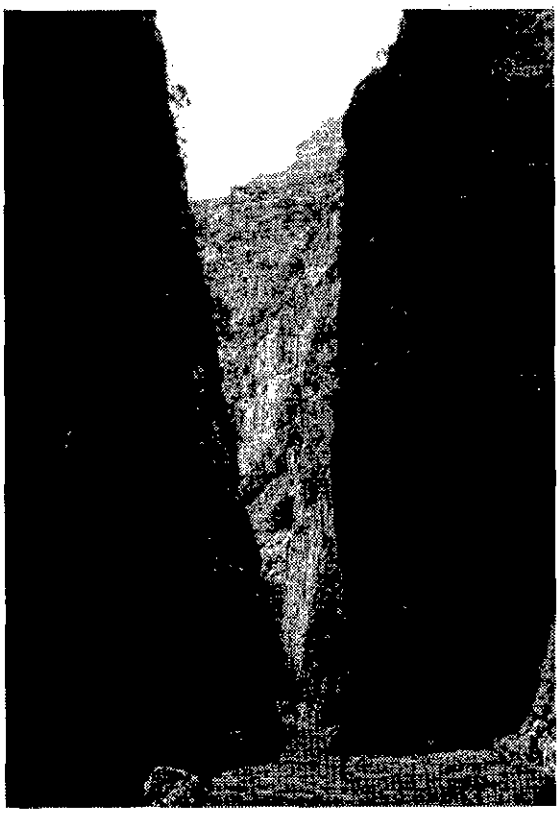


Figure 4.9 Gorge

**Canyons** are extended form of gorges. Canyons represent very deep, narrow but long valleys. The steepness of the valley sides depends on the nature of the rocks. The Grand Canyon of the Colorado River in the state of Arizona, USA having a length of 482.8 kilometres and depth of 2088.3 meter is the largest canyon in the world. The Canyon of Gandikota is situated on the Pennar River in Andhra Pradesh is known as the Grand Canyon of India.

**V-Shaped Valley** The valleys made by the rivers are erosional landforms. The valley is formed in the youthful stage of the river erosion. Due to the steep slope and large volume

of water, the river cuts its bed vertically forming narrow and deep river valley. This is called as V-shaped valley.

## Rapids and waterfalls

Rapids are stream sections with extremely strong currents, numerous obstacles, and steps in their streambeds. A waterfall is a vertical drop in a streambed. Both water fall and rapids are formed by vigorous erosion. Series of a waterfall in a river is called as Cascade.

## Plunge pool

A plunge pool is a deep depression in a stream bed at the base of a waterfall. It is created by the erosional forces of falling water at the base of a waterfall.

**Angel Falls**, in Venezuela, is Earth's highest waterfall (979 m). **Hogenakal falls**, Dharmapuri, Tamil Nadu sometimes is called as **the Niagara of India.**

## Grooves

Long and narrow depression at the base of a waterfall made by river runoff is called a groove. The grooves are created by water eroding soil from a hill or mountain in a short period of time.

The swirling movement of the water falling into the plunge pool is called **eddying**.

## Interlocking spurs

An **interlocking spur**, also known as an **overlapping spur**, is a projecting ridge that extends alternately from the opposite sides of a V-shaped valley. A river with a winding course flows down the interlocking spur.

## Pot Holes

The kettle-like small depressions in the rocky beds of the river valleys are called potholes. They are always cylindrical in shape. Potholes are generally formed in coarse-grained rocks such as sandstones and granites.

Figure 4.11 Hogenakal waterfalls, Dharmapuri, Tamil Nadu

## River Terraces

The narrow step like flat surfaces on either side of the valley floor are called river terraces. They represent the level of former valley floors.

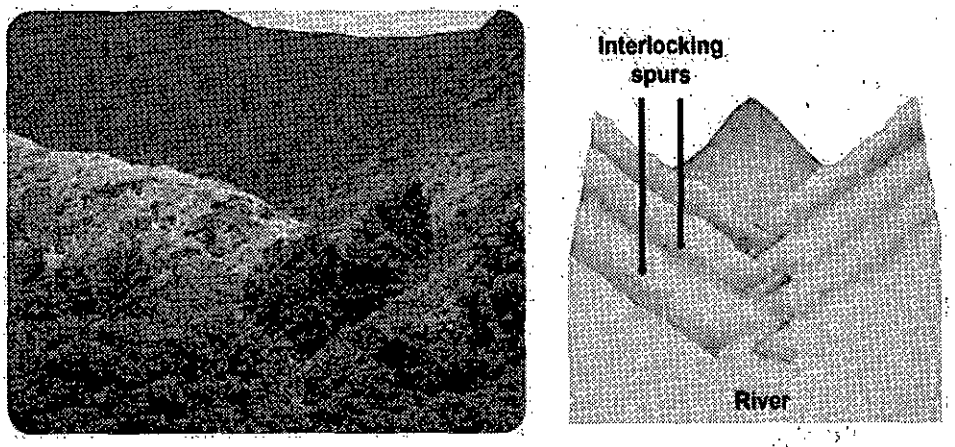



Figure 4.12 Interlocking spurs

## Landforms by the deposition of river

### 1. Alluvial fan

Alluvial fans are often found at the foot of arid or semiarid mountain ranges where intermittent streams flow. An alluvial fan is a fan shaped deposit of gravel, sand and other smaller particles of sediment.

Alluvial fans are found in Kosi river, Himalayan region, Death Valley National Park and along the sides of the Colorado River at Grand Canyon National Park, U.S.

Figure 4.13 Alluvial Fan

## 2. Peneplains

Peneplains represent low featureless plain having undulating surface and remnants of convex-concave residual hills.

## 3. Meander

A **meander** is a winding curve or bend in a river. **Meanders** are the result of both erosional and depositional processes. They are typical landform of the middle and lower course of a river. This is formed by vertical erosion, lateral erosion, and deposition within the floodplain.

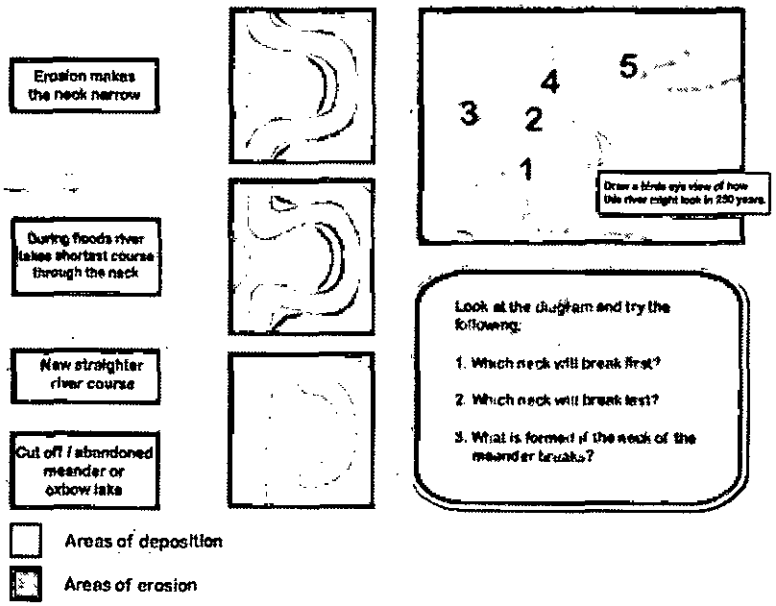



Figure 4.14 Meander

## 4. Oxbow lake

Oxbow lake is a free-standing body of water formed when the meander is cut off from the main river. This landform is so named because it resembles horse shoe

## 5. Levees

Raised bed and a bank of the river due to frequent flooding and deposition of the sediments is called levees.

## 6. Flood Plain

A flood plain is a flat area of land adjacent to a river. It stretches from the bank of its channel to the base of the enclosing valley walls which experiences flooding during the period of high discharge.

## 7. Estuary

The word "estuary" is derived from the Latin word aestuarium meaning tidal inlet of the sea, which is derived from the term aestus, meaning tide. An estuary is a partially enclosed coastal body of brackish water with one or more rivers flowing into it, and with a free connection to the open sea.

The inflow of both sea water and fresh water provides high levels of nutrients both in the water column and in sediment. Hence, it makes estuaries among the most productive natural habitats in the world. Narmada river estuary is located in Gujarat.

## 8.Delta

Delta is found in the old stage of a river. It is the triangular shaped landform made up of alluvial deposition in the mouth of the river. It is named after the fourth Greek alphabet called delta. Example, The Ganges Bhramaputra delta is the largest delta in the world.

**Types of Delta:** Delta is classified into the following based on the shape and kind of the load deposited by the river.

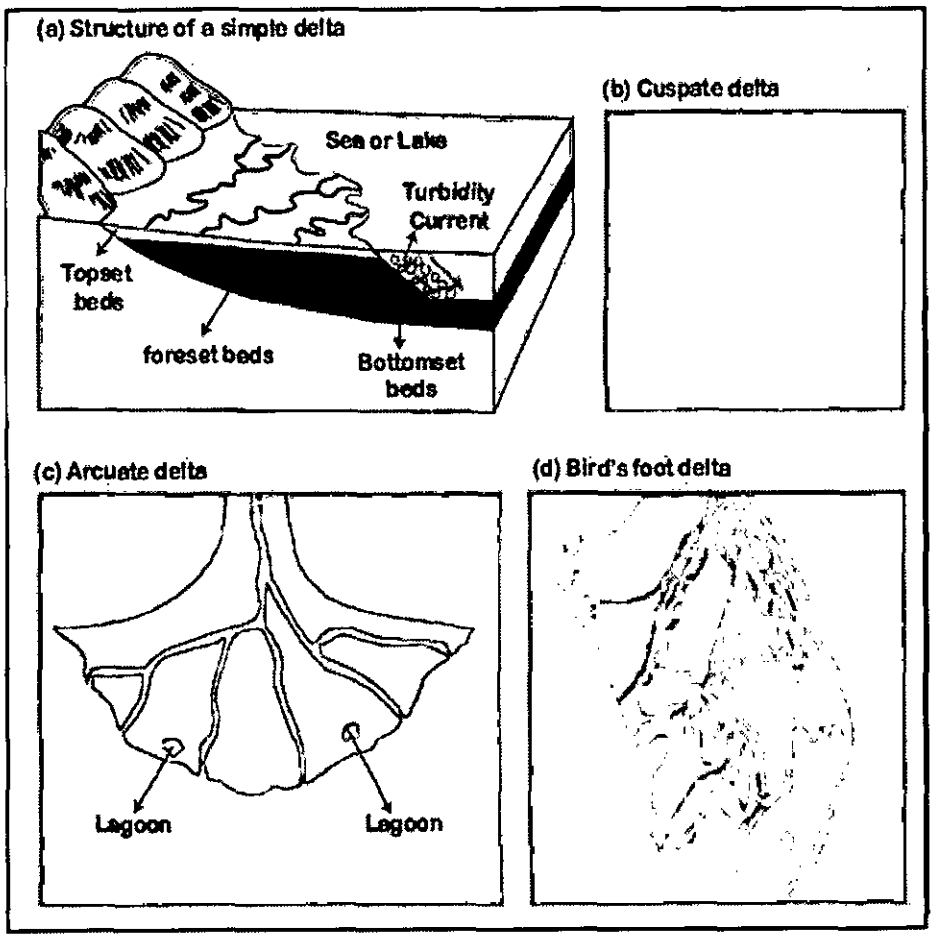
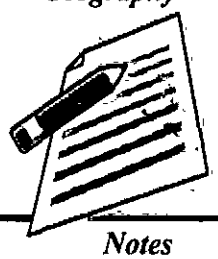



Figure 4.15 Types of Delta

1. **Arcuate Delta:** A bowed or curved **delta** with the convex margin facing the body of water. It is also known as fan-shaped **delta**. Example, River Nile Delta in Egypt and Ganga Delta in India.
2. **Estuarine Delta:** it is formed at the mouth of submerged rivers depositing down the sides of the estuary. Example, Seine River of France.
3. **Birds foot Delta:** They are formed due to deposition of finer materials by river water. Deposited alluvial material divides the river into smaller distributaries. Such delta is also called as finger delta. Example, Mississippi river delta, the USA.





4. **Lacustrine Delta:** It is formed when a river flows into a lake. Example, Lough Leanne river delta, Ireland.
5. **Truncated Delta:** Sea waves and ocean currents modify and even destroy deltas deposited by the river through their erosional work. Thus, eroded and dissected deltas are called truncated deltas.
6. **Abandoned Delta:** when the river shifts its mouth, the delta already made is left abandoned. Such a delta is called abandoned delta. Example, Yellow river delta, China and the Western part of Ganga delta made by Hooghly river, India.
7. **Cuspate delta** is a tooth shaped delta formed when a single distributary flows through and deposits its load on its either side. Example, Tiber River of Italy

## Ground water

Groundwater hydrology may be defined as the science of the occurrence, distribution and movement of water below the surface of the earth. Ground water is the underground water that occurs in the saturated one of variable thickness and depth below the earth's surface. Groundwater is an important source of water supply throughout the world. Its use in irrigation, industries, urban and rural home continues to increase.

## Origin of ground water:

Almost all groundwater can be thought of as a part of hydrologic cycle, including surface and atmospheric waters. Connate water is water entrapped in the interstices of sedimentary rock at the time it was deposited. It may have been derived from the ocean or fresh water sources and typically is highly minimized. New water of magmatic, almost all ground water can be thought of as a part of the hydrologic cycle, including surface volcanic or cosmic origin added to the terrestrial water supply is juvenile water.

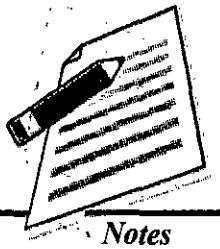
Ground water constitutes one portion of the earth water circulatory system known as the hydrologic cycle. Water bearing formations, of the earth crust act as conduits for transmission and as reservoirs for storage of water. Water enters these formations from the ground surface or form bodies of surface water

After which it travels slowly for varying distances until it returns to the surface by action of natural flow, plants or man. Ground water emerging into surface stream channels aids in sustaining stream flow when surface runoff is low or non-existent. Similarly, water pumped from wells represents the sole water source in many regions during much of every year.

All ground water originates as surface water. Principal sources of natural recharge include precipitation, stream flow, lakes and reservoirs. Other contributions known as artificial recharge occur from excess irrigation, seepage from canals and water purposely applied to augment groundwater supplies. Discharge of ground water occurs when emerges from underground. Most natural discharge occurs as flow into surface water bodies such as streams, lakes and oceans. Flow to the surface appears as spring. Groundwater near the surface may return directly to the atmosphere by evaporation from the soil and by transpiration from vegetation.

## Occurrence of ground water:

Ground water occurs in permeable geologic formations known as aquifers. i.e., formations having structures that permit appreciable water to move through them under ordinary





field conditions. Ground water reservoir and water bearing formation are commonly used synonyms.

An aquitard is a formation, which only seepage is possible and thus the yield is insignificant compared to an aquifer. It is partly permeable. An aquiclude is an impermeable formation which may contain water but incapable of transmitting significant water quantities. An aquifuge is an impermeable formation neither containing not transmitting water.

## Porosity:

The portion of a rock or soil not occupied by solid mineral matter may be occupied by groundwater. These spaces are known as voids, interstices, pores or pore space. Because interstices can act as groundwater conduits they are of fundamental importance to the study of groundwater. Typically, they are characterized by their size, shape, irregularity and distribution. Original interstices were created by geologic process governing the origin of the geologic formation and are found in sedimentary and igneous rocks. Secondary interstices developed after the rock was formed. Capillary interstices are sufficiently small so that surface tension fo4ces will hold water within them. Depending upon the connection of interstices with others, they may be classed as communicating or isolated. The amount of pore space per unit volume of the aquifer material is called porosity. It is expressed as the percentage of void space to the total volume of the mass.

## Permeability:

As stated above the ground water is stored in the pores of rock and will hence be available in the ground rocks, only if they are sufficiently porous. The porosity of the rock, thus defining the maximum amount of water that can be stored in the rock. In fact, the water can enter into a rock only if the rock permits the flow of water through it, it depends on whether the rock is permeable or not. The size of the pores is thus quite an important factor and it should be sufficiently large to make the rock permeable.

## Vertical distribution of groundwater:

The subsurface occurrence of groundwater may be divided into:

i) Zones of saturation

ii) Zones of aeration

In the Zones of Saturation water exists within the interstices and is known as the groundwater. This is the most important zone for a groundwater hydraulic engineer, because he has to tap out this water. Water in this zone is under hydrostatic pressure. The space above the water and below the surface is known as the zone of aeration. Water exists in this zone by molecular attraction.

This zone is also divided into three classes depending upon the number of interstices present. The capillary fringe is the belt overlying the zone of saturation and it does contain some interstitial water and is thus a continuation to the zone of saturation while the depth from the surface, which is penetrated by the rocks of vegetation, is known as the soil zone.

## Ground water (Karst Topography)

The word "karst" literally means "rocky mountain" comes from a region in former Yugoslavia that includes Croatia and Slovenia. The word is derived from the Slavic word Kras.

## What does Groundwater do?

Any limestone, dolomite or gypsum region showing typical landforms produced by the action of groundwater through the process of solution and deposition is called as Karst Topography (Karst region in the Balkans).

## Erosional Landforms due to Groundwater

Following are the erosional landforms formed due to the action of groundwater.

### 1. Sinkholes

A sinkhole is an opening more or less circular at the top and funnel-shaped towards the bottom. When as sinkhole is formed solely through the process of solution, it is called as a solution sink.

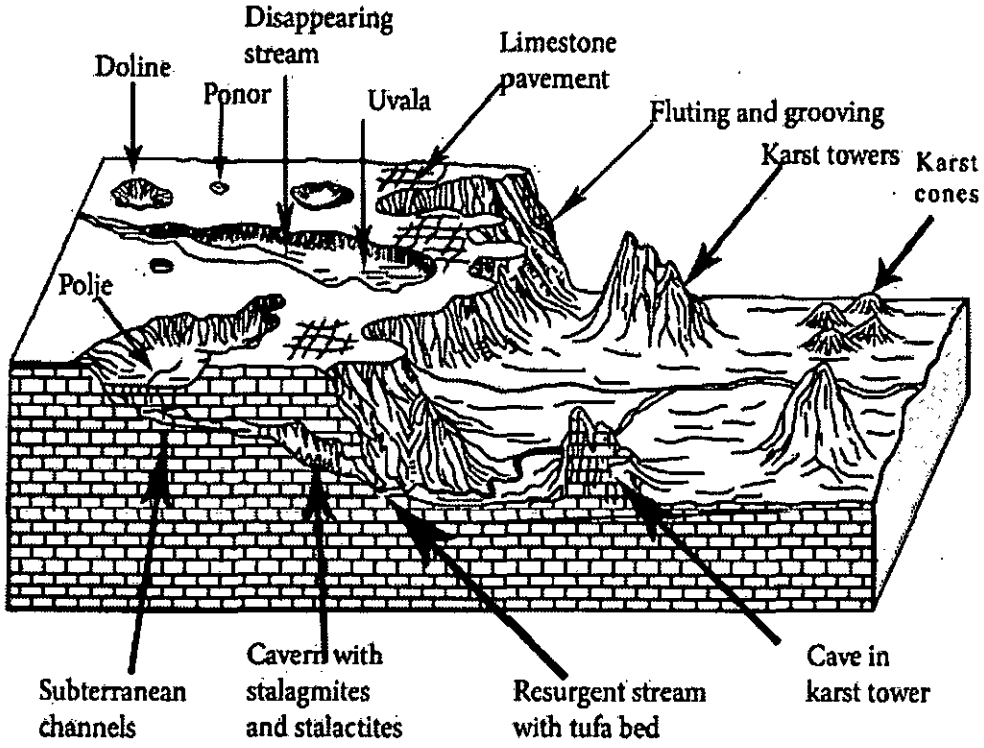



Figure 4.20 Karst features

### 2. Doline

A doline is a closed depression draining underground in karst areas. It can be cylindrical, conical, bowl or dish shaped. The diameter ranges from a few meters to many hundreds of meters. The name doline comes from dolina, the Slovenian word meaning valley.

### 3. Lappies

Lappies are the irregular grooves and ridges formed when most of the surfaces of limestone are removed by solution process.

Figure 4.21 Lappies

## 4. Uvala

Series of smaller sinkholes coalesce into a compound sinkhole is called uvala.

## 5. Polje

Polje is an elongated basin having a flat floor and steep walls. It is formed by the coalescence of several sinkholes. The basins often cover 250 square km and may expose "disappearing streams." Most of these basins have steep enclosing walls that range from 50 to 100 meter in height, giving rise to the name "blind valley."

## 6. Caves

Caves normally have an opening through which cave streams are discharged. Caves having an opening at both the ends are called tunnels.

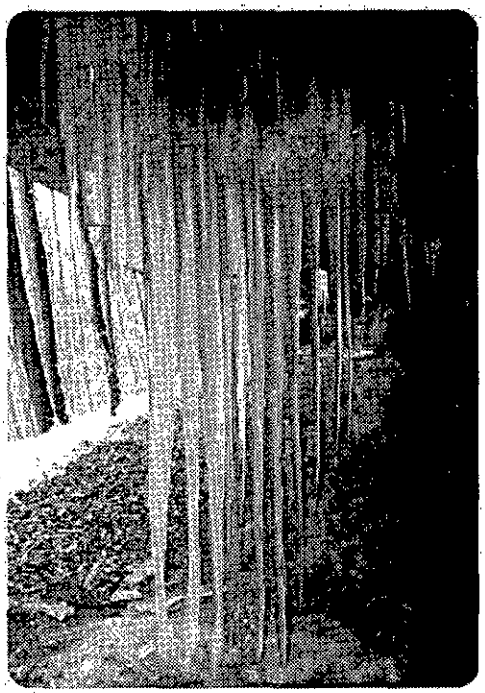


Figure 4.22 Curtains

## Depositional Landforms due to Ground water

The following depositional features are formed within caves.

Figure 4.23 Stalagmite, stalactite, and pillar

### 1. Curtains

Rain water drips from long crack in a cave roof forms a continuous strip of calcites. It is called as curtains.

### 2. Stalactite

Drops of water containing dissolved limestone seep down through cracks in the cave roof. Drops of water lose carbon dioxide and deposit calcite. Overtime deposition of calcite forms pillars hanging down from the roof of the cave. It is called as stalactite and where the stalactite stretches towards the sides are known as Helactites.

### 3. Stalagmite

Deposition of calcite forming icicles growing upward from the cave floor is called as stalagmite.

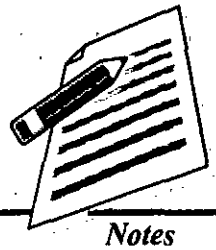
Stalactites are calcium carbonate deposits hanging as icicles while Stalagmites are calcium carbonate deposits which rise up from the floor.

### 4. Pillar

When both the stalagmite and stalactite join together, it is known as pillar.

### SUMMARY OF THE CHAPTER

Among the agents of gradation, the running water is most effective and important. A river has three-fold action- (a) erosion (b) transportation (c) deposition. The rock material carried by river water is called its load. The ability of a river to move rock material depends upon- (a)





the speed of water (b) the volume of water (c) the land structure and (d) the size, shape and weight of load. The work of river erosion is accomplished in four different ways-corrasion, corrosion, hydraulic action and attrition. The river transports its load in four different ways-by traction, saltation, suspension and solution. The deposition starts in plains and low-lying areas. The whole path followed by a river is called its course. The course of a river is divided into three sections-(1) the upper course (2) the middle course (3) the lower course. The upper course lies in mountain. Here vertical cutting is more important. The land features produced are gorges, canyons, rapids, waterfalls. The middle course lies at the junction of mountain and plains. Here the work of river is mainly transportation with some deposition. The land feature produced is meander. The lower course lies in the plain area. Here the work of river is mainly deposition. The land features produced are ox-bow lakes, braided streams, alluvial and flood plains, delta and estuary. The water which percolates inside the earth is called underground water. The upper limit of underground water is called water-table. The level of water table is not uniform but it varies seasonally. Consequently, the water-table is of two types permanent water table and temporary water table. Underground water comes to the surface through wells, tube wells and springs. Wells and tube wells are manmade holes dug into the earth surface through which water is obtained. In addition to these ordinary wells, there is a special type of well in which water flows out automatically under hydraulic pressure. They are called artesian wells.

## EXERCISE

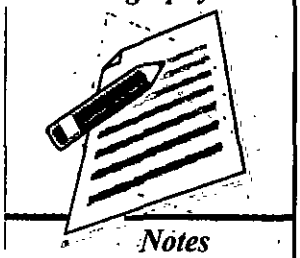
### MCQ

1) Which of the following would be best used to study the drought conditions in a region?
   a) satellite imagery
   b) water witching
   c) GPS
   d) ground truthing

2) Which of the following technologies would be the most effective means of monitoring water availability over a large area?
   a) satellite imagery
   b) water witching
   c) GPS
   d) ground truthing

3) What process accounts for the fact that the water on Earth now is the same water that has been on Earth for 4 billion years?
   a) Nitrogen Cycle
   b) Water Cycle
   c) Krebs's Cycle
   d) Life Cycle

4) What explanation can be used to describe the situation in the test tube shown above?
   a) Water is polar and oil is polar therefore the two substances will not mix.
   b) Water is non polar and oil is non polar therefore the two substances will not mix.
   c) Water is non polar and oil is polar therefore the two substances will not mix.
   d) Water is polar and oil is non polar therefore the two substances will not mix.



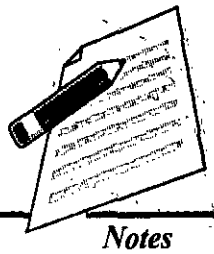


5) Which 2 sources of freshwater are used by municipalities for drinking water?
   a) oceans and icebergs
   b) groundwater and oceans
   c) rivers and groundwater
   d) icebergs and rivers

**Answers:** - 1. a 2. a 3. b 4. d 5. C

## Review Questions

1. Answer briefly the following questions:
   (a) In what different ways does a river transport its load?
   (b) List out factors which affect
   (1) energy of a stream and
   (2) carrying capacity of streams.
   (c) In what different ways is the work of river erosion accomplished?
2. Distinguish between the following pairs: (a) estuary and deltas (b) flood plain and braided stream.
3. The following landforms have been formed by rivers. Group them under erosional and depositional features. Gorge, V -shaped valley, meander, flood plain, alluvial fan, and canyon.
4. Explain the formation of the following with suitable diagrams: (a) Oxbow lake (b) Delta.
5. Explain systematically the work of river as an agent of gradation at each of the three stages of its course.
6. Answer the following questions in brief: (a) Explain the meaning of the term underground water. (b) How do streams in limestone regions suddenly disappear? (c) Why is construction of rails and roads difficult in areas of sinkholes. (d) Permanent water table and temporary water table. (e) Sinkhole and swallow hole. (f) Stalactite and stalagmite. (g) Permeable rocks and impermeable rocks. (h) Hot spring and geyser.
7. What is meant by 'Karst' topography? Name any five topographical features of karst topography and explain any two of these with the help of diagrams.



*Notes*

# 6 MAJOR LANDFORMS AND THEIR ECONOMIC SIGNIFICANCE

- Understand the concept of land reforms.
- Discuss the concept of mountains.
- Describe the concept of plateaus.
- Discuss the concept of plains.
- Discuss the economic significance of major land reforms.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of major land reforms so that their economic significance can be learned.

## Introduction

Landforms are the physical features on the Earth's surface. Mountains, Plateaus and Plains are some major landforms of the Earth. Natural processes such as weathering, water, elevation, sinking, and erosion of the soil are constantly shaping the Earth's surface. It doesn't really happen overnight. In fact, it takes hundreds and thousands of years for us to notice these changes. These processes lead to the formation of various landforms. In other words, landforms originate from these geological processes. Let's understand the processes that shape the landforms.

## External Process

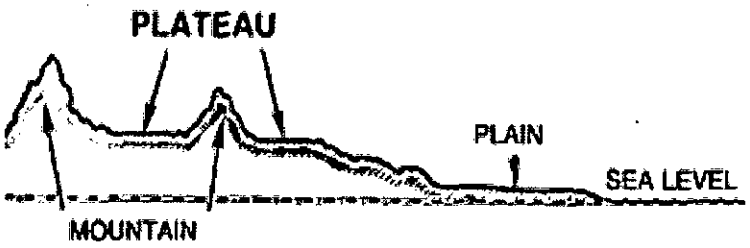
External process means effects caused by external factors such as rain or wind. These cause erosion and deposition. Erosion and deposition are natural processes that change the surface of the Earth. To clarify, erosion is a process in which sediments get deposited or dropped off in a different location. And sediments are nothing but the materials on the Earth's surface such as soil and rocks.

## Internal Process

As the name suggests, internal processes are processes that occur inside the surface of the Earth i.e., beneath the crust. For example, volcanic eruption and plate tectonics. These occur because of the intense heat in the Earth's core which causes the molten rock in the mantle layer to move. As a result, creating uneven movement on the surface. These layers are either uplifting or sinking.

## Types of Landforms

Depending upon the elevation and slope, landforms can be categorized into **Mountains**, **Plateaus**, and **Plains**. Let us look at them individually.



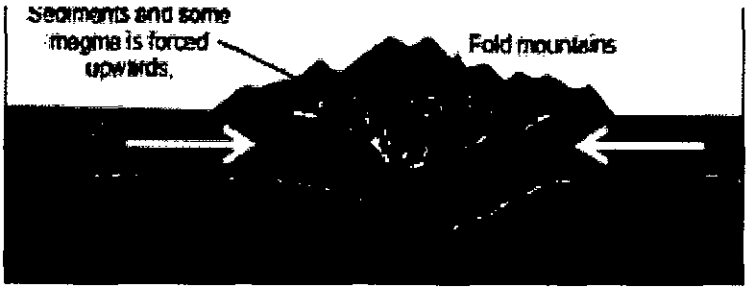

## Mountains

A Mountain is any landmass that is higher and steeper than a hill. A hill is a landform that extends above the surrounding terrain. In general, the mountains are higher than 2000 ft. Like in any other natural elevation such as atmosphere, as you go higher, the temperature drops and the climate becomes colder. Thus, habitation becomes harsher. And that's why there is less habitation in the mountainous areas.

Furthermore, because of the temperature drop, it is not uncommon for high mountains to develop ice on them. In fact, some of them have glaciers. Glaciers are permanently frozen rivers of ice. Also, because of the steep slopes of the mountains, there is less land available for proper farming. A range is a line of mountains. The Himalayas in Asia, the Alps in Europe and the Andes in South America are some examples of mountain ranges. These ranges are the storehouses of water. Many rivers have their origins in these mountains. In fact, the glaciers of this landform are the source of these rivers.

Mountains are generally untouched by civilisations and thus have the endangered species of plants and animals. They also inhibit a rich variety of flora and fauna. There are three categories of mountains. Let us know about them.

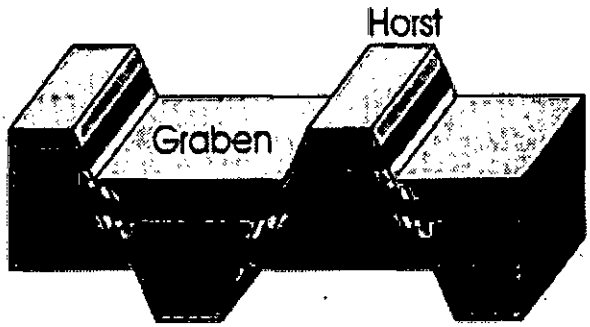
## 1. Fold Mountains



When two tectonic plates collide and the edges of these plates 'fold' because of the enormous push force between them it results in the creation of fold mountains. Scientists classify the fold mountains into 'young fold' and the 'old fold' mountains according to its age.

- The young fold ones are between 10 and 25 million years old. For example, the Himalayas in Nepal, the Alps in Europe and the Andes in South America.
- The old fold ones are older than 200 million years. For example, the Aravalli mountains in India (Rajasthan) and the Ural mountain in Russia.

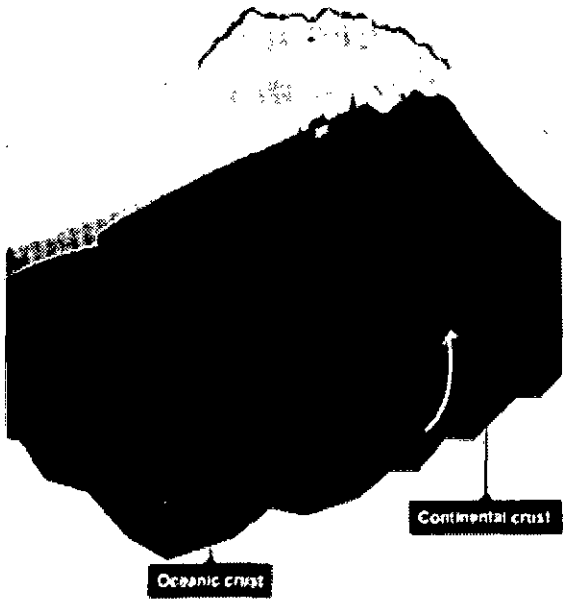
## 2. Block Mountains




Block mountains occur when large areas are broken and displaced vertically. These large areas of rock, sometimes stretching across hundreds of kilometres, are created by tectonic and localized stresses in the Earth's crust.

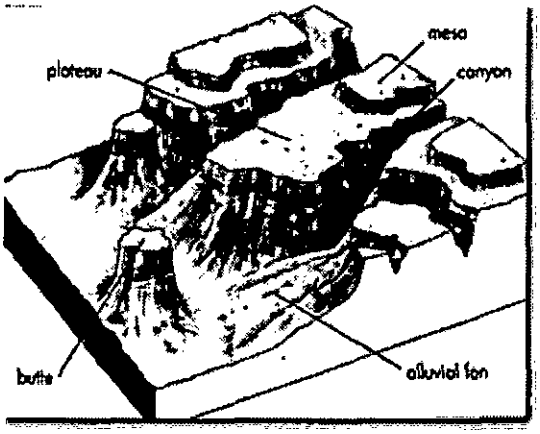
The uplifted blocks are termed as horsts and the lowered blocks are termed as grabens. They resemble piano keys. The examples of block mountains are the Rhine valley and the Vosges mountain in Europe.

## 3. Volcanic Mountains




Magna rising up from the mantle to the crust of the earth forms Volcanic mountains. Examples are Kilimanjaro and Mount Fuji.

## Plateaus




Plateaus are elevated flatlands. In other words, it is flat land which is standing high above the surrounding area. Furthermore, they may have one or more sides with steep slopes. Also, depending upon the plateau, their height varies from a few hundred meters to several thousand meters.

The most familiar plateau in India is the Deccan Plateau. They are mainly formed by lava, meaning they are volcanic in origin. The extension of Deccan Plateau is the Chhotanagpur plateau in India. It's a reserve for minerals such as iron ore, manganese and coal. Other examples include the African plateau and the Tibetian plateau. The African plateau is most famous for gold and diamond mining. And the Tibetan plateau is the highest plateau in the world.

Plateau regions give birth to the waterfall. For example, Hundru falls in the Chhotanagpur plateau and the Jog falls in Karnataka. Moreover, these landforms are also centres for tourism and scenic activities.

## Plains

Plains are the most fertile regions. They are stretches of largely flat land. These stretches of land are the most suitable for human habitation and agriculture activities like farming and poultry.

Rivers and their tributaries form plains. The rivers flow down the mountains and erode them. They deposit sediments along their courses and in valleys. These deposits form plains. In India, the Indo-Gangetic plains are the most densely populated regions of the country. As can be seen, where there is water, there is life.

## Mountain Features and Feature Description

**Arête:** A narrow ridge formed when two glaciers erode opposite sides of a mountain.

**Cirque:** A bowl shaped depression formed by the head of a glacier usually at the foot of a mountain.

**Crag:** A mass of rock that projects outward from a rock face or cliff. Face the side of a mountain that is very steep.

**Glacier:** A mountain glacier is formed by compacted snow into ice.

**Leeward side:** the leeward side of a mountain is opposite the windward side. It is protected from the wind and rain by the mountain.

**Horn:** A horn is a sharp peak formed from multiple glaciers.

**Moraine:** A collection of rocks and dirt left behind by glaciers.

**Pass:** A valley or path between mountains.

**Peak:** The highest point of a mountain.

**Ridge:** A long narrow top of a mountain or series of mountains.

**Slope:** The side of a mountain

## The economic significance of mountains

Mountains are useful to us in the following ways:

### (a) Storehouse of Resources

Mountains are the storehouse of natural resources. Large resources of minerals are found in mountains. The Appalachian range in the United States is well-known for coal and limestone deposits. We get timber, lac, medicinal herbs and wood for making pulp from the forests of the mountains. Tea and coffee plantations and some fruits orchards have been developed on mountain and hill slopes.

### (b) Generation of Hydro-electricity

Hydro-electricity is generated from the waters of perennial rivers in the mountain regions. The mountainous countries like Japan, Italy and Switzerland, which suffer from the shortage of coal have developed hydro-electricity.

### (c) Abundant Sources of Water

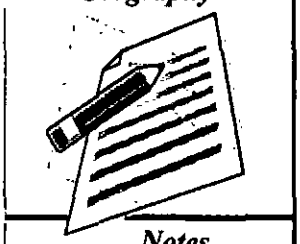
Perennial rivers rising in the snow fed or heavily rain fed mountains are the important source of water. They help in promoting the irrigation and provide water for many other uses.

### (d) Formation of Fertile Plains

The rivers that originate in the high mountain region bring silt along with water to the lower valleys. This helps in the formation of fertile plains. The great alluvial plain of northern India has been formed by the rivers Ganga, Sutlej and the Brahmaputra.

### (e) Natural Political Frontiers

The mountain ranges do act as natural political frontiers between countries and protect them from invasions to some extent. The Himalaya have formed a political frontier between India and China.





## (f) Effect on Climate

Mountainous areas have lower temperatures. They serve as climatic divide between two adjoining regions. The Himalaya for example forms a barrier to the movement of cold winds from Central Asia towards the Indian subcontinent. They also force the South West Monsoons to ascend and cause rainfall on their southern slopes.

## (g) Tourist Centres

The pleasant climate and the beautiful scenery of the mountains have led to their development as centres of tourist attraction. The tourist and hotel industries get an additional encouragement in such regions. Shimla, Nainital, Mussoorie and Srinagar are some of the important hill stations of India which attract tourists all over the world.

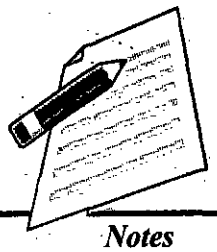
## Plateau

- A plateau is a flat-topped table land.
- Plateaus occur in every continent and take up a **third of the Earths land**.
- They are one of the four major landforms, along with mountains, plains, and hills.
- Plateaus, like mountains may be young or old. The Deccan plateau in India is one of the oldest plateaus.
- Valleys form when river water cuts through the plateau. The Columbia Plateau, between the Cascade and Rocky Mountains in the north western United States, is cut through by the Columbia River.
- Sometimes, a plateau is so eroded that it is broken up into smaller raised sections called Many outlier plateaus are composed of very old, dense rock formations. Iron ore and coal often are found in plateau outliers.
- Plateaus are very useful because they are rich in mineral deposits. As a result, many of the mining areas in the world are located in the plateau areas.

## Plateaus are of great economic significance. Comment with reference to India And World.

- The plateaus are famous for minerals. The plateau of France [Massif Central], the Deccan plateau of India, Katanga plateau of Congo [Copper mines], Western Australian plateau [Kimberly Plateau – Diamond mines] and Brazilian plateau [Brazilian Highlands] are very good sources of minerals. Iron, copper, gold, diamonds, Manganese, coal, etc., are found in these plateaus.
- East African plateau is famous for gold and diamond mining.
- In India huge reserves of iron, coal and manganese are found in the Chotanagpur plateau.
- In the plateau areas, there may be several waterfalls as the river falls from a great height. In India, the **Hundru Falls** in the **Chotanagpur plateau** on the river **Subarnarekha** and the **Jog Falls in Karnataka** are examples of such waterfalls. These sites are ideal for hydro-electric power generation. **Angel falls** in Venezuela is also a waterfall that descends down a plateau.

[Plateaus are not very useful from the point of view of agriculture. The hard rocks on plateaus cannot form fertile soil but agricultural activities are promoted where lava soils





have developed. It is difficult to dig wells and canals in plateaus. This hampers irrigation.]

- The lava plateaus like Deccan traps are rich in black soil that is fertile and good for cultivation. Example: Maharashtra has good cotton growing soils called **regurs**.
- Loess plateau in China has very fertile soils that are good for many kinds of crops.
- Many plateaus have scenic spots and are of great attraction to tourists. (Grand Canyon, USA, many waterfalls)

## Plateau Formation

- Tectonic plateaus are formed from processes that create mountain ranges – **volcanism (Deccan Plateau)**, crustal shortening (thrusting of one block of crust over another, and folding occurs. Example: **Tibet**), and thermal expansion **(Ethiopian Highlands)**.

## Thermal expansion

- Thermal expansion of the lithosphere means the replacement of cold mantle lithosphere by hot asthenosphere).
- Those caused by thermal expansion of the lithosphere are usually associated with hot spots. The **Yellowstone Plateau in the United States**, the **Massif Central in France**, and the **Ethiopian Plateau in Africa** are prominent examples.
- When the lithosphere underlying a broad area is heated rapidly – e.g., by an upwelling of hot material in the underlying asthenosphere – the consequent warming and thermal expansion of the uppermost mantle causes an uplift of the overlying surface. The **high plateaus of East Africa and Ethiopia** were formed this way.

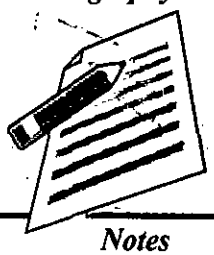
Hotspot Volcanism – Hawaiian and Reunion

## Crustal shortening

- The great heights of some plateaus, such as the Plateau of Tibet is due to **crustal shortening.**
- Crustal shortening, which thickens the crust as described above, has created high mountains along what are now the margins of such plateaus.
- Plateaus that were formed by crustal shortening and internal drainage lie within major mountain belts and generally in arid climates. They can be found in North Africa, Turkey, Iran, and Tibet, where the African, Arabian, and Indian continental masses have collided with the Eurasian continent.

## Volcanic Flood Basalts – Traps

- Volcanism Types – Exhalative, Effusive, Explosive, Subaqueous
- Volcanic Landforms – Extrusive and Intrusive
- Volcanism – Andesitic, Basaltic-Geyser, Hot Water Spring
- A third type of plateau can form where extensive lava flows (called **flood basalts or traps**) and volcanic ash bury pre-existing terrain, as exemplified by the **Columbia Plateau** in the north western United States, **Deccan Traps** of peninsular India, **Laurentian plateau or The Canadian Shield** and the **Siberian Traps of Russia.**
- Volcanic plateaus are commonly associated with eruptions that occurred during the Cenozoic or Mesozoic.





- Eruptions on the scale needed to produce volcanic plateaus are rare, and none seems to have taken place in recent time.
- The volcanism involved in such situations is commonly associated with hot spots. The lavas and ash are generally carried long distances from their sources, so that the topography is not dominated by volcanoes or volcanic centres.
- The thickness of the volcanic rock can be tens to even hundreds of metres, and the top surface of flood basalts is typically very flat but often with sharply incised canyons and valleys.
- The volcanic eruptions that produce lava plateaus tend to be associated with hot spots. For example, the basalts of the Deccan Traps, which cover the Deccan plateau in India, were erupted 60–65 million years ago when India lay in the Southern Hemisphere, probably over the same hot spot that presently underlies the volcanic island of Reunion.
- In North America the Columbia River basalts may have been ejected over the same hot spot that underlies the Yellowstone area today. Lava plateaus of the scale of those three are not common features on Earth.

## Others

- Some plateaus, like the Colorado Plateau, the Ordos Plateau in northern China, or the East African Highlands, do not seem to be related to hot spots or to vigorous upwelling in the asthenosphere but appear to be underlain by unusually hot material. The reason for localized heating beneath such areas is poorly understood, and thus an explanation for the distribution of plateaus of that type is not known.
- There are some plateaus whose origin is not known. Those of the Iberian Peninsula and north-central Mexico exhibit a topography that is largely high and relatively flat.

## Plateau Types

- There are two kinds of plateaus: **dissected plateaus** and **volcanic plateaus.**

## Dissected plateau

- A dissected plateau forms as a result of upward movement in the Earth's crust.
- The uplift is caused by the slow collision of tectonic plates. The **Colorado Plateau**, in the western United States, Tibetan plateau etc. are examples.

## Volcanic plateau

- A volcanic plateau is formed by numerous small volcanic eruptions that slowly build up over time, forming a plateau from the resulting lava flows.
- The **Columbia Plateau** in the north western United States of America and **Deccan Traps** are two such plateaus.

## Others

- **Intermontane plateaus** are the highest in the world, bordered by mountains. The **Tibetan Plateau** is one such plateau.
- **Continental plateaus** are bordered on all sides by the plains or seas, forming away from mountains.

## Major plateaus of the World

### Tibetan Plateau

- **Highest and largest plateau** in the world and hence called the **'roof of the world'.**
- Formed due to collision of the Indo-Australian and Eurasian tectonic plates.
- The plateau is sufficiently high enough to reverse the Hadley cell convection cycles and to drive the monsoons of India towards the south. [We will learn this in future posts]
- It covers most of the Autonomous Tibetan Region, Qinghai Province of Western China, and a part of Ladakh in Jammu and Kashmir.
- It is surrounded by mountains to the south by the Himalayan Range, to the northeast by the **Kunlun Range**, and to the west by the **Karakoram Range.**

### Columbia – Snake Plateau

- River Columbia and its tributary Snake meet in this plateau.
- It is bordered by the **Cascade Range** and **Rocky Mountains** and divided by the **Columbia River.**
- This plateau has been formed as the result of volcanic eruptions with a consequent coating of **basalt lava (Flood Basalt Plateau).**

### Colorado Plateau

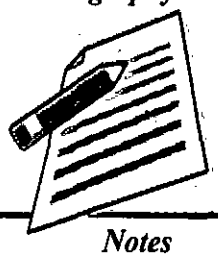
- It is lying to western part of U.S.A. It is the largest plateau in America.
- It is divided by the **Colorado River** and the **Grand Canyon.**
- This plateau is an example of intermontane plateau. Mesas and buttes are found here at many places [Arid Landforms].
- The plateau is known for the groundwater which is under positive pressure and causes the emergence of springs called **Artesian wells.**

### Deccan Plateau

- Deccan Plateau is a large plateau which forms most of the southern part of India.
- It is bordered by two mountain ranges, the Western Ghats and the Eastern Ghats.
- The plateau includes the Deccan Traps which is the **largest volcanic feature on Earth.**
- Made of multiple basalt layers or lava flows, the Deccan Traps covers 500,000 square kilometres in area.
- The Deccan Traps are known for containing some unique fossils.
- The Deccan is rich in minerals. Primary mineral ores found in this region are mica and iron ore in the Chotanagpur region, and diamonds, gold and other metals in the Golconda region.

### Kimberley Plateau

- Lies in the northern part of Australia.
- This plateau is made of volcanic eruption.
- Many minerals like iron, gold, lead, zinc, silver and diamond are found here.
- Diamond is also found here.



*Notes*

## Katanga Plateau

- It is lying in Congo.
- It is famous for **copper production.**
- Other minerals like Cobalt, Uranium, Zinc, Silver, Gold and Tin are also mined here.

## Mascarene Plateau

- Plateaus also form in the ocean, such as the Mascarene Plateau in the Indian Ocean.
- It extends between the Seychelles and Mauritius Islands.

## Laurentian Plateau

- Lying in the eastern part of Canada, it is a part of Canadian Shield.
- Fine quality of iron-ore is found here.

## Mexican Plateau

- It is called as 'Mineral Store'. Different types of metallic minerals like silver, copper etc. are obtained from here.
- World's biggest silver mine Chihuahua is situated in the plateau.

## Patagonian Plateau

- It is a Piedmont plateau (Arid Landforms) lying in southern part of Argentina.
- It is a rain shadow desert plateau.
- It is an important region for sheep rearing.

## Altiplano Plateau or Bolivian Plateau

- It is an intermontane plateau which is located between two ranges of Andes Mountain.
- It is a major area of Tin reserves.

## Massif Central

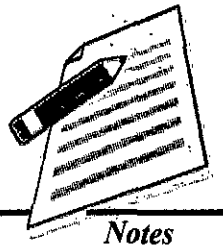
- This plateau lies in the central France.
- It is famous for Grapes cultivation.

## Anatolian Plateau

- Also known as Asia Minor, most of Turkey lies on this plateau.
- It is an intermontane plateau lying between Pontiac and Taurus Mountain ranges.
- Tigris – Euphrates Rivers flow through this plateau.
- Precious wool producing Angora goats are found here.

## Others

- **Spanish Plateau or Iberian Plateau:** It is situated in the middle of Spain. It is a lava plateau. It is rich in minerals like Iron.
- **Loess Plateau:** It is in China. The soil here is made of fine particles brought by the wind. This fine loamy soil is extremely productive. Crops grown in this soil along the **Yellow River** give great yields.





- **Potwar Plateau:** It is situated in northern plateau (Punjab) region of Pakistan. Its average **'Salt Range'** is located to the south-west of the plateau.
- **Bavarian Plateau:** Southern part of Germany.
- **Ahaggar Plateau:** A small plateau located in Algeria, Sahara.

## Plains

In geography, a **plain** is a flat expanse of land that generally does not change much in elevation. Plains occur as lowlands along valleys or on the doorsteps of mountains, as coastal plains, and as plateaus or uplands.

In a valley, a plain is enclosed on two sides, but in other cases a plain may be delineated by a complete or partial ring of hills, by mountains, or by cliffs. Where a geological region contains more than one plain, they may be connected by a pass (sometimes termed a gap). Coastal plains would mostly rise from sea level until they run into elevated features such as mountains or plateaus.

Plains are one of the major landforms on earth, where they are present on all continents, and would cover more than one-third of the world›s land area. Plains may have been formed from flowing lava, deposited by water, ice, wind, or formed by erosion by these agents from hills and mountains. Plains would generally be under the grassland (temperate or subtropical), steppe (semi-arid), savannah (tropical) or tundra (polar) biomes. In a few instances, deserts and rainforests can also be plains.

Plains in many areas are important for agriculture because where the soils were deposited as sediments, they may be deep and fertile, and the flatness facilitates mechanization of crop production; or because they support grasslands which provide good grazing for livestock.

## Types of plain

A small, incised alluvial plain from Red Rock Canyon State Park (California).
A flood plain in the Isle of Wight.

## Depositional plains

The types of depositional plains include:

- Abyssal plains, flat or very gently sloping areas of the deep ocean basin.
- Planitia, the Latin word for plain, is used in the naming of plains on extra-terrestrial objects (planets and moons), such as Hellas Planitia on Mars or Sedna Planitia on Venus.
- **Alluvial plains**, which are formed by rivers and which may be one of these overlapping types:
    - Alluvial plains, formed over a long period of time by a river depositing sediment on their flood plains or beds, which become alluvial soil. The difference between a flood plain and an alluvial plain is: a flood plain represents areas experiencing flooding fairly regularly in the present or recently, whereas an alluvial plain includes areas where a flood plain is now and used to be, or areas which only experience flooding a few times a century.
    - Flood plain, adjacent to a lake, river, stream, or wetland that experiences occasional or periodic flooding.
    - Scroll plain, a plain through which a river meanders with a very low gradient.

- **Glacial plains**, formed by the movement of glaciers under the force of gravity:
  - Outwash plain (also known as sandur; plural sandar), a glacial out-wash plain formed of sediments deposited by melt-water at the terminus of a glacier. Sandar consist mainly of stratified (layered and sorted) gravel and sand.
  - Till plains, plain of glacial till that form when a sheet of ice becomes detached from the main body of a glacier and melts in place depositing the sediments it carries. Till plains are composed of unsorted material (till) of all sizes.
- Lacustrine plains, plains that originally formed in a lacustrine environment, that is, as the bed of a lake.
- Lava plains, formed by sheets of flowing lava.

## Erosional plains

**Erosional plains** have been levelled by various agents of denudation such as running water, rivers, wind and glacier which wear out the rugged surface and smoothens them. Plain resulting from the action of these agents of denudation are called pene plains (almost plain) while plains formed from wind action are called pediplains.

## Structural plains

**Structural plains** are relatively undisturbed horizontal surfaces of the Earth. They are structurally depressed areas of the world that make up some of the most extensive natural lowlands on the Earth›s surface.

## Economic Significance of Plains

- The plains generally have deep and fertile soil.
- Since the plains have a flat surface, the means of irrigation are easily developed.
- Both these factors have made the plains agriculturally so important that they are often called **'food baskets of the world'.**
- The rich agricultural resources, especially of alluvial plains, have helped in the growth of agro-based industries.
- This has given employment to millions of people and has registered a marked increase in national production and per capita income.
- Since the plains are thickly populated, plenty of labour is available for the intensive cultivation and for supplying the workforce for industries.
- Since the plains have an even surface it favours the building of roads, airports and laying down of railway lines.
- The plains have been the centres of many modern and ancient civilizations.
- The major river valley civilizations of the world have flourished in the plains only.
- Hence, they are aptly referred to as the cradles of civilization.
- For example, there is the civilization of the Indus and the Nile Valley.
- Easy means of transport on land, the growth of agriculture and industries in plains have resulted in the setting-up and expansion of cities and towns.
- The most developed trade-centers and ports of the world are found in the plains only.
- Rome, Tokyo, Calcutta, Yangoon (Rangoon), Varanasi, Paris and other famous cities are situated in the plains.
- As much as 80% of the world's population lives in the plains.

## SUMMARY

Major landforms found on the earth's surface are the mountains, the plateaus and the plains. Besides the structure of rocks, the external and internal forces acting on the earth's surface also play a significant role in the development of these landforms. The landforms on the earth's surface have influenced human life in different ways. Fertile plains have been formed by the rivers originating in the mountains. These rivers are our perennial source of water for irrigation and other purposes. The plateaus are often described as the storehouse of minerals. Many of our major industries are dependent on the constant supply of these minerals. Besides this, the density of population is also influenced by the landforms. The plains including some of the valleys located in the mountain are teeming with people. Compared to the plains, the mountains and the plateaus have an uneven surface that is why they are generally sparsely populated.

## EXERCISE

### MCQ

1. Which of the following mountain are formed due to the force generated by the endogenetic force, for example- when two plates collide head on, and their edges crumbled?

   A. Fold Mountains  B. Block Mountains
   C. Volcanic Mountains  D. Dissected mountains

   **Ans:** A

2. Which of the following mountain is the best example of Fold Mountain?

   A. Sierra Nevada  B. Rocky Mountain
   C. Mount Fuji  D. Mount Mauna Loa

   **Ans:** B

3. Which of the following mountain are formed when the great blocks of the earth's crust may be raised or lowered?

   A. Fold Mountains  B. Block Mountains
   C. Volcanic Mountains  D. Dissected mountains

   **Ans:** B

4. Which of the following mountain is a block mountain?

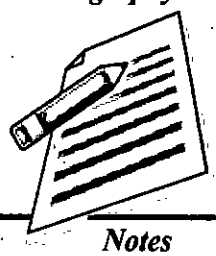
   A. Sierra Nevada  B. Rocky Mountain
   C. Mount Fuji  D. Mount Mauna Loa

   **Ans:** A

5. Which of the following mountains are called Mountains of accumulation?

   A. Fold Mountains  B. Block Mountains
   C. Volcanic Mountains  D. Dissected mountains

   **Ans:** C





## Review Questions

1. Name the four types of mountains found in the world and describe the formation of each type.
2. Describe how plateaus are useful to man.
3. Why are the plains called 'cradles of civilization'?
4. Describe the significance of mountains.
5. Distinguish between the following: (i) The intermontane plateau and the continental plateau. (ii) The block mountain and the volcanic mountain. (iii) The structural plain and the depositional plain.
6. Locate and label the following on the outline map of the world. (a) Rockies and Alps mountain ranges; (b) Patagonia and Tibetan plateaus; (c) Central low land of Australia and Hwang-Ho plains.

# 7 OCEAN: SUB MARINE RELIEF AND CIRCULATION OF OCEAN WATER

- Understand the concept of ocean.
- Discuss the concept of sub-marine.
- Describe the types of ocean.
- Discuss the concept of ocean water.
- Discuss the economic significance of ocean water.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of ocean so that the types and ocean water distribution can be learned.

## Introduction

## Oceans of the world

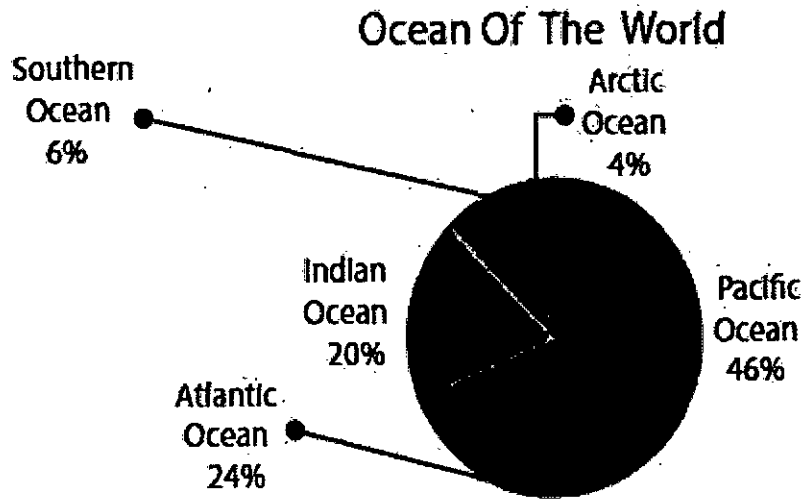



Figure 5.3 Distribution of the Oceans

## 1. The Pacific Ocean

Pacific Ocean is the largest ocean in the world. It is bigger than all continents put together. Portuguese explorer Ferdinand Magellan in 1521 named the ocean Pacific Ocean meaning 'peaceful' because he felt the ocean to be calm after sailing from the Atlantic Ocean through the stormy and dangerous Strait of Magellan. Average depth of this ocean is 4,280 meters.

## 2. The Atlantic Ocean

Atlantic Ocean is the second largest ocean of the world. The Atlantic Ocean's name refers to Atlas of Greek mythology. The North Atlantic Ocean was formed by the break-up of the supercontinent Pangaea and the south Atlantic was formed when the Gondwana land broke in the geological past.

### Fact File

The Suez Canal, an artificial sea-level waterway in Egypt, connecting the Mediterranean Sea to the Red Sea through the Isthmus of Suez was officially opened on November 17, 1869.

## 3. The Indian Ocean

The Indian Ocean is the third-largest in the world. It is named after India. Its calm open water has encouraged the sea trade earlier than the Atlantic or the Pacific Ocean.

## 4. The Southern Ocean

The Southern Ocean is the world's fourth largest ocean. The Southern Ocean is the youngest ocean and was formed 30 million years ago when South America moved away from Antarctica, opening the Drake Passage (Figure 5.4). This ocean has the boundary were cold, northward flowing water from the Antarctic mixes with warmer sub-Antarctic water. During summer in southern hemisphere over half of the Southern Ocean is covered with ice and icebergs.

## 5. The Arctic ocean

The Arctic Ocean is shallower and smaller than the other four oceans. It is completely surrounded by Eurasia and North America. It is covered by ice completely in winter. The Arctic Ocean's surface temperature and salinity vary seasonally as the ice cover melts and freezes alternatively. Its salinity is the lowest on an average of the five major oceans. Bering Strait connects the Arctic Ocean with the Pacific Ocean while the Greenland Sea and the Labrador Sea connects it with the Atlantic. The deepest point is Litke Deep in the Eurasian Basin, at 5,450 m.

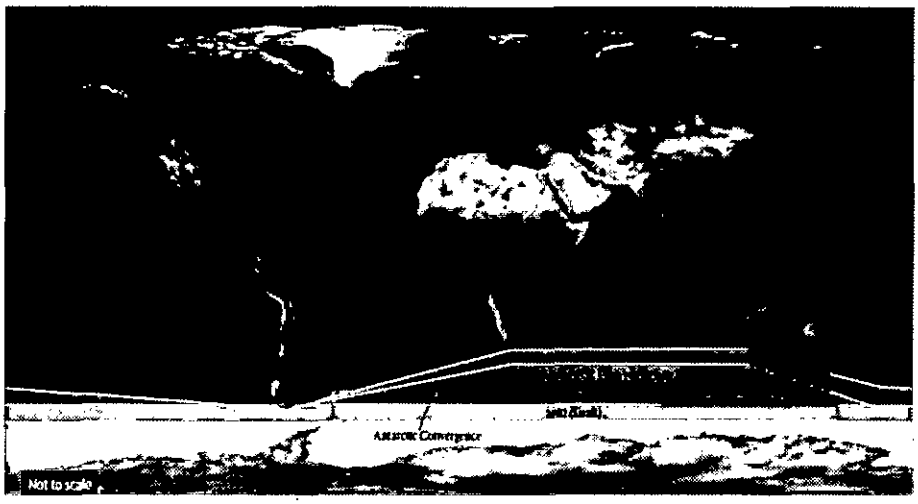



Figure 5.4 Extension of Southern Ocean

## Maritime zones

The low-tide line forms the base line for marking maritime zones. Water landward of the baseline in defined as **internal waters** over which the state has complete sovereignty. A country's **territorial sea** extends up to 12 nautical miles (22.2 km) from its baseline (Figure 5.5). The **contiguous zone** is a zone of water extending from the outer edge of the territorial sea up to 24 nautical miles (44.4 km) from the baseline.

An **Exclusive Economic Zone** (EEZ) extends from the base line to a maximum of 200 nautical miles (370.4 km).

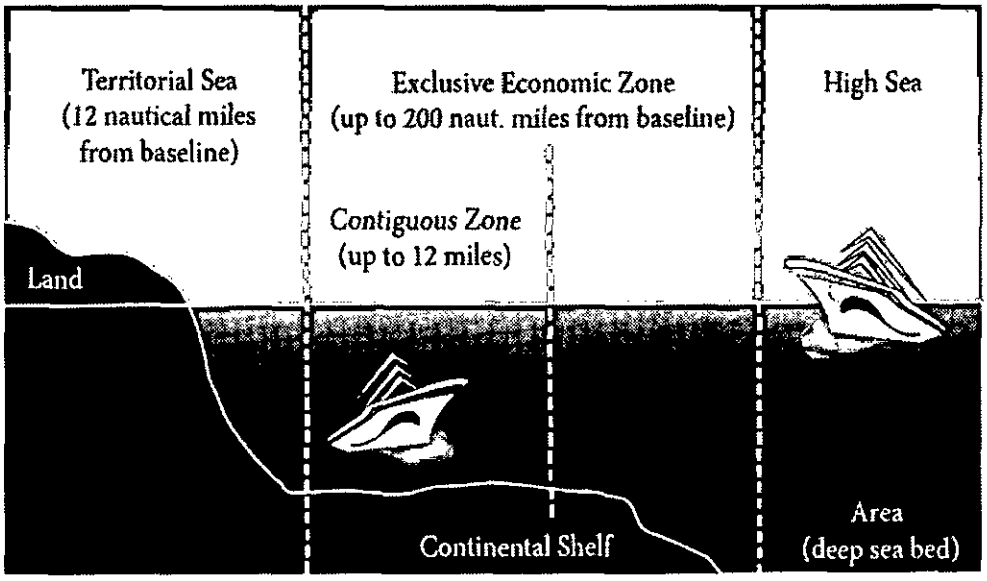
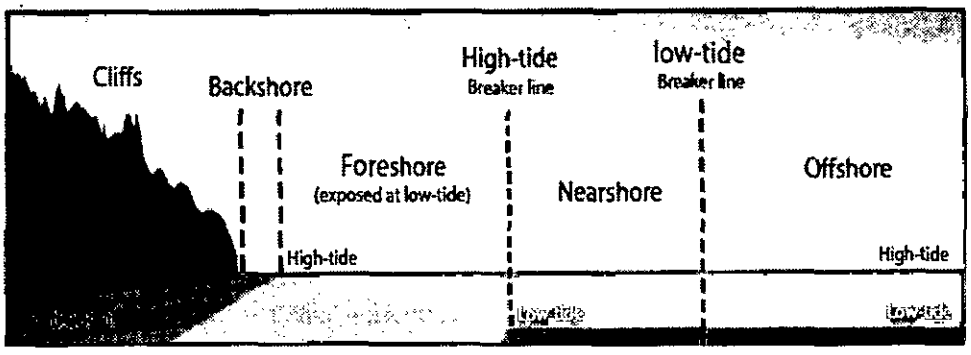



**Figure 5.5** Maritime Zones

A coastal nation has control of all economic resources within its exclusive economic zone, including fishing, mining and oil exploration. Everything beyond EEZ is called **International Waters or the High Seas.** No nation has sovereign rights over this area.

## Fact File

A nautical mile is based on the circumference of the earth, and is equal to one minute of latitude which is equivalent to one sixtieth of a degree of latitude. A nautical mile is a unit of measurement defined as 1,852 metres. Nautical miles are used in Navigational charts.



## Relief of ocean

The bottom of the ocean has a variety of landforms just as it is seen on the earth's surface. There are large mountain ridges, deep depressions, flat plains, basins and volcanoes. The configuration of an ocean floor is shown with the help of a **'Hypsometric curve'** or **'Hypsographic curve'.** It is a graph denoting the proportion of a landmass standing above or below the sea level (Figure 5.7).

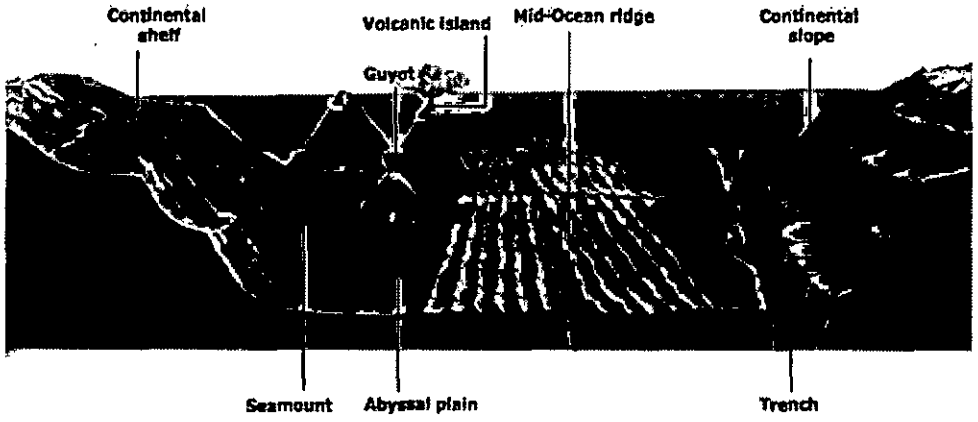



Figure 5.7 Major relief features of Ocean Floor

## Continental shelf

Continental shelf is the seaward extension of land that lies under the sea water. It occupies 7% of the sea floor. The continental shelf slopes gently away from the land and is covered with shallow seas with an average depth of 200 fathoms.

The width of the continental shelf varies according to the nature of the rock beneath the crust. If the crust is dynamic then the shelf would be narrow and vice versa. Continental shelves are formed due to either any one or combination of the factors like fluvial deposits, marine erosion, tectonic forces, and the fluctuations in sea level in the past. Continental shelves are well known for oil, natural gas, mineral deposits and coral reefs. World famous fishing grounds like Grand Bank are situated here. The world's widest continental shelf (1210 km long) is located along the coast of Siberia, in Russia.

Continental shelf on the east coast of India is formed by deltas of the Ganga, the Godavari, the Krishna and the Cauvery. On the West coast of India, the continental shelves are formed due to faulting and consequent submergence.

## Continental Slope

The zone of steep slope extending from the continental shelf to the deep sea plain or abyssal plain is called continental slope. The slope angle varies from 5° to 60°. It occupies 9% of sea floor. This is the region in oceans where landslides, turbid currents, large sediment slumps, under water canyons, gorges cut by the currents and rivers occur. The deposit from the continental shelves immediately falls down here. The origin of continental slope is believed to be due to erosion, tectonic and aggradational processes.

## Continental rise

The area between the continental slope and the sea floor is known as the continental rise. This part is noted for the accumulation of sediments similar to the alluvial fans near the foot hills in the land. It represents the boundary between continents and abyssal plain. It constitutes about 5% of the oceanic area.

## Abyssal plain

The Abyssal plain is the vast area of flat terrain in the bottom of the oceans. It is the largest part of ocean relief covering more than 50% of the total area.

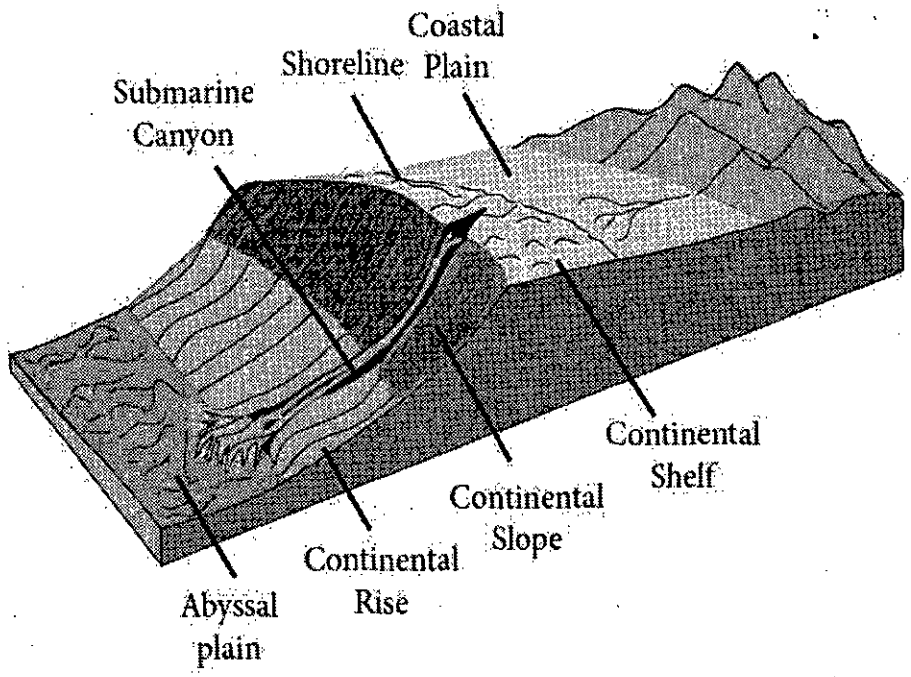



**Figure 5.8** *Ocean relief*

There is an accumulation of very fine sediments on the floor. The sediments are combinations of fine particles of clay and microorganisms. As in the case of sedimentary rocks of earth's surface these sediments are in layers and are used to trace geological events in the past.

## Mid oceanic ridges

The mid-ocean ridges are submarine mountains. They are continuous and are connected to form a single global mid-oceanic ridge system. They are formed by the tectonic forces acting from within the earth. Mid oceanic ridges are located on the divergent plate boundaries where magma flows through the fissure to form new oceanic crust. They form the longest mountain range in the world extending for more than 56,000 km long and has a maximum width of 800–1,500 km.

## Ocean trench

The long, narrow, steep-sided depressions formed by tectonic forces beneath the abyssal plain are called Ocean trenches. Oceanic trenches actually extend 3 to 4 km below the level of the abyssal plain. There are 26 oceanic trenches in the world: 22 in the Pacific Ocean, 3 in the Atlantic Ocean and only one in the Indian Ocean. The Challenger Deep in the Mariana

Trench, (10,994 m) in the Pacific Ocean is the deepest part of the earth. A trench forms along the convergent boundary where one plate subducts below the other (Figure 5.9).

## Island

An island is a landmass surrounded by water on all sides. Islands may be formed on the continental shelf or as oceanic islands. Most of the oceanic islands are volcanic in origin. Group of islands formed by subduction of ocean plate are known as **archipelago**. Islands of Japan form an archipelago.

**Major Ocean Trenches of the world**

| Name of the Trench | Location | Depth ( in Metres) |
|---|---|---|
| Challenger in Mariana Trench | North Pacific | 10,994 |
| Aldrich or Tonga Trench | South Pacific | 10,882 |
| Kurile Trench | North Pacific | 10,554 |
| Tizar Romanche Trench | South Atlantic | 7,761 |
| Sunda Trench | East of Indian Ocean | 7,450 |

*Source:* Geology.com

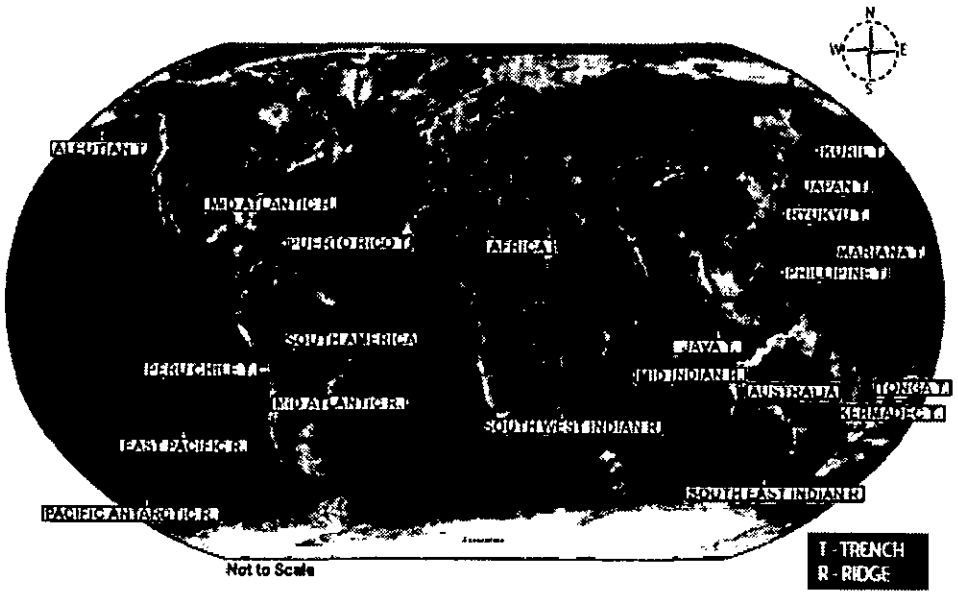



**Figure 5.9** Ridges and Trenches of the world

Marine organisms, the coral polyps colonize the tropical warm water and form islands known as **coral islands**. Lakshadweep Island in Indian Territory is made of corals. Andaman Nicobar Islands are of volcanic origin.

## Guyots

Flat topped volcanic hills submerged under the seawater are called **guyots.** It is a part of an underwater chain of volcanic mountains produced by slow plate movement.

## Seamounts

Seamounts are conical, volcanic hills submerged under ocean water. It does not reach to the water's surface. It is an isolated rise with an elevation of thousand metres or more from

the surrounding sea floor and with a limited summit area. It occupies 4.39 percent of ocean region. Seamounts and guyots are most abundant in the North Pacific Ocean.

## Bottom relief of Pacific Ocean

Continental shelf of the Eastern Pacific Ocean is very narrow due to the presence of trenches while those on the western coast are wide. Continental shelf adjoining coasts of Australia and Indonesia varies in width from 160 to 1,600 km. In the Pacific Ocean, the abyssal plains are very vast. Absence of mid oceanic ridges is the main reason for deep sea plains. Prominent submarine ridges of the Pacific Ocean are **Albatross plateau, Cocas ridge** and **Aleutian ridge.** Tasmania basin (New Zealand ) and east pacific basin are major basins of Pacific Ocean. Pacific Ocean has about 25,000 islands. There are number of archipelagos both in north and south Pacific Ocean. The Hawaii islands were formed by hotspot. The challenger deep in Mariana trench is the deepest part of Pacific Ocean (10994m).

## Bottom relief of Atlantic Ocean

In the North Atlantic Ocean, extensive continental shelves are found around the shores of Newfoundland (Grand bank) and British islands (Dogger Bank). In the South Atlantic Ocean, a very extensive continental shelf is found between Bahia Blanca and Antarctica (Figure 5.10).


Figure 5.10 Bottom relief of Atlantic Ocean

The most striking relief feature which is the 'S' shaped Mid–Atlantic ridge which extends for 16,000 km from Iceland in the north to Bouvet Island in the south. The ridge separates the Eurasian Plate and North American Plate in the North Atlantic, and the African Plate from the South American Plate in the South Atlantic. **Iceland** and **Faroe** are the few peaks of the Mid-Atlantic ridge.

The mid-Atlantic ridge divides the Atlantic Ocean into two major basins, i.e., East and West Atlantic basins. Other basins are Spanish basin, north and south Canary basin, Guinea basin, Brazilian basin and Labrador basin. **Puerto Rico Deep** (8,380 m) is the deepest of all deeps in the Atlantic Ocean. Other deeps are **Romanche Deep** and **South Sandwich Trench**. The West Indies is an island archipelago near the main land of North America. British Isles and Newfoundland are famous islands, formed on the continental shelf in the North Atlantic Ocean. Sandwich island, Georgia Island, Falkland and Shetland islands are islands in the South Atlantic Ocean.

## Bottom Relief of the Indian Ocean

The Indian Ocean has continental shelf of varying width. Continental shelf along the coast of Arabian Sea, the Bay of Bengal and Andaman varies in width from 192km to 280km. A variety of coral reefs thrive in the warm tropical water of the Indian Ocean.

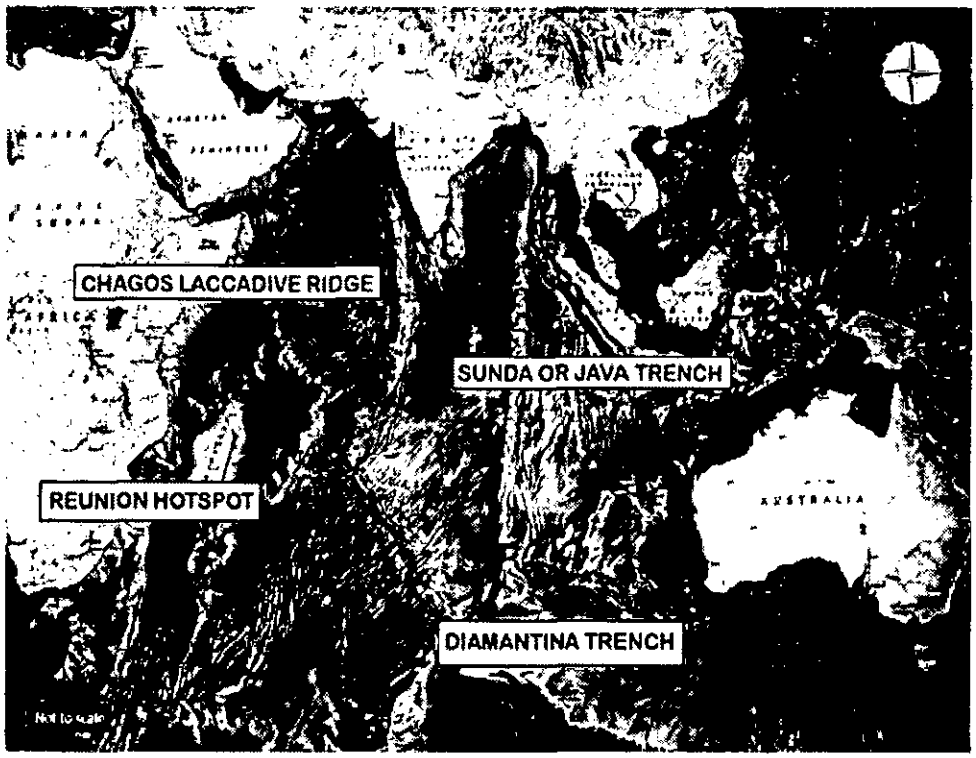



**Figure 5.11** Bottom relief of Indian Ocean

Indian Ocean has a continuous central ridge called the Arabic Indian ridge. Other important ridges include the East Indian ridge, West Australian ridge, South Madagascar ridge. Basins of Indian Ocean include Comoro basin, North Australian basin, South Indian basin and the Arab basin (Figure 5.11).

The average depth of the Indian Ocean is 3890m. Sunda deep near Java is the deepest part of this ocean (7450m). Madagascar and Sri Lanka are the most prominent islands present

in Indian Ocean. Andaman and Nicobar Islands in the Bay of Bengal are the raised part of mountains that are the extension of Arakan Yoma which forms a part of Himalayas. Reunion Island is located on a Hot spot.

## Fact File

Indian National Centre for Ocean Information Services (**INCOIS**) with its Marine Satellite Information Services uses the remotely sensed sea surface temperature (SST) to identify the locations of fish aggregation. The details of the Potential Fishing Zones (PFZ) are then disseminated to the fishermen once in every three days along the Indian Coast by displaying the details in the Lighthouse in their respective regional language (Figure 5.6).

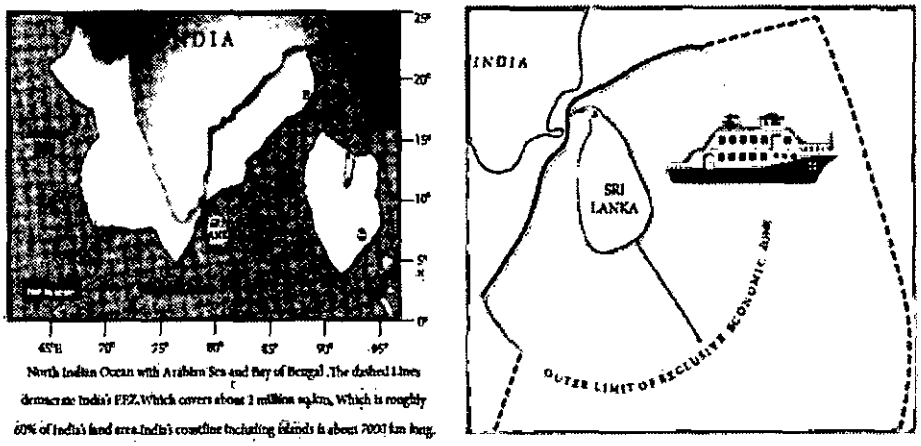



Figure 5.6 India's Exclusive Economic Zone

## Ocean Temperature

The measurement of degree of hotness or coldness of ocean water is referred to as ocean temperature. Temperature is normally measured in the unit of degree Celsius by thermometers. The major source of heat energy for ocean water is the radiation from sun. The heating and cooling capacity of water differs significantly from that of land.

## Factors affecting horizontal distribution of ocean temperature

The factors affecting distribution of ocean temperature are latitude, prevailing winds, ocean currents and local weather.

1. Latitude: The temperature of surface water decreases from equator towards the poles because of the slanting rays of the Sun pole ward.
2. Prevailing wind: Direction of the wind affects the distribution of temperature of ocean water. The off shore winds blowing from the land towards ocean or sea raise the temperature of ocean water. Winds blowing from snow covered regions in winter lower the surface temperature. In trade wind belt, the off shore winds initiate upwelling of cooler water from beneath and on shore winds pile up warm water to increase the temperature to certain extent.
3. Ocean currents: Warm currents raise the temperature of the oceans where they flow whereas cold currents lower down the temperature. Gulf Stream (warm current) increases the temperature of the eastern part of North America and the west coast of Europe. Labrador cold current reduces the temperature near north eastern coast of North America.

4. Apart from these, some minor factors like submarine ridges, local weather conditions like storms, cyclones, hurricanes, fog, cloudiness, evaporation and condensation also affect the surface temperature of ocean water.

These images show the sea surface temperature in Celsius. The Figure 5.12 shows the sea surface temperature in July and the Figure 5.13 in January. Cold temperatures are shown in purple, moderate temperatures in aquatic green and warm temperatures in yellow to red. Landmass is shown by black colour. The diurnal range and annual range of temperature of ocean is much less than that of the land.

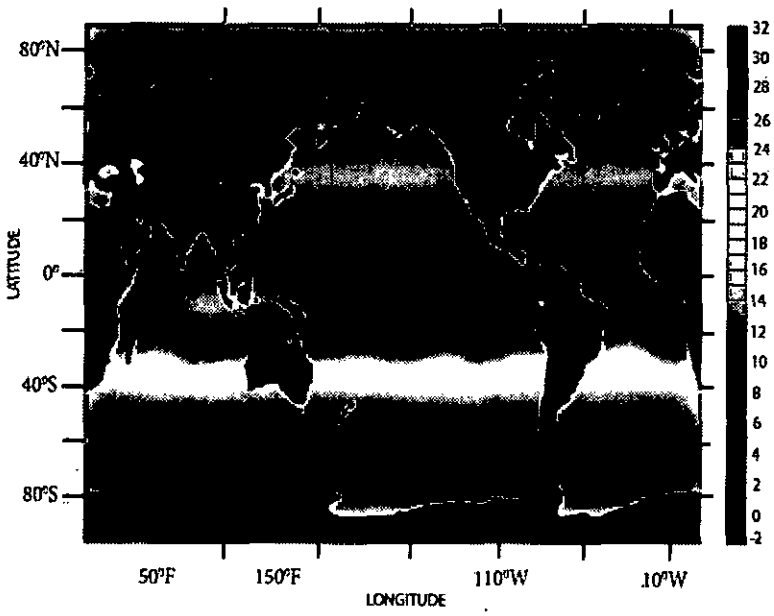



Figure 5.12 Sea surface temperature in July 1997

The temperature of the sea surface is highest (27°C to 30°C) not near Equator but few degrees north of the Equator. The lowest temperature recorded is -1.9°C near the poles. The maximum and minimum annual temperatures of ocean water are recorded in August and February in the Northern hemisphere and reverse in case of the southern hemisphere.

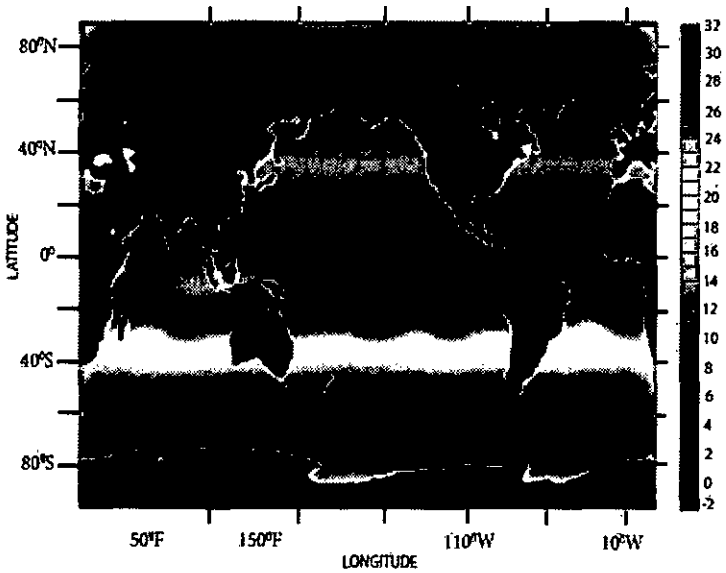



Figure 5.13 Sea surface temperature in January 1997

## Vertical distribution of temperature in oceans

The uppermost layer of ocean water is warm and well mixed surface layer with average temperature between 20° and 25°C. The depth of this layer varies according to seasons. On an average this layer extends up to 200 m in tropical region. Beneath this layer lies the thermocline layer.

This layer varies in depth between 200 metre to 1000 metre. This layer is unique that the temperature decreases rapidly with increasing depth. Below the thermocline temperature decrease is gradual up to 4000m. Beneath this depth the temperature of ocean water is constant at 4°C (Figure 5.14).

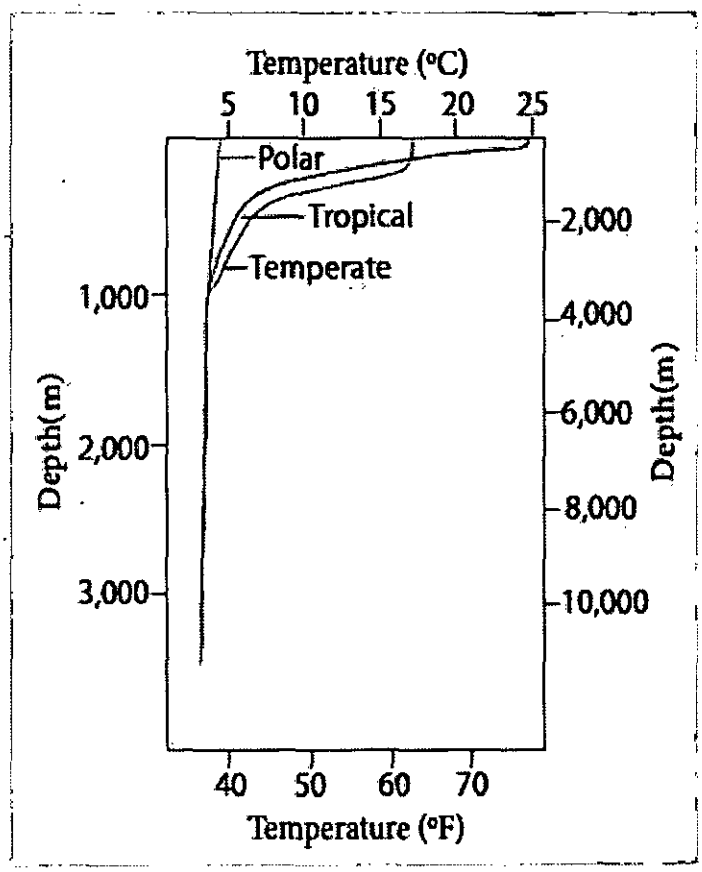



**Figure 5.14 Vertical distribution of temprature in Oceans**

## Salinity of the ocean

**Salinity** is defined as the ratio between the weights of dissolved salts (in grams) per 1000 grams of water. It is expressed as part per thousand (‰) and has no units. Example: 30‰ means 30 grams in 1,000 grams of sea water. The average ocean salinity is 35‰.

**Sources of salt in the ocean:** Sea water is a weak but complex solution made up of many things including mineral salts and decayed biological marine organisms. Most of the ocean salts are derived from weathering and erosion of the earth's crust by the rivers. Some of the ocean salts have been dissolved from rocks and sediments below the sea floor, while others have escaped from the earth's crust through volcanic vents as solid and gaseous materials.

## Fact File

Depth of water is measured in the unit 'Fathom'. One fathom is equal to 1.8 metre (six feet)

## Factors affecting the salinity of ocean water

The salinity of ocean water depends upon

1. The rate of evaporation
2. Amount of precipitation,
3. Addition of fresh water flow from rivers
4. Ice in Polar Regions
5. Upwelling of deep water initiated by prevailing winds and
6. Mixing of water by ocean currents.

## Distribution of salinity

On an average the salinity decreases from equator towards the poles. The highest salinity is observed between 20° and 40° north latitudes because this zone is characterized by high temperature, high evaporation but less rain than the equatorial region.

The marginal areas of the oceans bordering the continents have lower salinity than their interior due to addition of fresh water to the marginal areas through the rivers (Figure 5.15).

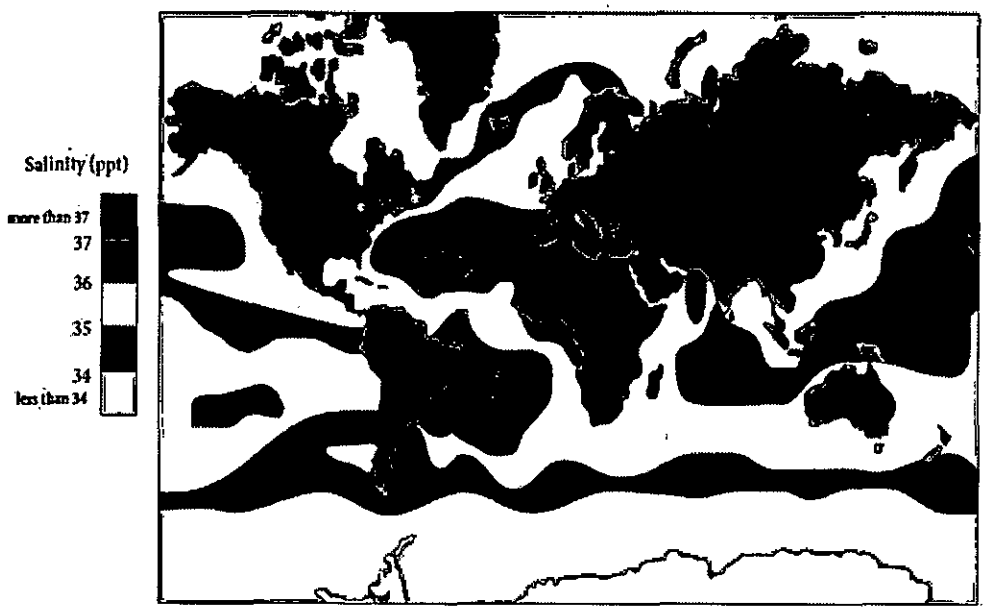



**Figure 5.15** Salinity of the Oceans

Very high salinity is recorded in Lake Von, Turkey (330‰ ) Dead Sea (238‰) and Great Salt Lake, Utah, USA (220‰).

## Ocean movements

Water in the ocean is never in a state of rest. Ocean water is always in motion. It moves horizontally as well as vertically. The movement of ocean water takes place in three different ways as waves, tides and ocean currents.

## Waves

The waves are oscillating movements in the ocean water which transfer energy from place to place. They are caused by friction of wind on the surface of water or any other disturbances on the sea bottom.

## Parts of Waves

1. **Crest:** The upper or highest part of a wave is called the crest. (Figure 5.16)
2. **Trough:** The lowest part of a wave is called the trough.
3. **Wave height:** The vertical distance between the crest and the trough is known as wave height.
4. **Wave length:** The horizontal distance between two crests or two troughs is known as wave length.
5. **Wave amplitude:** Wave amplitude is one-half of the wave height.
6. **Fetch:** The distance of open water across which the wind can blow without interruption is called fetch.

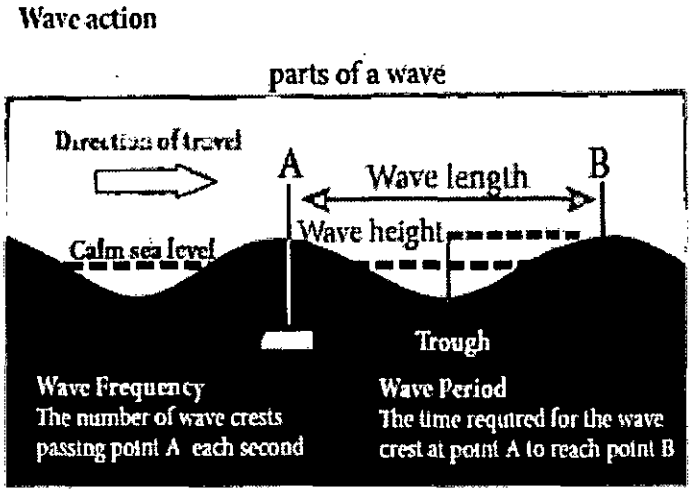



**Figure 5.16 Parts of a wave**

7. **Frequency:** The number of wavelengths that pass a fixed point per unit of time is frequency. Example, 100 waves per sec per cm.
8. **Period:** The time taken by one wavelength to pass a fixed point is known as period.
9. **Velocity:** Refers to speed and direction.
10. **Steepness:** Steepness of the wave is equal to the height divided by length.(H/L)

## Tides

The rhythmic rise and fall of the sea water due to gravitational pull of the moon and the sun is called a Tide. Isaac Newton (1642– 1727) was the first person to explain tides scientifically. The rise of seawater towards the land is known as High tide or flow tide. The fall of seawater more towards sea is known as 'Low tide water' or ebb tide. On any day there will be two high tides and two low tides. The highest high tide occurs on full moon day and new moon day. It is known as **spring tide** (Figure 5.17). Spring tide happens when the sun, earth and

moon aligned in straight line. The lowest low tide is known as **neap tide**. It happens when the sun, earth and moon are positioned at right angles.

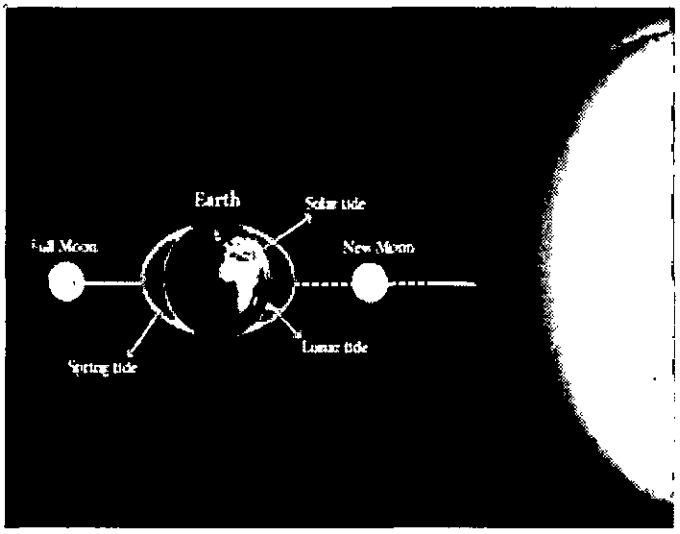



**Figure 5.17 Tides**

The movement of ocean water as a result of tidal action is known as a tidal current. In places of narrow coastal inlet these tidal currents flow rapidly through the mouth with greater height and velocity. For example, in the Bay of Fundy, between Nova Scotia and New Brunswick of Canada, the difference between high and low tides is as high as 14m. Ports which utilize the tidal current for entry and exit of ships from the harbour are known as tidal ports. In India Kolkata and Kandla are examples of tidal harbours.

## HOTS

Why does the **highest Tide** occur when the sun, earth and moon are aligned in a straight line?

The Gulf of Cambay and the Gulf of Kutch in Gujarat on the west coast have the maximum tidal range of 11m and 8m with average tidal range of 6.77m and 5.23m respectively. Tides help to clear the sediments deposited by rivers on their bed and thus prevent siltation of harbours. The energy of the tides is used to generate electricity. Tidal power stations have been set up in UK, Canada, France and Japan. In India Gulf of Khambhat, Gulf of Kutch and Sundarbans have scope for tidal energy production.

## Fact File

A harbour is a sheltered water body where ships are anchored. A port is the area at the edge of a water body where boats and ships are docked, where transfer of goods and passengers take place and where trading is facilitated.

## Ocean currents

Large mass of moving water from one part of the ocean to another in a definite direction is called as ocean current. The movement is produced due to earth's rotation, temperature difference of ocean water, salinity, density and some extent due to air pressure and winds. Ocean currents can be classified on the basis of mode of origin, volume and velocity and boundaries.

In the order of velocity ocean currents can be classified as drifts, currents and streams. **Drifts** are movement of surface water of low velocity influenced by prevailing winds, **currents** are movement of oceanic water in definite direction and greater velocity and **streams** are larger mass of water moving in a definite direction and much greater velocity than the drifts and currents. Ocean currents are distinguished by the temperature they possess. When ocean currents originate from equator it is termed as **warm current**. Likewise, when a current start from polar region it is termed as **cold current**.

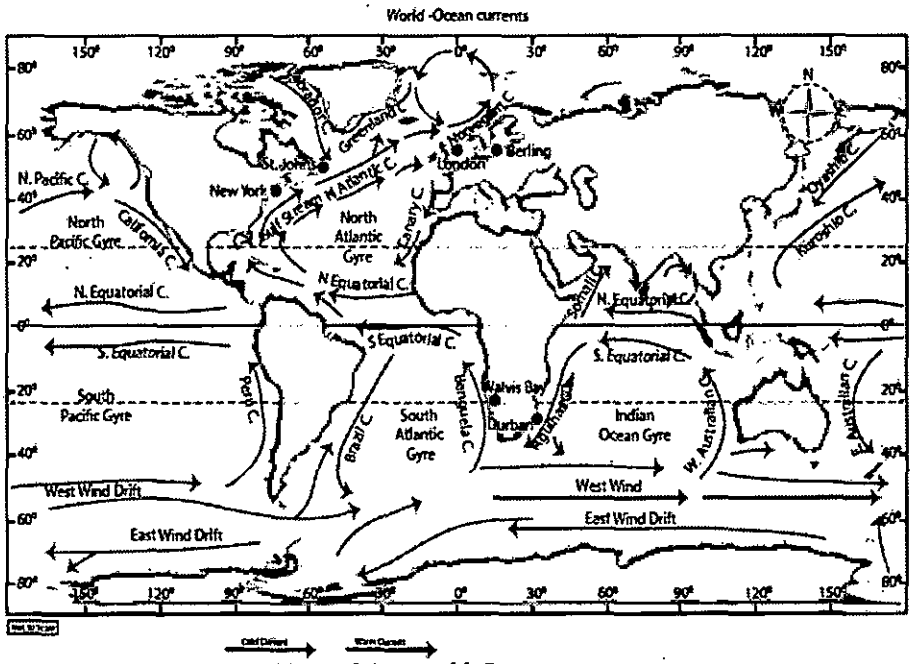



Figure 5.18 World-Ocean currents

Vertical circulation of ocean water takes place due to difference in salinity and temperature between the surface and the water deep below. Upwelling is an oceanographic phenomenon that involves movement of dense, cooler, and usually nutrient-rich water towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water. Down welling is the process of accumulation and sinking of cold high saline water beneath warmer or fresher water.

## Major ocean currents of the world

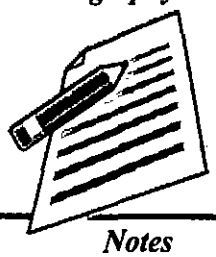
In every ocean, there is circulation of ocean water from Equator to pole and from pole to equator. The warm currents from the equator flows over the surface of ocean towards the pole and sink to the bottom of the ocean floor in the higher latitudes due to high density and flow towards the equator to complete the circulation. This large-scale circulation is known as **gyre**.

The gyre circulates is clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere.

## a. Ocean currents of the Pacific Ocean

### 1. North Equatorial current.

North equatorial current originates from Revilla Gigedo island west of Mexico and flows towards the Philippines Island covering a distance of about 12,000 km from east west. It





is a warm current. It derives from its water from the Californian current and the South east Monsoon drift which flows north along the Mexican coast. The volume of water increases from east to west as many small currents join it from right. It gets divided into two and the northern branch joins the Kuroshio Current and the southern branch abruptly turns and forms the Pacific counter current.

## 2. South equatorial current.

South equatorial current is originated due the action of the trade winds from east to west. It is a warm current. It extends for about 13,600km from east to west. It is stronger than the North equatorial current. It is further divided into many branches due to the presence of many islands and uneven surface topography.

## 3. Kuroshio current ( Black Tide)

It is a warm ocean current flowing in north easterly direction up to 30o N latitude and it carries warm water off the Formosa coast. It flows towards north and meets Oyashio cold current off the Kuril Islands. It is also called as Japan current.

## 4. Oyashio Current( Parental Tide)

It originates from the Bering Strait and flows towards south carrying cold water. It is a cold current. It meets with Kuroshio warm current and Aleutian current.

## 5. Californian Current.

Californian current is flowing towards south along the west coast of U.S.A between 48o N and 23o N latitudes. It is cold current which exhibits great amount of up welled water. When it enters the region of Trade winds, it is deflected to the right and joins the equatorial current.

## 6. Peru Current.

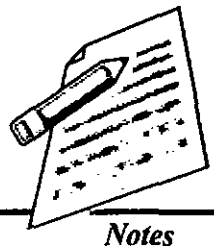
Peru Current is perhaps the best studied ocean current of the Pacific Ocean. Alexander Von Humboldt in 1802 noted the details of the Peru Current. Hence, it is also known as Humboldt Current. It is a cold current. It is flowing towards north along the west coast of South America carrying cold water from northerly deflection of the Sub-Antarctica water moving in 40o S.

## 7. El Nino or Counter current.

It is a warm counter ocean current of the pacific equatorial waters flowing south ward at 400 m depth to a distance about 180 km.

## 8. West Wind Drift.

It is an easterly moving drift in the Pacific Ocean extending from Tasmania to the South American coast. It is a cold current. The speed of the drift is greater under the influence of Roaring Forties. It splits into two branches and one moves south around the Cape Horn into the Atlantic Ocean and the Other one moves northward along the Peruvian coast due to deflection and joins the Peru Current.





## b. Currents of the Atlantic Ocean

### 1. North equatorial current.

North equatorial current is flowing from east to west. It is a warm current. It is situated between 5o – 20o N latitudes. After leaving the west coast of Africa, it attains its main characteristics. When it reaches the east coast of South America, it splits into two branches and one branch called Antilles current is moving along the coast of West Indies and another branch is diverted into the Caribbean Sea.

### 2. South Equatorial current.

It is flowing south of equator within 0o – 12o S latitude in between the coast of Africa and South America. It is a warm current. It is a northern continuation of Benguela current. It is stronger than the North equatorial ocean current. It is caused by the action of Trade winds.

### 3. Gulf Stream.

Gulf Stream starts from the Gulf of Mexico and carries warm waters into the colder latitudes. It is a warm current. It bends with the coastline up to 40th parallel after which the direction is almost to the east, due to the force and the direction of the westerlies and the deflective force of the earth. It joins the Labrador cold current near New Found land, Canada after passing through the strait of Florida. The Gulf Stream was discovered by Ponce de Leon in 1513.

| S. No. | World's Fishing banks | Confluence of ocean currents |
|---|---|---|
| 1. | The Grand bank (Atlantic Ocean, Western Europe) | Gulf Stream and Labrador current |
| 2. | The Agulhas bank (Atlantic Ocean, South west Africa) | Benguela cold current and Agulhas warm current |
| 3. | The Dogger bank (Atlantic Ocean, North east of N.A) | North Atlantic drift and canary cold current |
| 4. | The Reed bank (South China Sea, Pacific Ocean) | Kuroshio Warm current and Oyashio Cold Current |
| 5. | The Pedro bank (India Ocean) | South Equatorial warm current and W. Australian cold current |

### 4. Canaries Current.

The ocean current flowing along the Western coast of North Africa between Maderia and Cape verde is known as the Canaries Current. It is a cold current. It is flowing towards south and merging with the North equatorial current.

### 5. Labrador Current.

In the north Atlantic, a cold current flow from the Baffin Bay and Davis Strait towards south. It brings cold waters from polar zone and moves along the coast of green land.

## 6. Benguela current.

It is a cold current flowing northward along the western coast of Africa is known as the Benguela current. It carries cold waters from sub-Antarctica surface water and mixes with south equatorial current.

## c. Currents of the Indian Ocean

The south Indian gyre is formed by south equatorial current, Madagascar current west wind drift and west Australian current. To the north of equator, the currents in the Arabian Sea and Bay of Bengal flow in the clockwise direction as southwest monsoon drift and in the anti-clockwise direction as northeast monsoon drift due to the influence of monsoon winds.

The Antarctic circumpolar current flows between 40 to 60° S latitude. It flows from west to east influenced by the westerly and circles around entire Antarctica. There is a counter west ward current within this circum polar current.

## d. Currents of the Southern Ocean

The Southern Ocean surrounds the continent of Antarctica. The large oceans, the pacific, the Atlantic and the Indian Ocean merge into this circum-global zone of water to their south. The movement of water in the Southern Ocean is in one sense a relatively simple, generally west-east circum-polar drift caused under the influence of north-westerly winds. This general flow sends offshoots to the three major oceans to its north. The Peru or Humboldt Current in the Pacific Ocean, the Falkland Current and the Benguela Current in the Atlantic Ocean and the West Australian Current in the Indian Ocean receive a part of their cold waters from the Southern Ocean.

Besides the surface currents, there is also a very complex system of subsurface currents between the Southern Ocean and the oceans to its north.

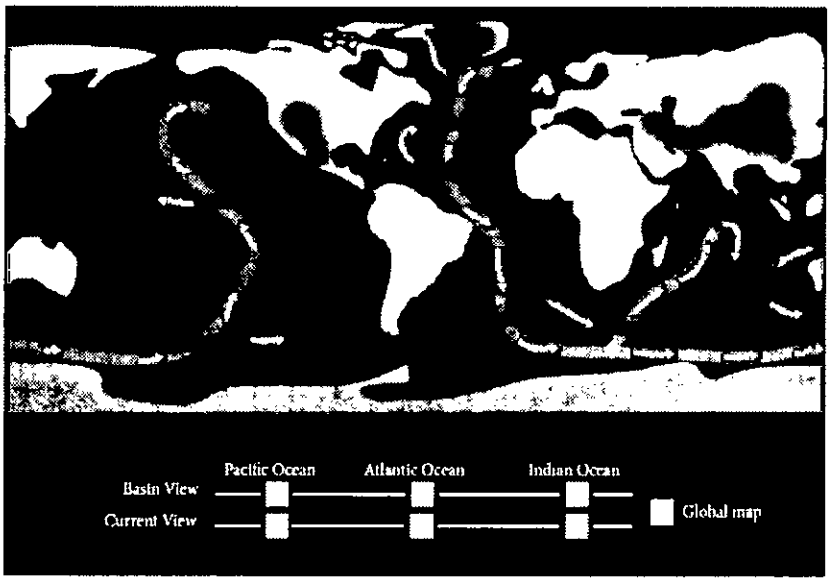



Figure 5.20 Thermohaline circulation

Generally, the water moves from this ocean towards the equator on the surface and at great depths but at in remediate depth, there is a movement of water from the equatorial areas towards the Southern Ocean.

## The significance of Ocean Currents

1. Ocean currents play an important role in the earth's climate. They distribute energy and nutrients within the ocean.
2. Fog is formed where warm current and cold current meet. For example, when the Gulf Stream and Labrador Current meet near New Found land one of the densest fogs is formed.
3. The warm ocean current increases the temperature of an area where it flows to and Cold Ocean current decreases the temperature of the area.
4. The warm current brings heavy rainfall when the wind blows over it becomes warm while the cold current brings drought when the wind blows over it becomes cold and dry. For example, the wind blowing over the Peru Current is cold and dry causing the formation of the Atacama Desert located on the west coast of Peru.
5. It regulates the global temperature. It gives free navigation. The Gulf Stream keeps ports & harbours of Russia and Scandinavia navigable throughout the year. The Kuroshio Current makes ports on Japan navigable during winter.
6. It distributes minerals and pollution added to it becomes highly diluted and later negligible.
7. It helps in growth of juveniles of certain fish and its distribution to other countries - from its place of origin. Some up welling and down welling are due to currents which bring minerals to photic zone used by phytoplankton. Major fishing grounds are located in the zones where cold current and warm current meet.

| Normal Situation | El Nino Situation |
|---|---|
| ➢ Near equator the water of the Pacific Ocean is warmer in the western side and cooler in the eastern side due to upwelling of the cold current. | ➢ Near equator the warm water in the Pacific Ocean extends from western side to eastern side suppressing the ➢ upwelling of the cold water. |
| ➢ Air (Walker) circulation is dominant in the western Pacific Ocean. The air ascends in the western side and descends over the cooler eastern side | ➢ Air (Walker) circulation is dominant in the eastern part of Pacific Ocean. The air ascends in the warm eastern Pacific Ocean. |
| ➢ Heavy rain is experienced in the western warmer region and dry conditions prevail in the cooler region. | ➢ Heavy rain is experienced in the eastern warmer region and dry condition prevails in the western part. |
| ➢ The Southeast Asia and Australia receive heavy rain on normal years. | ➢ Southeast Asia and Australia experience dry weather conditions. |
| ➢ West coast of South America experiences dry weather. | ➢ West coast of South America receives heavy rainfall. |

## El Nino

El Nino is a phenomenon that occurs in the equatorial Pacific Ocean characterized by a positive sea surface temperature departure from normal (1971-2000 base period) in the region lying within the latitude 5°N to 5°S and longitudes 120° W to 170°W . This phenomenon occurs every two to seven years (Figure 5.19).

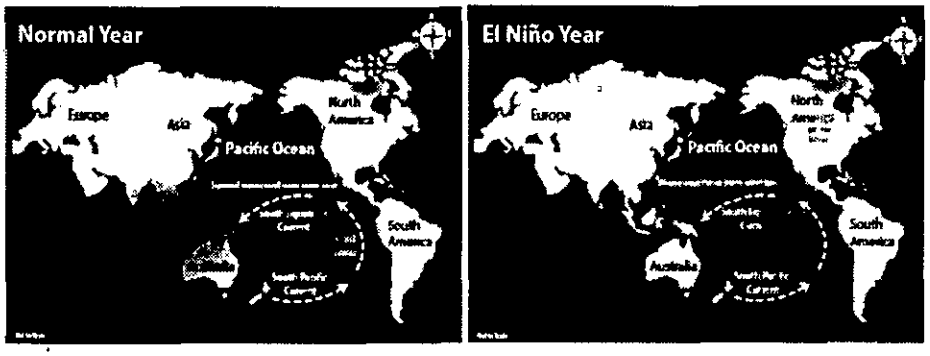



Figure 5.19 Wind circulation during Normal and El Nino Conditions

## El Nino happens when

Sea surface temperature increases between the central and eastern equatorial Pacific Ocean between the country Ecuador and the International Date Line

•The increase in temperature is sustained for a period of eighteen months to Two years.

•The temperature increase is up to 30 m beneath the ocean surface.

•When there is a modified vertical air circulation above the Pacific Ocean

## Global influence of El Nino

El Nino effect is experienced at Global level. The change in air circulation affects the economy of different countries also. Global weather patterns are altered to such an extent that they affect eco system, agriculture, tropical cyclone, drought, forest fire, floods and flood related health hazards. El Nino influences the jet streams. Due to this phenomenon California experiences heavy rainfall, northern Europe experiences dry winter, Southern Europe experiences mild wet winters, there are a smaller number of cyclones in Sea of Japan, and heavy rain in East Africa. South East Asia experiences severe drought and forest fire. Peru in South America receives heavy rainfall during El Nino.

Increase of temperature in the east Pacific Ocean is correlated with normal monsoon conditions in India while the increase of temperature in the central Pacific has high correlation with drought conditions in India. When temperature increases further to the west it suppresses the Indian Monsoon.

## La Nina

La Nina is just the opposite to the condition of El Nino. When trade winds are strong, colder water up wells on the East Pacific Ocean, walker air circulation is confined to the west Pacific, wet condition in Southeast Asia and dry weather in South America is observed.

The difference in the atmospheric pressure between the west and east tropical Southern Pacific Ocean is referred to as Southern Oscillation. Meteorologists have established a close inter link between Southern Oscillation and occurrences of El Nino and La Nina events. The acronym **'ENSO'(El Nino Southern Oscillation)** is often used to study both the phenomena.

## Thermohaline circulation

As the name indicates there is a large-scale churning of ocean water due to difference in temperature and salinity. The down welling of ocean water occurs in the extreme ends of

Atlantic Ocean one near the Norwegian coast and another at Weddell Sea. Upwelling of cold water occurs in the North Pacific Ocean and in the Indian Ocean. This cycle of water movement within the Global Ocean is also known as **Conveyor Belt** (Figure 5.20). The slow, steady and three-dimensional flow of water in the conveyor belt distributes dissolved gases and solids, mixes nutrients and carries it to various ocean basins. This cycle provides a stabilizing effect on climate of the earth. If it is disturbed, it is capable of causing sudden climatic change within the period of a few decades. The conveyor belt is a simplified version of actual circulation in the oceans.

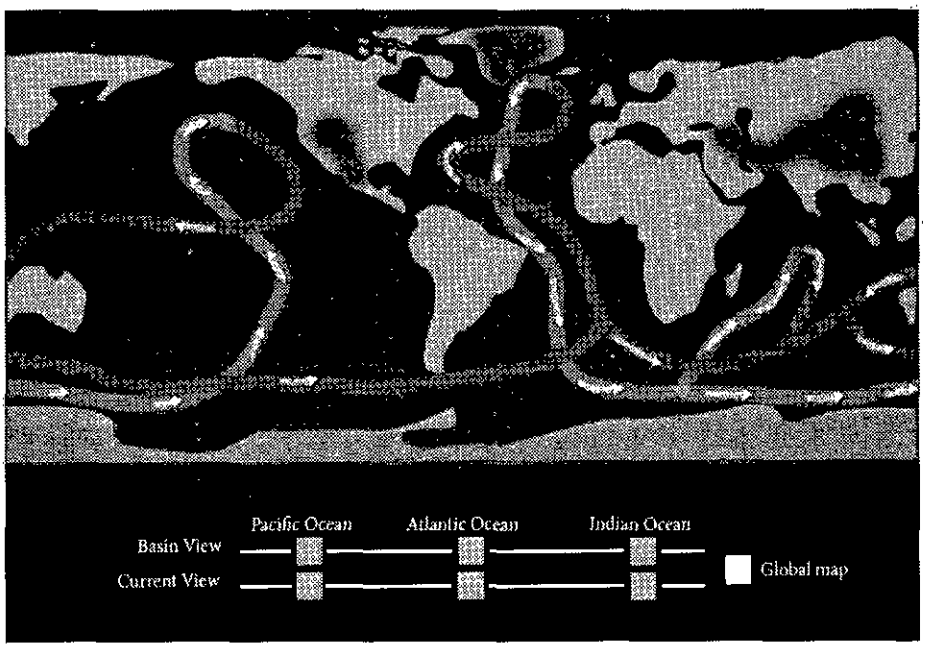



Figure 5.20 Thermohaline circulation

## Importance of ocean for humans

We are well aware that oceans cover about 71 % the earth's surface. They form a major part of our environment and have an overwhelming influence on humans and his activities. In this section we will be studying the importance of oceans in different spheres of human life.

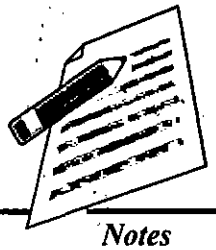
## (a) Ocean as modifiers of climate

The most important part played by the oceans is as modifiers of climate.

(i) The ocean stores a large quantity of heat, hence it is often called "the saving bank for the solar energy, receiving deposits in season of excessive insolation and paying them back in seasons of want". The extensive deep waters of oceans gain as well as loose heat more slowly than the land when both are subjected to the same amount of insolation. The contrast in the temperature of the ocean and land explains the difference in the temperature of coastal and interior region.

(ii) The oceans supply water vapour to the atmosphere and thus are the basic source of all precipitation on earth. They are also the vital source of fresh water on earth.

(iii) Ocean currents are important regulators of temperature on the earth's surface. They help in exchange of heat between low and high latitudes and are essential in sustaining the global energy balance. On the local scale, the warm ocean currents bring a moderating





influence to coasts in higher latitudes; cool currents reduce the heat of tropical deserts along narrow coastal belts.

(iv) The influence of oceans on climate becomes clearer if we consider the distribution of pressure and prevailing wind system over the sea surface. The ocean's surface has six or more permanent centres of high pressure. These high-pressure areas give birth to the planetary wind system over the earth. These planetary winds determine the amount of rainfall and its distribution over the earth's surface. The westerlies give rainfall on the West European Coast after collecting moisture from the warm North Atlantic Drift.

## (b) Oceans and Resources

The oceans have always been a great source of food and other products of value to man. The animals and plants of the sea constitute a vast resource from which man can derive food, fertilizers for agriculture and raw material for industry. Fish and other marine animals form a rich source of food and nutrition for man. With the progress of human society and the increasing population, man's dependence on sea for other products has increased. Fishes now make up more than 10 per cent of the total animal protein that human consume.

## (c) Oceans and Mineral Resources

Oceans are the store house of a large number of useful metallic and non-metallic minerals. Foremost among the minerals are the petroleum deposits of the continental shelves. In the energy hungry world, they are the most sought-after resources. Vast deposits of petroleum have been found in many places such as in the North Sea, off the coast of South California and Texas, in the Mediterranean Sea, Persian Gulf, Bombay High in the Arabian Sea. The common salt or sodium chloride is extracted from sea water. Apart from salt, magnesium and bromine have long been extracted from sea water. The mineral wealth of the seas also includes metals. All the metallic elements are present in the seawaters in some degree. However, waters and sediments of ocean are heavily saturated with such metals as zinc, copper, lead, silver and gold, especially in the volcanic region of the oceanic ridge. The technology to exploit these minerals has not yet developed. The most significant are mineral nodules found on the deep-sea floor. The important ones are phosphorites and manganese nodules.

## (d) Ocean and Energy

The energy resources of the oceans are of various types - tidal power, geothermal energy and energy from the ocean temperature. Tidal energy was in use even in the 12th Century. Water wheels driven by the tides were used for grinding grain. Today, efforts are being made to harness the energy to run electric generators. There are difficulties in the. use of tidal power because of the irregularities of tides, However, a few tidal power stations are working in Russia, France and China.

## (e) Ocean Transportation and Trade

Ocean were originally considered as barriers but today they act as natural link among continents and nations of the world. They provide natural highways at low cost for international trade. They facilitate movement of bulky goods. The water is buoyant and needs less motive power. Oceans are a great boon to international trade.

## SUMMARY OF THE CHAPTER

*All living organisms on the earth depend on water. About 71 % of the earth's surface is covered* by water. The earth is the only known planet in the solar system with abundant water. The oceans are the single largest continuous body of water encircling land. The oceans contain 97.2% of the world's water. There are four oceans - the Pacific oceans, the Atlantic oceans, the Indian ocean and the Arctic ocean. The ocean floor which once was considered to be flat has variety of features such as continental shelf; continental slope, abyssal plains and the deeps. Pacific Ocean is the largest ocean. It comprises of thousands of islands. The greater part of the ocean comprises of the deep seas. Mariana trench in the Pacific Ocean is the deepest known part of the ocean with a depth of 11022 metres. The Atlantic Ocean is almost half the size of the Pacific Ocean. The world's widest shelves like Dogger Bank and Grand Bank are found here. The largest continuous Mid Atlantic Ridge is the important feature of the Atlantic Ocean. Indian ocean is smaller than the other two oceans. The temperature of the surface water of the oceans varies from one part of the ocean to the other. It is generally high near the equator and low near the poles. There is variation in the vertical distribution of temperature too Oceans are of great importance to man. They influence the climate of the earth's surface 'and provide rich source of marine food and minerals. They are also helpful in international trade by providing free highways.

## EXERCISE

### MCQ

1. Where is the deepest part of world's ocean located?
   (a) Arctic Ocean (b) Atlantic Ocean
   (c) Indian Ocean (d) Pacific Ocean
   **Answer** (d).

2. Which of the following oceans has the most coral reefs?
   (a) Arctic Ocean (b) Atlantic Ocean
   (c) Pacific Ocean (d) Indian Ocean
   **Answer** (c).

3. Which of the following oceans holds almost 50% of total water on the planet?
   (a) Pacific Ocean (b) Atlantic Ocean
   (c) Indian Ocean (d) Arctic Ocean
   **Answer** (a).

4. Match the seas with the coastal countries?

| Sea | Country |
|---|---|
| 1. Red Sea | A. China |
| 2. Black Sea | B. Russia |
| 3. Yellow Sea | C. Turkey |
| 4. White Sea | D. Saudi Arabia |

(a) 1 - C; 2 - D; 3 - A; 4 - B (b) 1 - D; 2 - C; 3 - A; 4 - B
(c) 1 - D; 2 - C; 3 - B; 4 - A (d) 1 - D; 2 - A; 3 - C; 4 - B

**Answer (b).**

5. Which of the following oceans has the most trenches or deeps?
   (a) Atlantic Ocean (b) Indian Ocean
   (c) Arctic Ocean (d) Pacific Ocean

   **Answer (d).**

## Review Questions

1. Describe the important relief features of the ocean floor with the help of a diagram.
2. Distinguish between the following terms: (a) Continental shelf and continental slope. (b) Submarine trench and submarine Ridge.
3. Describe the difference between a seamount and a guyot.
4. Explain the importance of continental shelf to humans.
5. Write short notes on: (a) Submarine canyons (b) Continental rise.
6. Define the term salinity and how is it expressed?
7. Why does temperature of ocean decrease with depth?
8. What are tides? How are they caused?
9. Distinguish between spring tide and neap tide with the help of a diagram.
10. Give reasons to account for the following. (a) Spring tides occur on new moon and full moon. (b) In the lower latitudes the eastern sides of the land masses are warmer than the western sides. (c) In the higher latitudes the eastern sides of the landmasses are cooler than the western side.

# 8 STRUCTURE AND COMPOSITION OF ATMOSPHERE

- Understand the concept of atmosphere.
- Discuss the structure of atmosphere.
- Describe the composition of atmosphere.
- Discuss the importance of atmosphere.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of atmosphere so that the structure and composition of atmosphere can be learned.

## Introduction

You must have heard people, in the countryside, saying

"When sheep collect and huddle, Tomorrow will puddle!"

"If ants march in a straight line, expect rain"

Phrases like 'a cold morning', 'sunny day', 'cloudy day' and rainy day refer to the weather. Weather refers to the state of atmosphere at a particular place at any given time denoting the short-term variations of atmosphere in terms of temperature, pressure, wind, moisture, cloudiness, precipitation and other elements. Weather is highly variable from time to time, day to day and place to place. Weather is not constant. It is always changing within hours or a day.

On the other hand, climate is the average weather conditions of an area for a long period of time. The World Meteorological Organisation (WMO) has suggested data for a period of 30 consecutive years to be referred for calculating the climatic averages of various weather elements. Climate is constant. It is a permanent condition of a place.

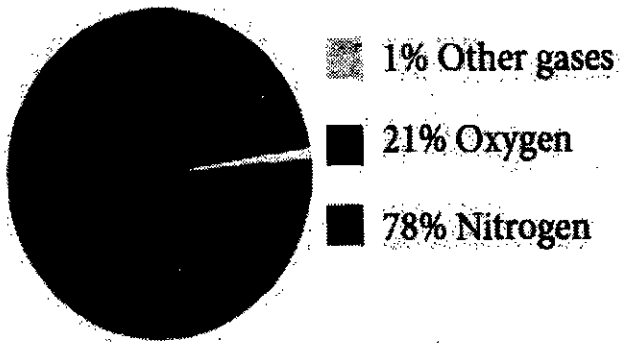



**Figure 6.1 Components of Atmosphere**

The ancient Greeks called the tilt of latitude as '***klima***', literally meaning 'slope' or 'inclination'. Then the earth was divided into seven latitudinal regions, called '***klimata***'. The word came into modern European languages as clime or 'climate', denoting the average weather condition.

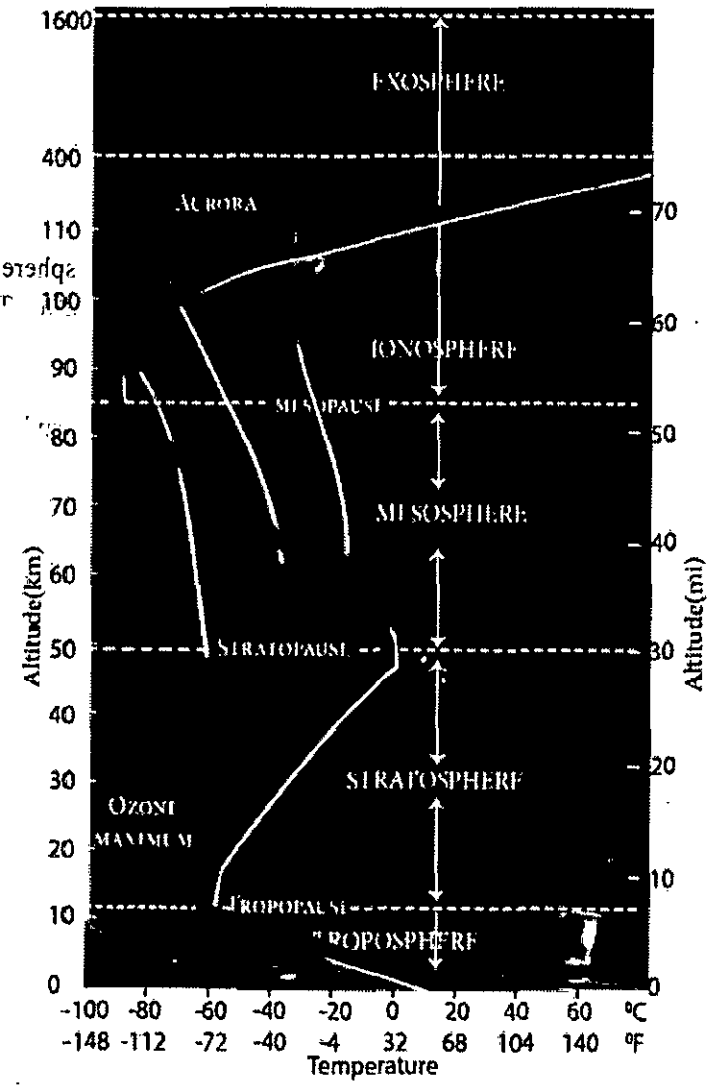



**Figure 6.2 Structure of the Atmosphere**

## Composition of the Atmosphere

The atmosphere is essential for the survival of all the organisms on the earth. The atmosphere is a blanket of gases and suspended particles that entirely envelope the earth. It extends outward over thousands of kilometres from the earth's surface.

Water vapour, aerosols and tiny solid particles occur in varying quantities as suspended material. These are responsible for weather phenomena as they have ability to absorb and release heat energy.

The atmosphere is composed of mixture of many gases, water vapour and other solid particles. The major components are nitrogen (78%), oxygen (21%) and other gases (1%). Argon, Carbon dioxide, Neon and the other gases found in the atmosphere (Figure 6.1).

## Layers of the Atmosphere

The atmosphere is divided into five distinct layers (Figure.6.2) based on the temperature variations. They are,

1.Troposphere

2.Stratosphere

3.Mesosphere

4.Ionosphere( Thermosphere) and

5.Exosphere

## Troposphere

The troposphere( Figure 6.2) is the lower most layer of the atmosphere. It extends approximately to a height of 8 km from the poles and 18 km from the equator. The height of the troposphere changes seasonally also. It increases during summer and decreases during winter.

All weather phenomena occur in this layer as it has dust particles and water vapour. This layer has clouds which produce precipitation on the earth. The Sun's rays directly fall on the earth and then they are reflected back into the atmosphere. The temperature decreases in the troposphere with increase in altitude at the rate of 1 ° C for 165 metre or 6.5 ° C for every 1000 metres of ascent. This is known as **lapse rate of temperature.** This is the densest layer as it contains 70 to 80 percent of gases. The outer boundary of the troposphere is called tropopause, which is about 1.5 kilometre thick.

## Stratosphere

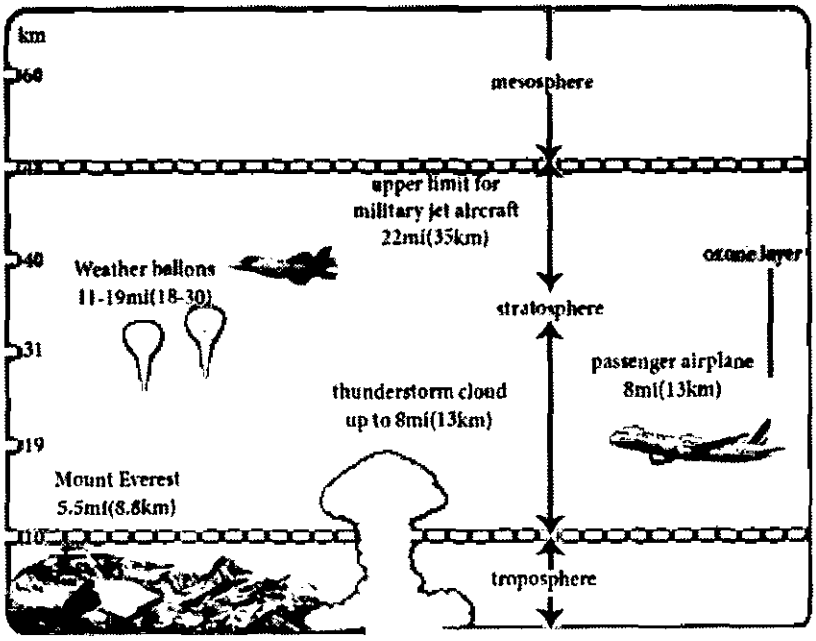



Figure 6.3 Stratosphere

It is the second layer of the atmosphere found above the troposphere. It approximately extends up to a height of 50 km from the earth's surface. Temperature is constant up to a height of 20 km and increases gradually up to the stratopause where temperature is nearly -4° C. The lower part of this layer is highly concentrated with ozone gas which is called as **'ozonosphere'.**

It prevents the ultra-violet rays from the Sun to enter into the lower part of the atmosphere as the rays are highly harmful it causes skin cancer and other ill effects to living organisms. But the ozone layer safeguards the life on the earth.

## Mesosphere

The mesosphere is the third layer of the atmosphere found approximately up to a height of 85 km above the surface of the earth. It is the coldest layer of the atmosphere. The temperature decreases with increase of altitude due to the absence of ozone. Its upper boundary is called **mesopause** where temperature reaches 2908C. Luminous noctilucent clouds form here due to the presence of cosmic dust. Meteors falling from the space get burned in this layer. It is because when meteors hit the air, the air gets compressed and heated up causing meteors to burn out.

## Ionosphere (Thermosphere)

The ionosphere is the fourth layer of the atmosphere extending approximately up to a height of 400 km. The temperature increases rapidly up to 1,0008C. It is due to the absorption of very short wave and high energy solar radiation by the atoms of hydrogen and oxygen gases. When light energy is transformed into heat energy, some gas molecules lose or gain electrons and become the charged particles called ions. The charged particles forming the lower part of the thermosphere as a zone, is called Ionosphere (Figure 6.4). These ionised particles create auroras at higher latitudes. Ionosphere can reflect radio waves back to the earth. This facilitates long distance wireless satellite communication. The credit of discovering ionosphere goes to Hennelly and Heaviside.

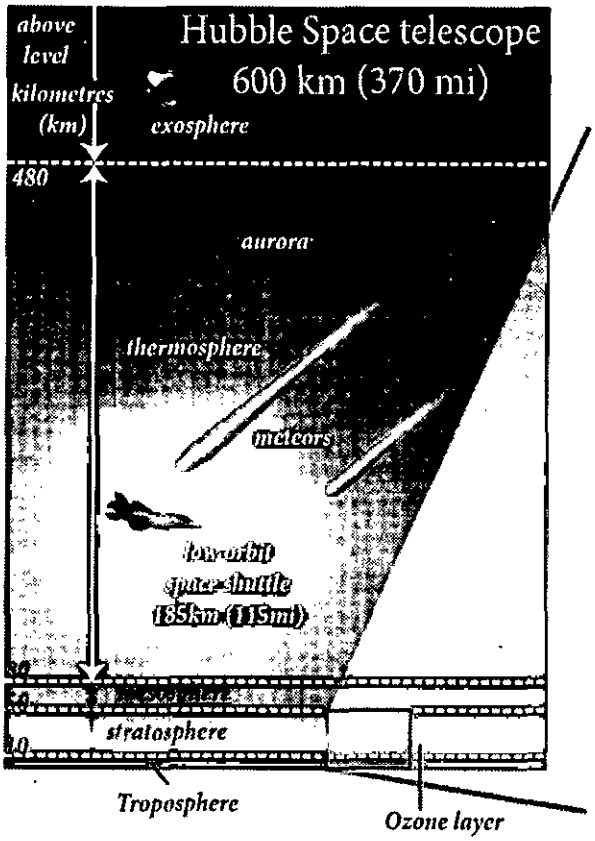



Figure 6.4 Thermosphere

## Exosphere

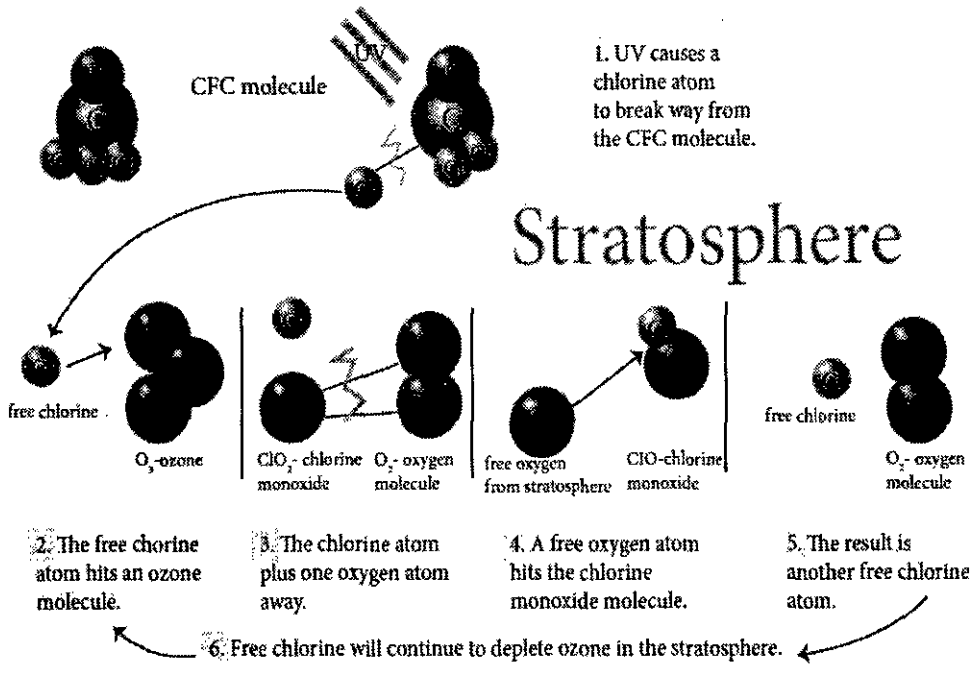
The upper most layer of the atmosphere which extends into the outer space from above 400 km up to 1600km. It has rarefied contents. It contains mainly oxygen and hydrogen atoms. These atoms can travel hundreds of kilometres without colliding with one another. Thus, the exosphere has no longer behaves like a gas. The temperature increases with increase of altitude and it ranges as high as 1650 ° C. The gravitational pull is minimal in this layer. This layer gradually merges with the space.

## Ozone and Ozone Depletion

Ozone (O3) is form of oxygen that combines three atoms into each molecule. It absorbs and filters the harmful ultraviolet B radiation coming from the sun. This way the ozone layer protects all life on earth. However, ozone is harmful when it develops near the ground. It causes health problems like asthma and other respiratory illness.

**Ozone Depletion:** A steady decline in the concentration of ***ozone*** in the earth's stratosphere (the **ozone layer**) is called ozone depletion.

**Ozone depletion** occurs when chloro fluoro carbon (CFC) and halon gases, formerly found in aerosol spray cans and refrigerants are released into the atmosphere and they cause chemical reactions that break down **ozone** molecules and reduce the concentration of them. Nitrogen oxide released by emitted by supersonic aircrafts can also destroy the ozone molecules to break down. Ozone-depleting substances are present throughout the stratospheric ozone layer because they are transported great distances by atmospheric air motions. The severe depletion of the Antarctic ozone layer known as the "ozone hole" occurs because of the special atmospheric and chemical conditions that exist there and nowhere else on the globe. The very low winter temperatures in the Antarctic stratosphere cause polar stratospheric clouds (PSCs) to form. Special reactions that occur on PSCs, combined with the relative isolation of polar stratospheric air, allow chlorine and bromine reactions to produce the ozone hole in Antarctic springtime.



Satellite images of the earth over last decades observed that the atmospheric ozone layer is getting thinner. On October 2, 2015, the ozone hole was recorded to its maximum size of **28.2 million sq.km** over Antarctica (Figure 6.5). The size of the ozone hole is larger than the size of continent of North America. The ozone holes over Antarctica allow the ultraviolet radiation to enter and cause global warming, skin cancer, eye cataract and even blindness.

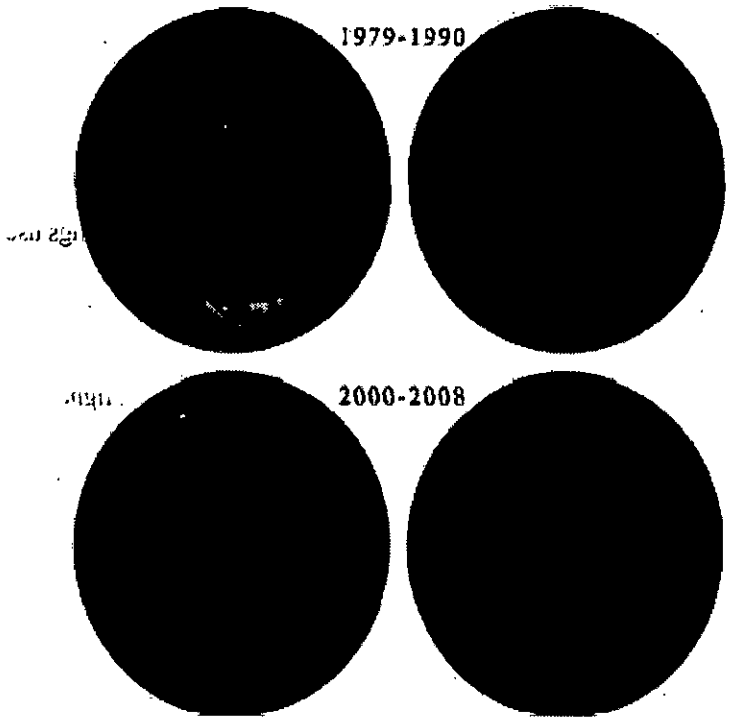



**Figure 6.5 Spread of Ozone hole**

**Depletion** of the **ozone layer** has consequences on human, animal, plants and microorganisms. This typically results from higher UV levels reaching us on earth. Research confirms that high levels of UV rays cause non-melanoma skin cancer.

To protect the ozone layer for our future generation, avoid using products which are emitting pollutants such as aerosol sprays, blowing agents for foams and packing materials, as solvents and as refrigerants.

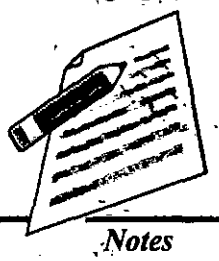
## Cyclic process of the atmospheric gases

The cycle of main gases found in the atmosphere is given below:-

(a) Carbon cycle (b) Oxygen cycle (c) Carbon dioxide cycle (a)

## Carbon cycle

1. The element of carbon is present in the atmosphere in the form of carbon dioxide. The source of carbon for all living beings is atmosphere.
2. Green plants receive carbon dioxide from the atmosphere which is used for making food with the help of the sun light. This is called photosynthesis. By this process the plants create 'carbohydrates' in the form of food. Carbohydrates thus, produced by plants are used as a food by all Living beings.





3. Carbon dioxide gets dissolved in the water bodies and gets collected in the form of lime on the earth. After dissolution of lime stone, carbon dioxide again reaches in the atmosphere. This process is called carbonization. In this way carbon dioxide goes on moving between the atmosphere and waterbodies of the earth.
4. Carbon dioxide produced by breathing of plants and animals, disintegration of plants and animals and by burning fossil fuels like coal, petroleum and natural gas again returns back to the atmosphere. In this way, the process of receiving of carbon-dioxide from the atmosphere and going back to it from the surface of the earth keeps on going continuously. It keeps the balance between the carbon and biosphere.

## (b) Oxygen Cycle

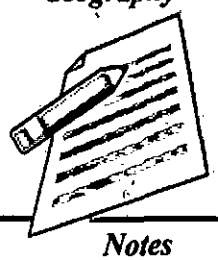
1. The amount of oxygen in the atmosphere is about 21% and all living beings use oxygen present in the atmosphere for breathing.
2. For the burning of fuels like wood, coal, gas etc. oxygen is essential and carbon dioxide gas is produced by their burning.
3. The main sources of oxygen in the atmosphere are plants and trees. Higher the number of trees and plants, the availability of oxygen will be more.
4. Oxygen produced through photosynthesis by the green plants goes back to the atmosphere. In this way the process of oxygen cycle goes on continuously.

## (c) Nitrogen cycle

Nitrogen is an important element for life. The amount of nitrogen gas in the atmosphere is 78%. The main source of nitrogen are nitrates present in the soil. From the atmosphere, nitrogen enters into bio components through the biological and industrial processes. Nitrogen compounds from the plants are transferred to the animals through food chain. The process of transformation of nitrogen gas of the atmosphere into nitrogen components is called nitrogen Fixation. Bacteria's decompose dried plants and dead animals. It produces nitrogen gas which goes back into the atmosphere. In this way the cycle of nitrogen gas is completed.

## SUMMARY

The atmosphere is made up of different kinds of gases which surrounds the earth. Two important gases nitrogen and oxygen together are found on the 99% part of the atmosphere. The atmosphere is composed of troposphere, stratosphere, mesosphere, ionosphere and exosphere. All weather-related incidents take place in the troposphere whereas stratosphere is considered to be ideal for flying of aeroplanes. Radio waves are reflected back on the earth from the ionosphere. This has made possible the radio broadcast. The element of carbon in the atmosphere is found in the form of carbon dio-oxide gas. The main sources of carbon are petroleum, wood, coal and gases. The main sources of oxygen in the atmosphere are plants and trees. Oxygen is very important for breathing and for the burning of fuels. The main source of nitrogen for the plants is nitrate present in the soil. Nitrogen gas is produced by decomposition of plants and animals and goes back to the atmosphere.





## EXERCISE

### MCQ

1. The boundary between troposphere and stratosphere is known as
   (a) tropopause (b) ionopause
   (c) stratopause (d) mesopause
   **Answer:** (a)
2. Ozone hole is
   (a) increase in the concentration of ozone
   (b) hole in the ozone layer
   (c) depletion of the ozone layer in the troposphere
   (d) depletion of the ozone layer in the stratosphere
   **Answer:** (d)
3. If an object is present at a distance of 5 km from the surface of the earth, it is present in
   (a) Troposphere (b) Thermosphere
   (c) Mesosphere (d) Stratosphere
   **Answer:** (a)
4. The uppermost layer of atmosphere is known as
   (a) Ionosphere (b) Troposphere
   (c) Stratosphere (d) Exosphere
   **Answer:** (d)
5. Which among the following does not cause pollution?
   (a) Automobiles (b) Thermal power plant
   (c) Hydro-electric plant (d) Nuclear power plant
   **Answer:** (c)

### Review Questions

(1) Which is called atmosphere?
(2) Distinguish between troposphere and stratosphere.
(3) State the importance of ozone gas.
(4) Explain the cycle process of nitrogen gas.
(5) Explain the oxygen cycle with the help of a diagram.
(6) Describe the structure of the atmosphere with the help of a diagram.
(7) Write notes on the following. (i) Carbon cycle. (ii) Importance of atmospheric is gases. (iii) Water vapour. (iv) Dust particles.

# 9 ATMOSPHERIC PRESSURE AND WINDS

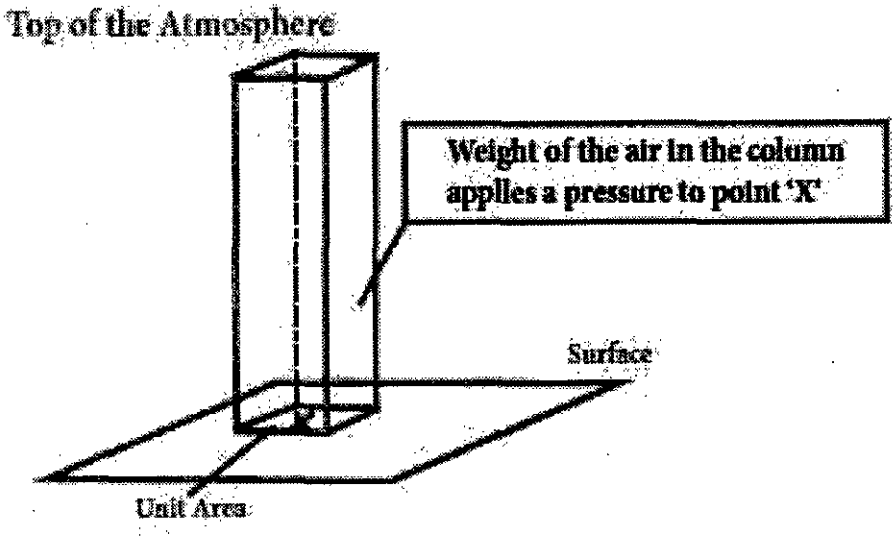
- Understand the concept of winds.
- Discuss the types of winds.
- Describe the concept of atmospheric pressure.
- Discuss the distribution of winds.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of atmospheric pressure and winds so that the types and distribution of atmospheric pressure and winds can be learned.

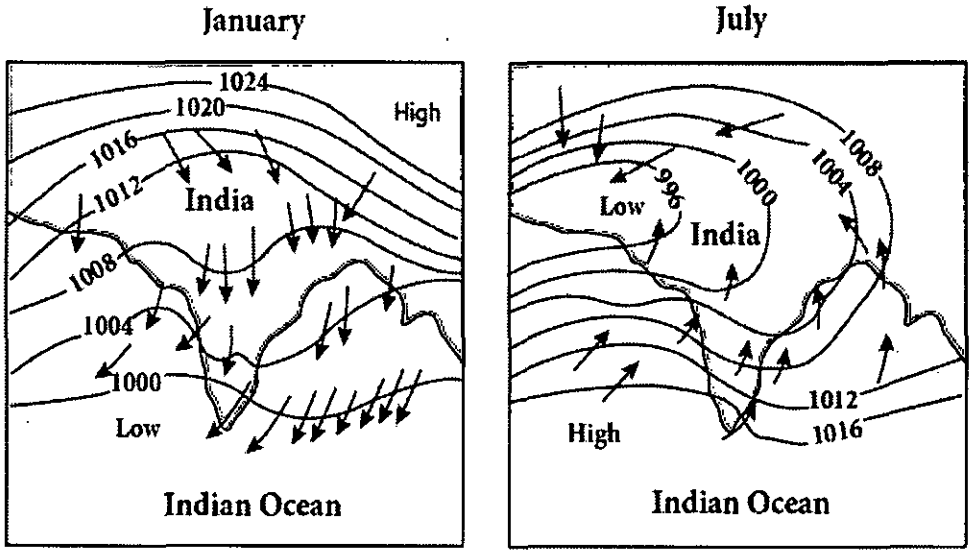
## Introduction

Atmospheric pressure is defined as the force per unit area exerted against a surface by the weight of the air molecules above the earth surface. In the Figure below (Figure 6.10), the pressure at point 'X' increases as the weight of the air increases. The atmospheric pressure is not distributed uniformly over the earth. The amount of pressure increases or decreases, according to the number of molecules, that exerts the force on the surface.




When temperature of the air increases, the air expands and reduces the number of molecules over the unit area. It leads to reduction in pressure. Similarly, when the temperature falls, the air contracts and the pressure increase. Therefore, the temperature and atmospheric pressure are inversely related.

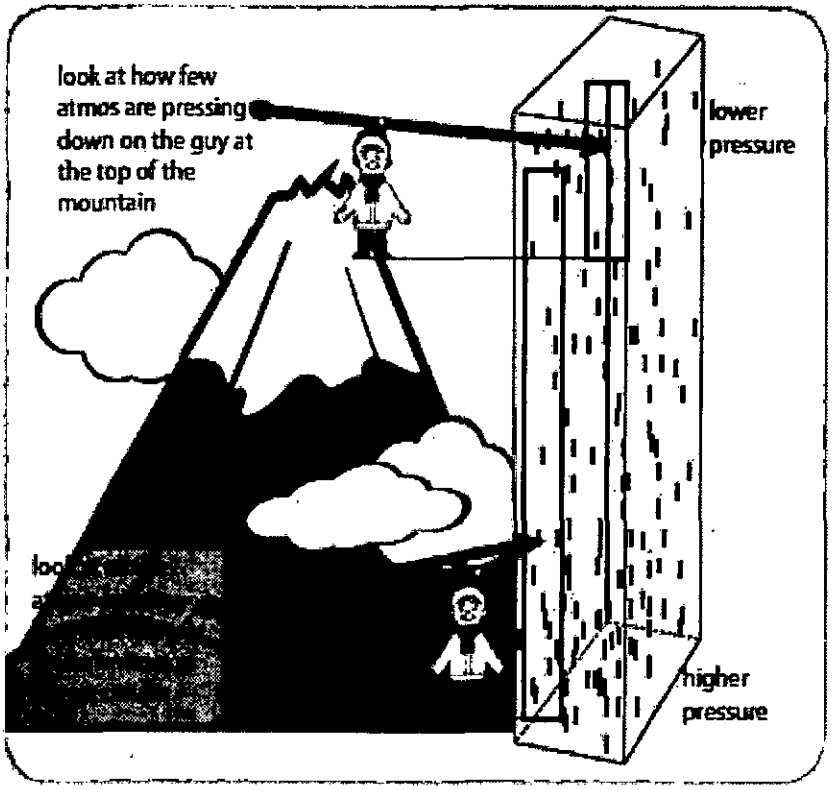
Atmospheric pressure is measured by an instrument called 'Barometer'




## Vertical Distribution of Atmospheric Pressure

The relationship analysis between altitude and atmospheric pressure is very peculiar. The upper atmosphere is thin and less dense. The pressure at sea level is highest and keeps decreasing rapidly with increasing altitude because of the progressive reduction of the mass above the point where it is measured (Figure 6.12).

Relationship between Standard Pressure and Altitude

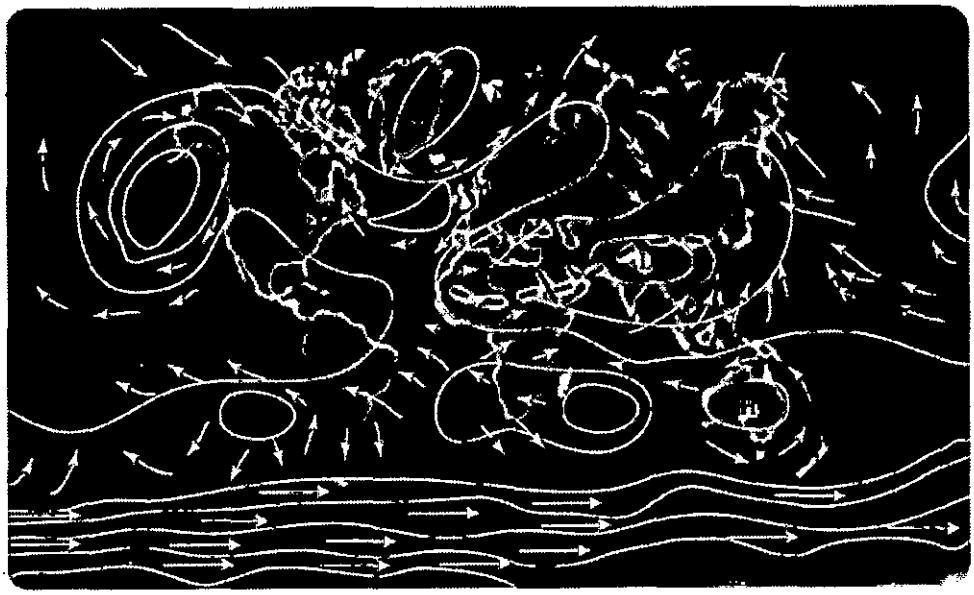


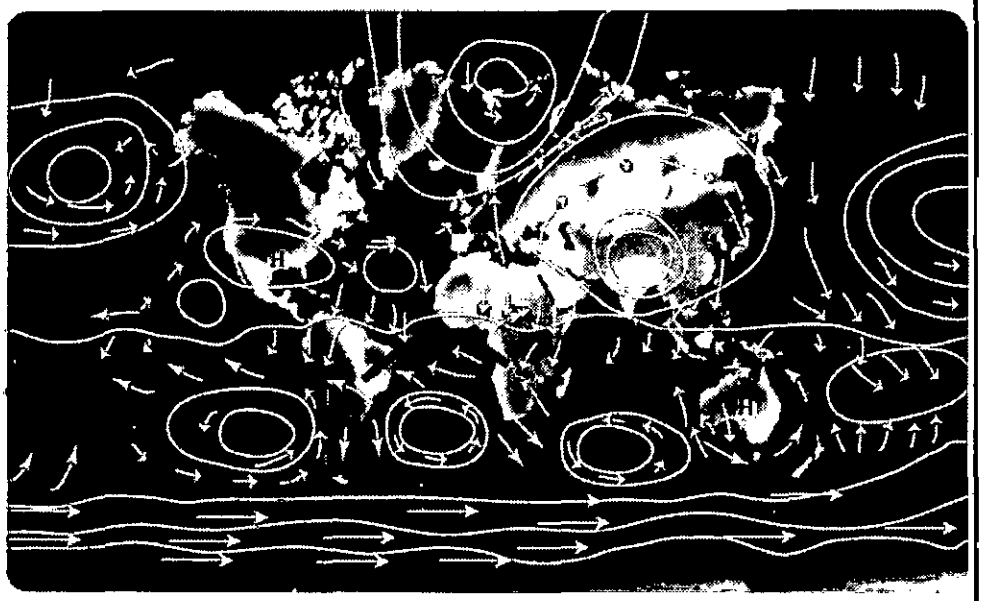
| Altitude in m | Atmospheric pressure in m b |
|---|---|
| Sea level | 1013.25 |
| 1,000 | 898.76 |
| 2,000 | 795.01 |
| 3,000 | 701.01 |
| 4,000 | 616.60 |
| 5,000 | 540.48 |
| 10,000 | 264.0 |

## Horizontal Distribution of the Atmospheric Pressure

When the air gets heated it expands, becomes light and rises vertically. As air rises, the pressure it exerts on the earth surface is reduced, causing a low-pressure area (Figure 6.13).

On the other hand, cool air is dense and heavy. As a consequence, it sinks vertically. It results in additional weight and pressure which cause a high-pressure area to occur on the ground.





## Coriolis Effect

The rotation of the earth affects the moving objects on the earth surface. Free moving objects, affected by the rotation of the earth, do not follow a straight line. In the northern hemisphere they drift towards right and towards left in the southern hemisphere. A car travelling down a straight road at 95 km/hr in northern hemisphere would drift to the right of the path if the friction between surface and tyre is absent. The tendency is called as Coriolis Effect as it was discovered by Coriolis. This is the reason why racket launching stations are located on the east coastal areas. Example: Sriharihota, French Guyana.

## Pressure Belts of the Earth

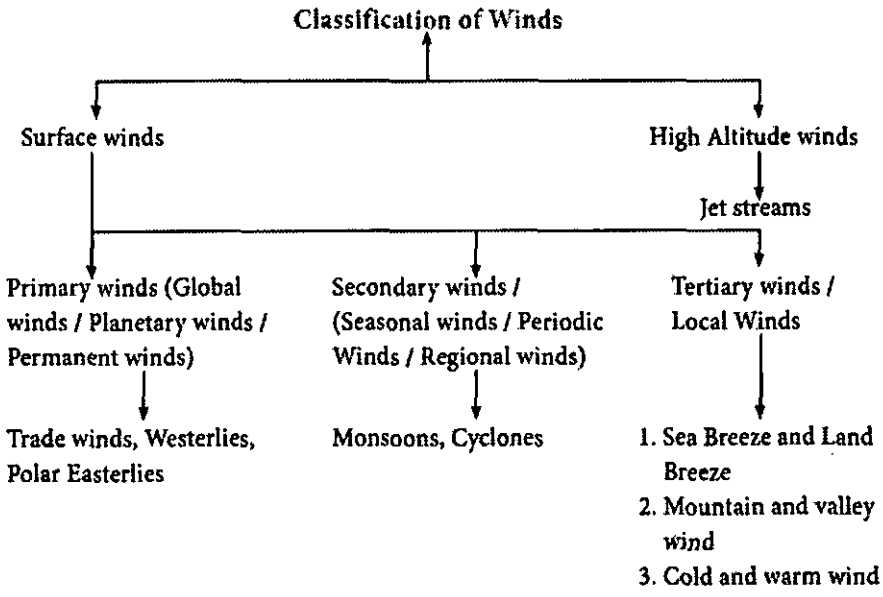
The atmospheric pressure belts envelope on the surface of the earth. They are equatorial low-pressure belt, sub-tropical high-pressure belts, sub polar low-pressure belts and polar high-pressure belts (Figure 6.13).

## Wind Systems

Wind is the horizontal movement of air molecules from areas of high pressure to areas of low pressure to maintain the atmospheric equilibrium. The wind always moves perpendicular to isobars. If the earth did not rotate, the winds would blow in a straight path. Then the rotation of the earth results in Coriolis effect and it deflects the direction of the wind. Wind direction is identified by an instrument called Wind Vane and wind speed is measured by Anemometer.

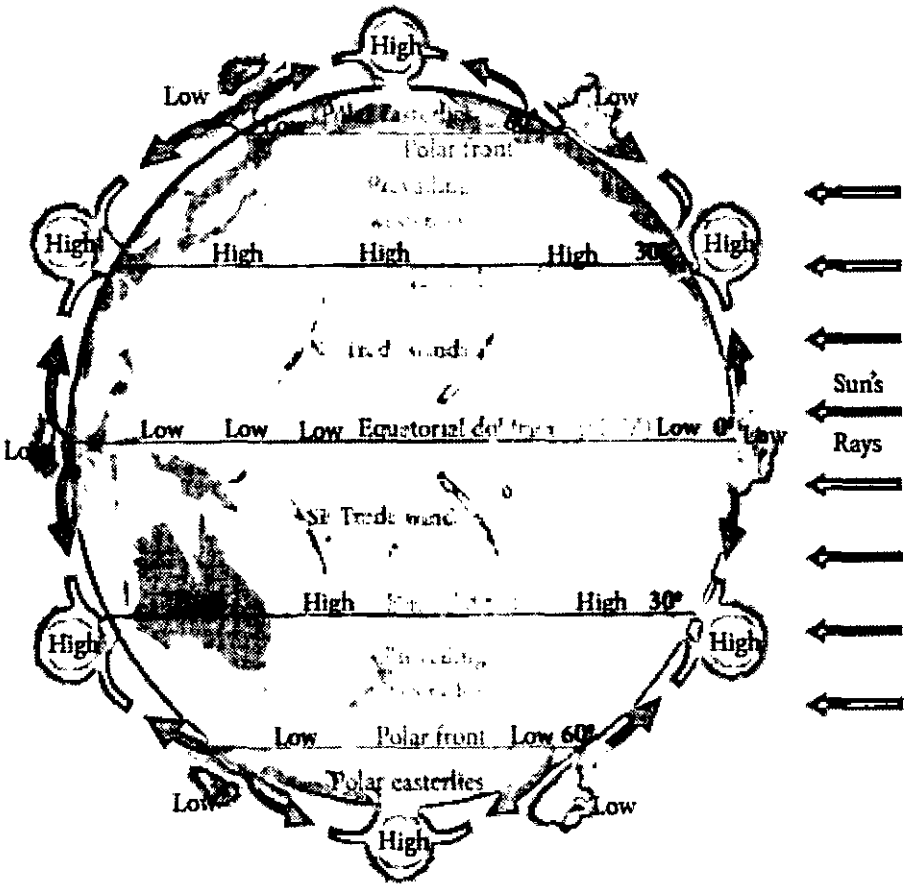
## Types of Winds

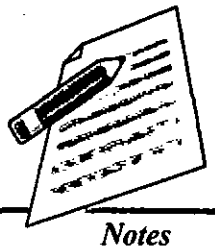
Winds are classified based on the nature and area of influence as follows;




## General Atmospheric Circulation, Pressure Belts and Primary Wind System

From the equator to the poles, each hemisphere has four pressure belts and totally there are seven belts on the globe. The pressure belts lead to formation of primary wind system as follows (Figure 6.14):







## a. The equatorial low-pressure belt (between 58oN and 58oS):

This is the region of calm, weak and changeable winds. Due to the high temperature over this region, the air gets heated expands and become lighter and rises upward and creates low pressure over the region. This region is a belt of calm and referred to as the 'Doldrums'. The winds blow from the sub-tropical high-pressure belt towards the equatorial low-pressure belt. Due to Coriolis Effect these winds are deflected to the right in the northern hemisphere and to the left in the southern hemisphere. As winds are named after the direction from which they originate they are called as the North East and South east trade winds. As the winds favoured trading ships, they are called as 'Trade winds.

## b. The sub-tropical high-pressure belt (25o to 35o N and S):

Air begins to cool when it reaches higher altitude over equatorial region and flows towards the poles. This wind collides with the wind coming from the polar region at higher altitude and subsides down over sub-tropical latitudes. This leads to formation of high-pressure belt along the sub-tropical region. It is said that to avoid the slowing down of ship due to high pressure the horses were thrown into the sea. So, this belt is called as 'Horse latitude'. The sinking air bifurcated in to two branches towards the equator and poles, they are called as trade winds and westerly respectively. Westerlies flow towards the pole from sub tropics and turn towards right and left in northern hemisphere and southern hemisphere respectively.

## c. The sub polar low-pressure belt (50o to 60o N and S):

The warm westerly wind from sub-tropical region moves towards the pole and collide with the cold polar easterly wind from polar high-pressure region and raises up to form sub polar low-pressure belt.

## d. Polar high-pressure belt (80o N and S to pole):

The constant low temperature at the poles due to inclined solar radiation and reduced insolation leads to the formation of polar high-pressure belt on both poles.

The high pressure on the surface always coincides with the low pressure at higher altitude while the low pressure on the surface always coincides with higher pressure on the higher altitude. High pressure always has divergence of air masses from the centre but low pressure has convergence of air.

## Basis of Formation of Pressure Belts

There are two important bases on which the pressure belts are formed. They are;

a. Temperature: The equatorial low pressure and polar high-pressure belts are formed due to high and low temperature respectively. So, they are called as 'Thermally formed pressure belts.

b. Dynamism: The sub-tropical high and sub polar low-pressure belts are formed due to movement and collision of wind system. So, they are called as 'Dynamically formed pressure belt system'.

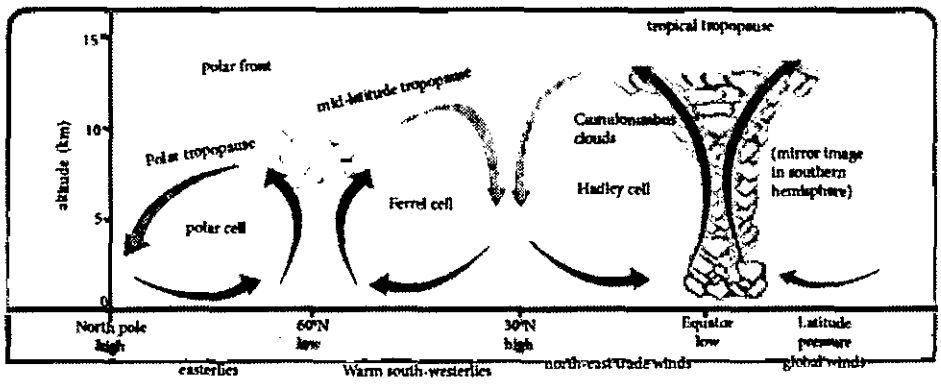



**Figure 6.15** Meridional circulation

## Meridional Cell System

The cell along with trade winds, equatorial low and sub-tropical high-pressure belts is called as 'Hadley cell', meanwhile the cell formed by westerly wind along with sub-tropical high and sub polar low-pressure belt is called 'Ferrell's cell'. The cell at polar formed by polar easterlies with polar high and sub polar low-pressure belt is called as 'Polar cell' (Figure 6.15).

## ITCZ – Inter Tropical Convergent Zone

The region where both trade wind systems meet is known as 'Inter Tropical Convergent Zone'.

## Shifting of Pressure Belts and Primary Wind System

These pressure belts and primary wind systems are dynamic in character as they shift 5° north and 5° south from their position along with the apparent movement of the sun.

## Secondary Wind System

Both monsoon and cyclones are considered as secondary or regional wind systems.

## Monsoons

The word 'Monsoon' is derived from the Arabic word, 'Mausim' which means 'Season'. Monsoons are seasonal winds which reverse their direction due to unequal heating and cooling of the land and the water.

## Mechanism of Monsoon

The land absorbs more heat energy during summer, which leads to the formation of low pressure over continent. But the ocean will have relatively lower temperature than the continent leading to the formation of high-pressure system over ocean. So, the wind blows from sea to land during summer season.

Meanwhile the land reradiates more heat energy to space during winter leading to the formation of high pressure above the continent. But the ocean will have relatively higher temperature than the continent leading to formation of low-pressure system over ocean. So, wind blows from land to sea during the winter season. This mechanism has an important effect on rainfall received over the region.

## Nature of Monsoon System

There are three distinct characteristics related to monsoon wind system which differentiates it from other wind systems. They are;

a. Minimum 1608 reversal of wind direction between seasons.
b. They affect a large part of the continents and oceans.
c. The formation of low- and high-pressure systems over land and water and their interchange between the seasons.

Monsoon system is classified into two groups based on the location. They are;

a. Asian Monsoon
b. South Asian Monsoon

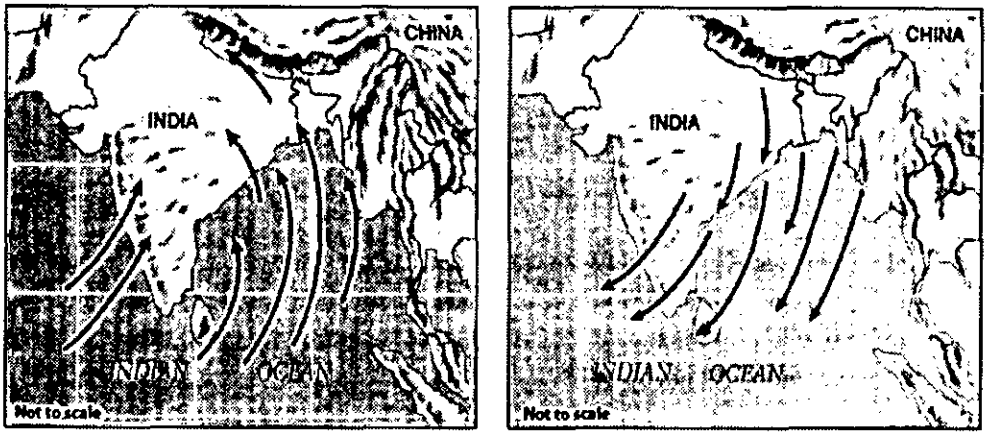
## a. Asian Monsoon

The Asian monsoon system is divided into two components based on season it flows. The presence of high temperature with low pressure in the lake Baikal region and low temperature with high pressure in the Aleutian islands region leading to flow of wind from Pacific Ocean to interior part of Asia during summer is called 'Summer Monsoon of Asia'. This leads to rainfall in the east coast of Asia.

Meanwhile, in winter the low temperature and high pressure in the Lake Baikal region and high temperature and low pressure in the Aleutian Island region leading to flow of wind from Central Asia to Pacific Ocean is known as 'Winter Monsoon of Asia'. As the wind system flows off shore, the rainfall does not occur in the continent of Asia except western coast of Japan.

## b. South Asian Monsoon

South Asian Monsoon includes the countries in the southern part of Himalayas, that is India, Pakistan, Bangladesh, Sri lanka, Maldives, Nepal and Bhutan. This monsoon system has been classified into two groups based on the direction of origin of wind namely south west monsoon and north east monsoon (Figure 6.16).




Summer Winter



## South West Monsoon

During summer the Indian peninsula is heated more than the sea around it. Intense low pressure is formed in the region of Peshawar of Pakistan. At the same time, the Indian Ocean has higher pressure due to relatively low temperature. So, the wind blows from Indian Ocean towards South Asia as Southeast Winds. The wind turns towards right due to Coriolis Effect and blows as south west winds which bring heavy rains around four months of the year. This is known as south west monsoon in Indian Sub-continent. This wind system bifurcates into two branches as Arabian Sea branch and Bay of Bengal branch.

## Arabian Sea Branch

The Arabian Sea branch strikes the Western Ghats at perpendicular direction and rises over it. The orographic effect by the Western Ghats results in heavy rainfall in the windward side and low rainfall in the leeward side. So, the west coast of India receives high rainfall when compared to the eastern side of the Western Ghats. Kerala is the first state to receive rainfall from the south west monsoon in India, which occurs during first week of June. Then, the wind gradually moves towards the north of the western coast and leads to gradual development of the monsoon in parts of Karnataka, Goa, Maharashtra, Gujarat and Rajasthan. The wind further advances towards foot hill of the Himalayas and creates orographic rainfall in the Himalayan states, Punjab and Haryana. The other part of the Arabian Sea branch moves towards the east and results in onset of monsoon in Uttar Pradesh and Bihar. Here, it unites with the Bay of Bengal branch and leads to heavy rainfall and flood.

## Bay of Bengal Branch

Bay of Bengal branch flows from south west which results in orographic rainfall in Sri Lanka and reaches Andaman and Nicobar Islands and results in orographic rainfall. Indira points in the Great Nicobar is the first place which receives rainfall during south west monsoon in India during middle of May. The wind flows parallel to the east coast of India and Eastern Ghats. So, Coromandel Coast of India doesn't get enough rainfall during south west monsoon. The wind strikes Arakanyoma Mountain in Myanmar and results in heavy rainfall in western coast of Myanmar. The wind funnels towards north eastern part of India after deflected by the Arakanyoma Mountain in Myanmar. This wind strikes Meghalaya plateau which leads to heavy rainfall in Bangladesh and North eastern part of India. Mawsynram, the wettest place (highest annual rainfall) in the world, is located in the windward side of Meghalaya plateau.

The wind further advances towards the Himalayas where it creates heavy rainfall in the southern slopes. This leads to flood in River Brahmaputra. The wind gradually moves towards the west and results in onset of monsoon in Bhutan, Sikkim, West Bengal, Nepal and Bihar. It joins with Arabian Sea branch in Bihar and results in heavy rainfall and flood.

The south west monsoon gradually withdraws from south Asian continent due to apparent movement of the Sun towards the southern hemisphere. This is called as 'Withdrawal of South West Monsoon'.

## North East Monsoon

During winter the Indian Subcontinent becomes colder than the Indian Ocean. As a result, the wind blows from Northeast to South West direction. This is dry wind system and it does

not produce rainfall in the coastal region of south Asia except the Coromandel Coast of India and Sri Lanka.

## Mawsynram, world's wettest place!

''It was the kind of rain you wouldn't see anywhere else. We could barely see four feet ahead of us. We could touch the clouds, smell the clouds, and taste the clouds'' said a local resident! Yes, it is about Mawsynram which is located in Meghalaya's East Khasi Hills, with the cluster of about 1,000 homes. It holds the Guinness Record for "the wettest place on earth". The average annual rainfall is 11,861mm, according to the Guinness website.

However, the soil in the limestone plateau doesn't absorb water. "There is barely any forest cover, so a lot of erosion of top soil happens. All of it flows down into Bangladesh. The irony is that "the wettest place on earth" grapples with an acute water shortage after monsoon ends around October. Hence, people call world's rainiest place Mawsynram, which is also world's wettest desert. This is known as North East Monsoon or Retreating Monsoon in South Asia. Agriculture in India mostly depends on the rainfall brought by the monsoons. During the El Nino year the temperature of the ocean water increases. This weakens the high pressure over Indian Ocean thereby reduces the strength of south west monsoon over south Asia. However, during winter, it induces the low pressure over the ocean resulting in severe depressions and cyclones.

## Tertiary Winds

The tertiary winds are formed due to pressure gradients which may develop on a local scale because of differences in the heating and cooling of the earth's surface.

## Sea and Land Breezes

During daytime, land heats up much faster than water. The air over the land warms and expands leading to form low pressure. At the same time, the air over the ocean becomes cool because of water's slower rate of heating and results in formation of high pressure. Air begins to blow from high pressure over ocean to the low pressure over the land. This is called as 'Sea breeze'. During night time, the wind blows from land to sea and it is called as 'Land breeze' (Figure 6.17).

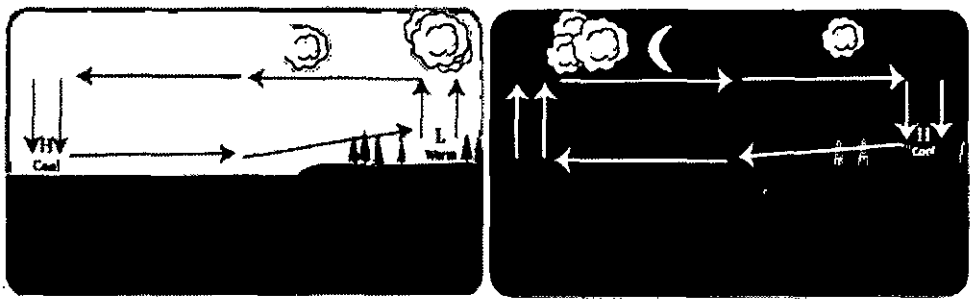


*Figure 6.17 Sea breeze and Land breeze*

Sea breeze and land breeze influence the movement of boats near the coastal region and fisher men use these winds for their daily fish catching. Fishermen go for fishing at early morning along the land breeze and return to the shore in the evening with the sea breeze.

## Mountain and Valley Breezes

A valley breeze develops during the day as the sun heats the land surface and air at the valley bottom and sides. As the air gets heated it becomes less dense and begins to blow gently up the valley sides. This is called as 'valley wind'. This process reverses at night leading to blow of wind from mountain top to valley bottom referred to as 'mountain wind' (Figure 6.18).

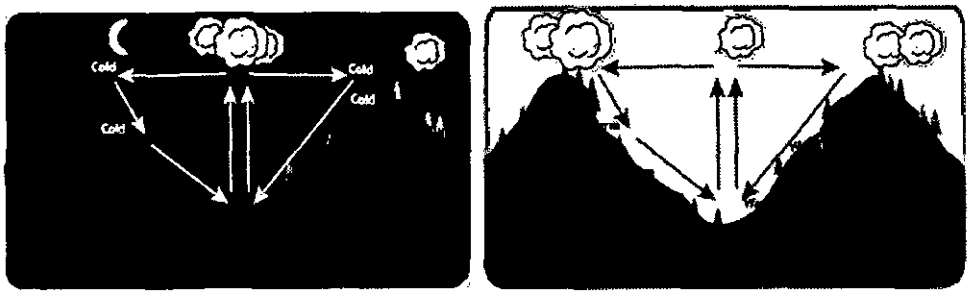



**Figure 6.18 Mountain and Valley breeze**

Mountain and valley wind systems influence the weather pattern of the mountain top and valley bottom.

Mountain top can be seen clearly at early morning and valley bottom at evening. But mountain top will be covered with clouds at evening due to rising of valley wind system and valley bottom would be covered by clouds at early morning due to arrival of mountain wind system. These clouds are sometimes called as 'fog' which is used for cultivation in the dry regions like Yemen.

## Local Winds

Local wind systems influence the weather pattern where ever they blow (Figure 6.19). Some important local winds are;

**Bora:** North easterly from eastern Europe to north eastern Italy

**Chinook:** Warm dry westerly off the Rocky Mountains

**Fohn:** Warm dry southerly off the northern side of the Alps and Switzerland.

**Harmattan:** Dry northerly wind across central Africa

**Karaburan:** 'Black storm' a spring and summer katabatic wind of central Asia

**Khamsin:** South easterly from North Africa to the eastern Mediterranean

**Loo:** Hot and dry wind which blows over plains of India and Pakistan.

**Mistral:** Cold northerly from central France and the Alps to Mediterranean.

**Nor'easter:** Strong winds from the northeast in the eastern United States, especially New England

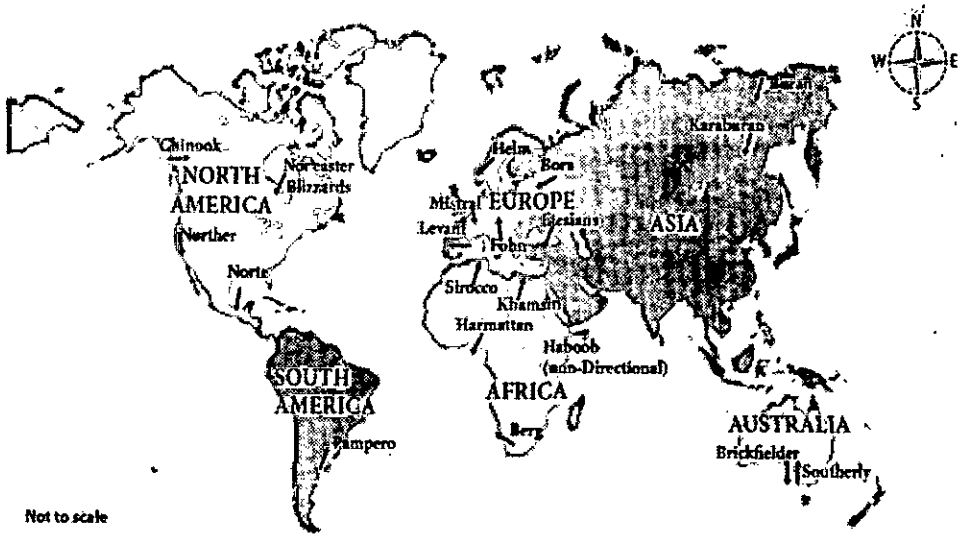
**Nor 'wester:** Wind that brings rain to the West Coast, and warm dry winds to the East Coast of New Zealand's South Island, caused by the moist prevailing winds being uplifted over the Southern Alps, often accompanied by a distinctive arched cloud pattern.

**Pampero:** Argentina, very strong wind which blows in the Pampa.

**Simoom:** Strong, dry, desert wind that blows in the Sahara, Israel, Jordan, Syria, and the desert of Arabia.

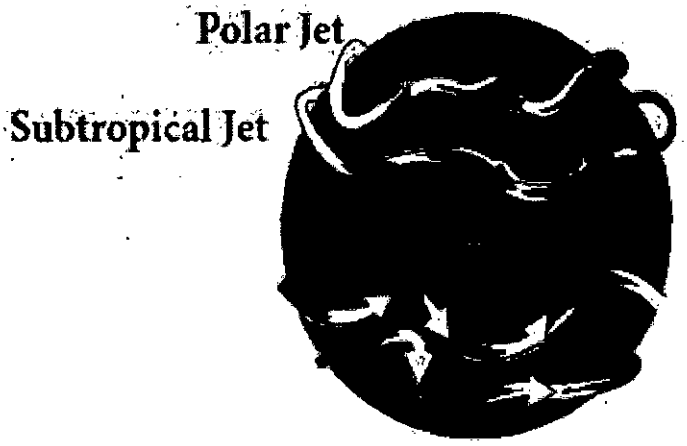
**Sirocco:** Southerly from North Africa to southern Europe.

**Zonda wind:** On the eastern slope of the Andes in Argentina.




## Jet Streams

Jet streams are high altitude westerly wind system blows at a height of 6 to 14 km, with very high speed up to 450 km/h in wavy form at both hemispheres. As they encircle the poles they are called as 'Circum polar wind system' (Figure 6.20).




Although the jet streams flow at higher altitude they also influence the surface weather pattern of the Earth.

## The Major impacts of Jet streams

**1. Creation of Polar vortex:** Polar westerly jet stream will carry cold polar air masses towards temperate region which creates severe cold waves in North America and Eurasia during winter.

**2. Sudden burst of South west monsoon:** Sudden withdrawal of polar westerly jet stream from Indian sub-continent to northern part of Pamir, leads to sudden burst of South west monsoon into Indian Sub-continent.

**3. Late and early *monsoon in South Asia:*** *Rate of with drawl of polar westerly jet stream* decides the onset of south west monsoon. Slower and faster rate of with drawl leads to late and early onset of south west monsoon.

**4. Intensity of monsoon rainfall:** The arrival of tropical easterly jet stream influences the intensity of south west monsoon. This leads to increasing intensity of rainfall during south west monsoon.

**5. Bringing rainfall to India by western disturbances:** Polar westerly jet stream carries rainy clouds from cyclones formed over Mediterranean Sea during winter towards India. These clouds pile up on the Himalayas and results in rainfall over the states of Punjab and Haryana. This assists in the cultivation of wheat in India.

**6. Development of super cyclone:** The condition at which the speed of the jet stream is transferred to tropical cyclone may leads to development of super cyclone.

## SUMMARY

Atmospheric pressure is the weight of the column of air at a given place and time. It is measured by an instrument called barometer. Unit of measurement of pressure is millibar. The distribution of atmospheric pressure varies both vertically and horizontally. It is shown on the maps through isobars which are the imaginary lines joining the places having equal air pressure. In high latitudes, atmospheric pressure is more than the pressure at low latitudes. The zonal character of horizontal pressure is commonly known as pressure belts. There are four pressure belts spread over the earth. They are equatorial low-pressure belt, sub-tropical high-pressure belts, sub-polar low-pressure belts and the polar highs. Thermal factor causes



difference in pressure. Pressure belts are not fixed, they shift northwards in summer and south wards in winter with the apparent movement of the sun. Pressure gradient is the difference in horizontal pressure between regions of high pressure and region of low pressure. The difference in air pressure causes movement of air called wind. There are wind systems that blow regularly on a daily pattern. Examples include the land and sea breezes, the mountain and valley breezes and winds warmed as a result of compression. There is a close relationship between pressure gradient and wind speed. Monsoon are seasonal winds while local winds below generally on diurnal basis. Air masses are horizontal large bodies of air which have uniform temperatures and moisture contents. The boundary line between two different air masses is called a front. Air masses and front cause temperate cyclones in mid-latitudes. Another type of cyclones are tropical cyclones which originate on tropical oceans and influence the coastal areas. Sometimes they turn violent and cause heavy loss to life and property.

## EXERGISE

### MCQ

1. What are westerly winds?
   a) Winds blowing from sub-tropical high-pressure areas to sub-polar low-pressure areas
   b) Winds that trade with each other
   c) Winds blowing from equatorial high-pressure areas to sub-tropical low-pressure areas
   d) Winds blowing from equatorial low-pressure areas to sub-tropical high-pressure areas

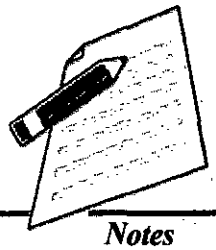
   **Answer:** a

2. Westerly winds of Southern Hemisphere _____
   a) weaker and maintain a constant direction than its counterpart in Northern Hemisphere
   b) are stronger and maintain a constant direction than its counterpart in Northern Hemisphere is
   c) are stronger but do not maintain a constant direction than its counterpart in Northern Hemisphere
   d) blow from equatorial low-pressure areas to sub-tropical high-pressure areas

   **Answer:** b

3. What are periodic winds?
   a) Westerly winds
   b) Winds that do not change their direction periodically with the change in season
   c) Winds that change their direction periodically with the change in season
   d) Trade winds

   **Answer:** c





4. Which of the following are examples of periodic winds?
   a) Gusts
   b) Windstorm
   c) Westerly winds
   d) Monsoons, land and sea breeze, mountain and valley breeze

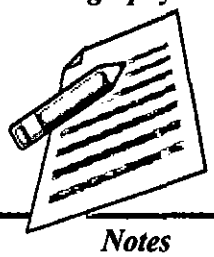
   **Answer:** d

5. A downburst is created by an area of rain-cooled air that _____
   a) after hitting the ground generates strong winds which spread in all directions
   b) don't hit the ground
   c) after hitting the ground generates extremely weak winds which spreads in all directions
   d) are short gusts

   **Answer:** a

## Review Questions

1. Answer the following questions in about 30 words each. (a) What is an atmospheric pressure? (b) How is atmospheric pressure measured? (c) What are the following? (i) Millibars (ii) Isobars. (d) What is the effect of altitude on air pressure?
2. Distinguish between the following in 50 words each: (a) Air current and wind. (b) Planetary winds and periodic winds. (c) Foehn and Mistral. (d) Katabatic and Anabatic Breezes.
3. Give reasons for the following in 100 words: (a) Low pressure is prevalent in sub-polar regions (b) Sea breezes blow during day time. (c) Winds change their direction in both the hemisphere.
4. Define the following: (a) Air mass (b) front.
5. What are temperate cyclones? How do they differ from tropical cyclones?
6. What is the role of coriolis force in the deflection of winds?
7. Explain the following terms: (a) Horse latitudes (b) Doldrums.
8. On an outline map of the world mark and label the following. (a) Prominent areas of low pressure in January. (b) Prominent areas of high pressure in July in Northern Hemisphere



*Notes*



# 10 HUMIDITY AND PRECIPITATION

- Understand the concept of humidity.
- Discuss the types of humidity.
- Describe the concept of precipitation.
- Discuss the concept of clouds.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of humidity and precipitation so that the types and distribution of humidity and precipitation can be learned.

## Introduction

Humidity is the amount of water vapour in the atmosphere. Temperature of the air controls the capacity of the air to hold moisture. The maximum amount of moisture that can be hold by the air in the particular temperature is called as Humidity Capacity. As the volume increases with the temperature of the air, it can hold more moisture. So, humidity capacity increases with temperature. It is measured as weight of humidity or volume of the air.

Humidity of the air can be expressed in the following ways.

a. **Absolute Humidity:** This measures the total amount of water vapour present in the air at particular time. It is highly variable based on the surface on which the air moves. It is measured as weight of humidity/ volume of the air.

   Hygrometer is used to measure the relative humidity of a region.

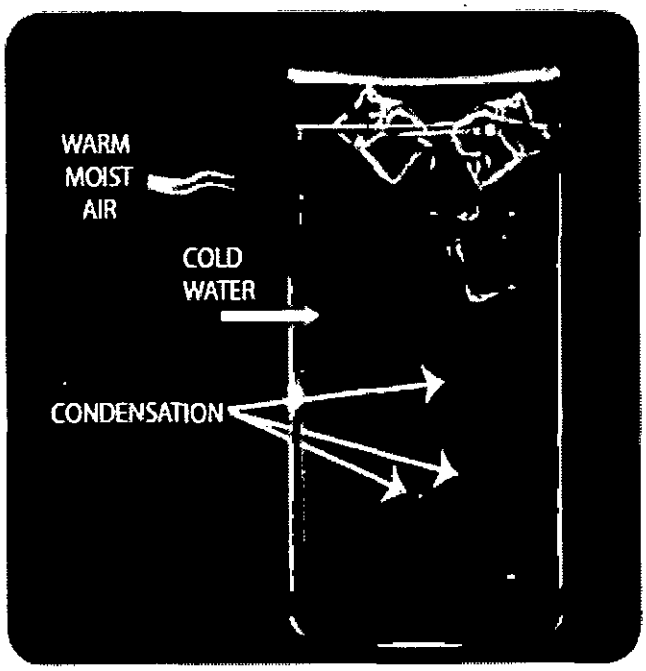
b. **Relative Humidity (RH %):** This is the ratio of Absolute humidity and humidity capacity in term of percentage. It reveals the condition of air to get saturated. This is controlled by both temperature and moisture content of the air. The condition is that when the temperature increases RH% decreases. But when absolute humidity increases RH% increases.

## Process of Condensation

Condensation is the change of the physical state of water vapour (gas state) into water (liquid state). The following process explains mechanism of condensation in the atmosphere.

If an air reaches 100% relative humidity, it means that the air is completely filled with moisture content. It indicates that both the absolute humidity and the humidity capacity of the air are in same level. This condition is called 'saturation of air' which can be attained by reducing the temperature of the air or increasing the moisture content. The temperature at which the air gets saturated is called as 'dew point'. The RH crosses the 100% when the temperature of the air drops below its dew point. This condition is called as 'super saturation'

of the air. In this condition the air releases the excess moisture out of it in the form of tiny water droplets which floats and form clouds in the atmosphere.




If the same process occurs on the surface of the earth, it is called as 'fog' or cloud on the ground.

## Clouds and its Types

Clouds are tiny water droplets suspended in the air formed due to the condensation.

The clouds can be classified based on their form, height and appearance as follows: (Figure 6.22)

a. **High clouds:** Mainly cirrus (Ci) which are feathery form at 6 km above the ground.
   - Cirrus (Ci) – This looks fibrous and appears as wisps cotton in the blue sky. It indicates fair weather and gives brilliant sun set.
   - Cirro Cumulus (Cc) – This appears as white globular masses, forming a mackerel sky.
   - Cirro Stratus (Cs) – This resembles a thin white sheet. The sky looks milky and the sun and moon shines through these clouds and form a 'halo'.

b. **Middle Clouds:** Mainly Alto (Alt) clouds at 2 km to 6 km above the ground.
   - Altocumulus (Alt-Cu): These are woolly, bumpy clouds arranged in layers appearing like waves in the blue sky. They indicate fine weather.
   - Altostratus (Alt-St): These are denser and have watery look.

c. **Low Clouds:** Mainly Stratus or sheet clouds below 2 km height.

   Stratocumulus (St-Cu): This is rough and bumpy clouds with wavy structure.
   - Stratus (St): This is very low cloud, uniformly grey and thick, appears like highland fog. It brings dull weather and light drizzle. It reduces the visibility and is a hindrance to air transportation.
   - viii. Nimbostratus (Ni-St): This is dark dull cloud, clearly layered, as it brings rain, snow and sleet and it is called as rainy cloud.

d. **Clouds with vertical extent:** These are mainly cumulus clouds whose heights extend from 2 km to 10 km approximately.
   - Cumulus (Cu): This is vertical cloud with rounded top and horizontal base, associated with convectional process in the tropical region. It also called as 'fair weather cloud'.
   - Cumulonimbus (Cu-Ni): This is over grown cumulus cloud with great vertical extent, with black and white globular mass. The cauliflower top spreads like an anvil. This is formed due to heavy convection in the tropical regions. It is accompanied by lightning, thunder and heavy rainfall.

## Fog, Mist and Smog

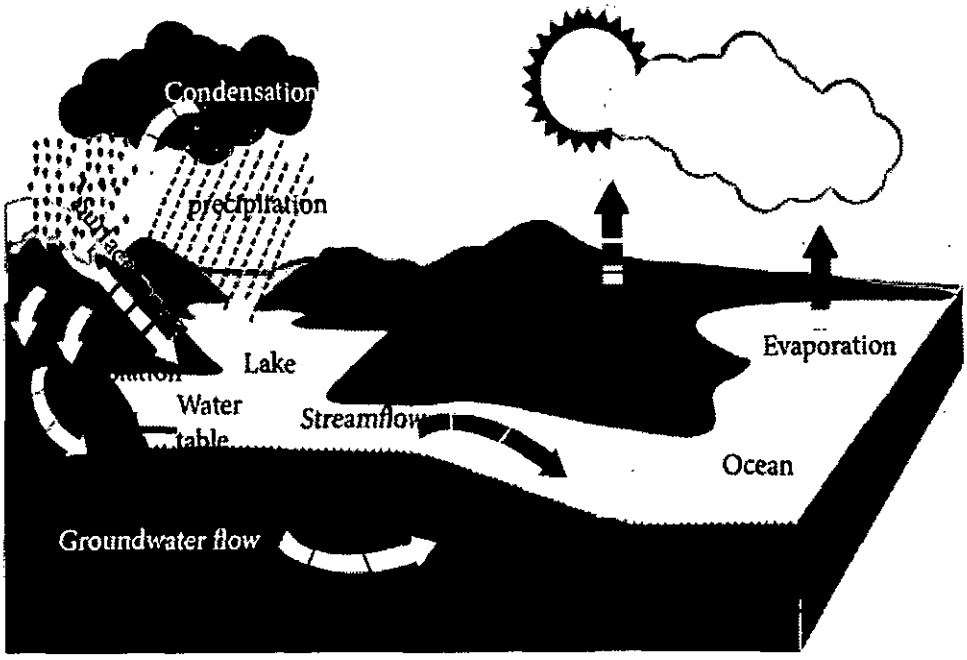
**'Fog'** is defined as almost microscopic droplets of water condensed from super saturated air and suspended over or near the surface of the earth. Fogs reduce the visibility to less than 1 km. Fog occurs during calm or light wind conditions. It is more common in the areas near to the ocean due to the supply of more moisture by sea breeze. In the interior of the continents fog is formed due to reduction of temperature to extreme low during the winter nights.

If the fog has higher visibility due to lesser water drops near the surface it is termed as **'mist'.**

In large industrial areas the air is more polluted. If the fog forms in that area it mixes with the pollutants and turns into smog (smoke 1 fog 5 smog) which is more hazardous to the health of the people.

## Hydrological Cycle

Continuous movement of water among the three spheres is known as **Hydrological Cycle.** Hydrological cycle involves evaporation, condensation, precipitation, advection, interception, evapo-transpiration, infiltration, percolation and runoff to the ocean (Figure 6.24).




**Evaporation** is the process by which water in liquid state changes into vapour state using heat energy from Sun. Evaporation is maximum when the temperature is high, on the large expanse of water and when dry winds blow over water surface.

**Condensation** is the process by which water vapour cools to form water droplet by losing temperature. The condensation occurs when dew point is reached in the atmosphere.

**Precipitation** is the process by which all forms of water particles fall from the atmosphere and reach the ground.

## Precipitation

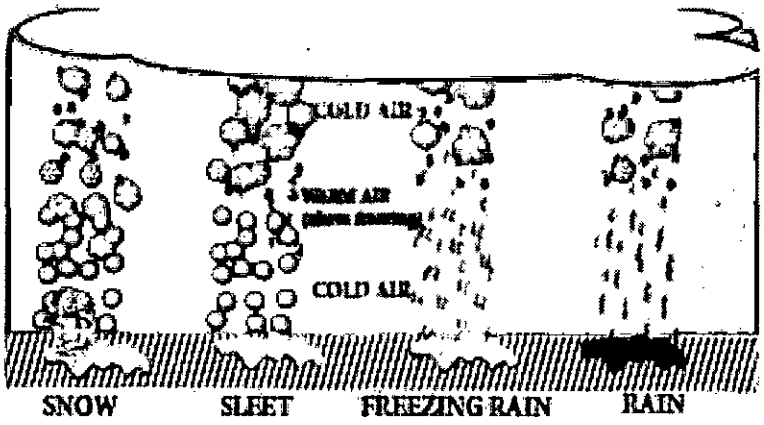
Precipitation is the product of condensation of atmospheric water vapour that falls under gravity and reaches the surface of the earth.

In order to fall as rain, drop or snow, the tiny drop lets in a cloud must grow larger. The droplets accumulate over the nuclei and combine to grow large enough to fall and reach the surface of the earth due to gravity.

If the drop is smaller it falls slowly so that it evaporates before it reaches the ground. Ice crystals in cloud also cause precipitation. Each ice crystal grows by cooling so that they become large in size and fall to the ground. They melt on the way due to friction with the atmosphere and fall as rain.

## Forms of Precipitation

The precipitation has various forms based on the condition of occurrence (Figure 6.27). The various forms are;




**Rainfall:** When water droplets of more than 0.5 mm diameter fall from the atmosphere to the ground it is called as 'Rainfall'. If the diameter is less than 0.5mm, it is called as 'Drizzle'.

**Hail:** When precipitation occurs at sub-zero temperature, the water droplets crystallise and fall as ice pellets with the size of 5 to 50 mm or some times more. This is called as 'Hail'.

**Sleet :** Precipitation occurs as falling of raindrop along with ice pellets less than 5 mm diameter or snow, called as 'Sleet'.

**Snow:** Precipitation occurs at below freezing point and falls as thin ice flakes or powdery ice, called as 'Snow'.

**Dew:** Condensation of water droplets on the objects at the surface of the earth such as leaves and grasses are called as 'Dew'.

## Fact File

## Cloud Seeding or Artificial Rainfall

People have always wanted to create rain, so that they would not suffer from drought. Modern science has been successful in causing rain in a limited way through cloud seeding. This method is based on the knowledge of growing ice crystals in clouds.

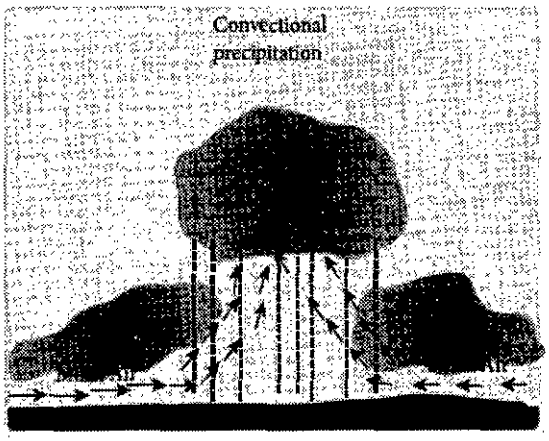
One method to cause rainfall from clouds is to introduce particles of dry ice (solid CO2) into the cloud from an air plane. The dry ice causes ice crystals to form in the cloud. These ice crystals coalesce, grow, melt and fall as rain. Cloud seeding will not be successful unless the cloud is already saturated with water vapour.

## Types of Precipitation (Rainfall):

Precipitation can be classified based on the causes for the rising up of air,

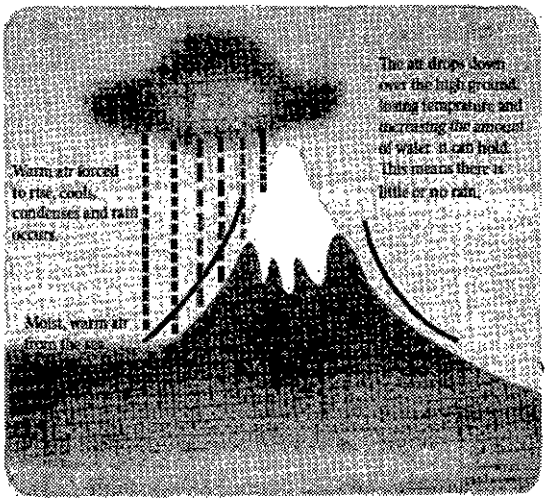
a. Convectional rainfall
b. Orographic or Relief rainfall
c. Cyclonic or Frontal rainfall

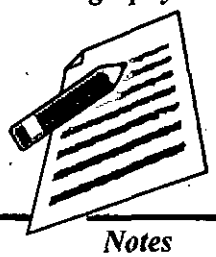
**Convectional Rainfall:** As a result of heating of the surface air, the warm moist air expands and is forced to rise to a great height. As the air rises, it cools, reaches dew point and condenses to form clouds. This process influences the upper tropospheric circulation. By further cooling, precipitation takes place as rainfall. This rainfall occurs throughout the year near the equator in the afternoon. It is called as 4 'O' clock rainfall region. In middle latitudes, convectional rainfall occurs in early summer in the continental interiors (Figure 6.29).




## Orographic or Relief Rainfall

It occurs when large mass of air is forced to rise across land barriers, such as high mountain ranges, plateaus, escarpments, or over high hills. On the windward side of the region the warm moist air raises, temperature of the air falls below its dew point, forming clouds which give subsequent rainfall. As the wind moves to the leeward side it has emptied itself of moisture and thus descends the slope as warm dry winds. The leeward side of the mountain therefore is called as the **rain shadow region (Figure 6.30).**







When altitude increases, the rainfall also increases in orographic pattern. But the rainfall decreases with altitude, once the amount of moisture reduces in the air after a point where it reaches maximum rainfall which is called as 'Maximum Rainfall Line'. This condition where the rainfall decreases with altitude is called 'Inversion of Rainfall'.

## Cyclonic or Frontal Rainfall

This type of precipitation is associated with a cyclonic activity (Tropical and Temperate) and also occurs along the frontal zone. Cyclonic rainfall is associated with Cumulo Nimbus (CuNi) clouds. The rainfall is very heavy and accompanied with lightning and thunder and high-speed winds which has the potential to cause damage.

'Frontal rainfall' is associated with fronts which form due to collision of different air masses. Warm front is formed due to advent of warm air masses which leads to moderate rainfall. In the same way cold front is formed due to advent of cold air mass which leads to heavy rainfall with lightning and thunder.

An isohyets or isohyetal **line** is a **line** joining points of **equal rainfall** on a map in a given period. A map with isohyets is called an isohyetal map.

## Cloud Burst

A 'cloud burst' is a sudden aggressive rainstorm falling in a short period of time limited to a small geographical area. Meteorologists say that the rain from a cloud burst is usually of the heavier rain with a fall rate equal to or greater than 100 mm (3.94 inches) per hour. Generally, cloudbursts are associated with thunderstorms. The air currents rushing up words in a rain storm hold up a large amount of water. For example, cloud bursts in the region of Uttarakhand (2013) and Chennai (2015).

## SUMMARY

Water vapour is highly variable. It is an important component of atmosphere. It is responsible for global heat balance, atmospheric phenomena and sustaining plant and animal life on our planet. The water vapour present in the atmosphere is called humidity, which is expressed as absolute humidity and relative humidity. Of these, the relative humidity is most reliable measure. Water vapour enters into atmosphere through a process called evaporation. Temperature of the air controls the amount of moisture it can hold at a given volume. The air which holds the moisture to its full capacity is called saturated air and the temperature at which it reaches saturation point is termed as dew point. Condensation is a process of changing of water vapour into liquid or solid state. It happens when temperature of an air falls below dew point. Condensation occurs near the ground as dew, mist, or fog and at higher levels of clouds. Falling down of atmospheric moisture is called precipitation which occurs due to continuous condensation. Drizzle, rainfall, snowfall, sleet and hail are various forms of precipitation. The rainfall occurs in three different ways conventional, orographic and cyclonic. The distribution of precipitation in the world shows marked regional and seasonal variation. Some regions receive heavy rainfall while others scanty precipitation. Some regions receive precipitation throughout the year while others only in the winter or summer. Several factors affect rainfall distribution.

## EXERCISE

### MCQ

**1. Rainfall is also known as _____**

a) Precipitation
b) Condensation
c) Infiltration
d) Down pour

**Answer:** a

**2.** In which of the following season is evaporation loss from free water is large?

a) Winter b) Spring
c) Autumn d) Summer

**Answer:** d

**3.** The equipment to measure atmospheric humidity is

(a) Anemometer (b) Psychrometer
(c) Hydrometer (d) Lysimeter

**Answer:** (b)

**4.** The mass of water vapour in a unit mass of air is referred to as

(a) relative humidity
(b) specific humidity
(c) approximate humidity
(d) absolute humidity

**Answer:** (b)

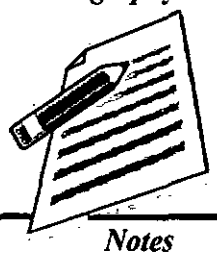
**5.** The ozone layer is present in

(a) Thermosphere (b) Stratosphere
(c) Troposphere (d) Mesosphere

**Answer:** (b)

### Review Questions

1. Explain the importance of water vapour present in the atmosphere.
2. What is evaporation? Discuss the factors which affect the rate of evaporation. Give examples in support of your answer.
3. Explain the process and forms of condensation.
4. How does precipitation occur? Discuss the various forms of precipitation.
5. Differentiate between: (a) Evaporation and condensation; (b) Absolute humidity and relative humidity; (c) Saturated air and unsaturated air; (d) Rainfall and precipitation; (e) Sleet and hail; (f) Conventional and orographic rainfall.





6. Discuss in detail the regional and seasonal distribution of precipitation in the world.
7. Give reasons for each of the following: (a) Equatorial regions receive precipitation throughout the year. (b) Mediterranean regions receive rainfall only in winter. (c) Amount of precipitation decreases from coastal areas to interior, parts of continents. (d) Tropical deserts are found on the western parts of continent. (e) Evaporation decreases towards poles.
8. On the given outline map of the world, show the following with appropriate symbols: (a) Two areas getting precipitation above 200 cms. (b) Two areas of scanty precipitation in lower latitudes. (c) Two regions getting precipitation only in winter. (d) Cold deserts of the world.

# 11 BIOSPHERE

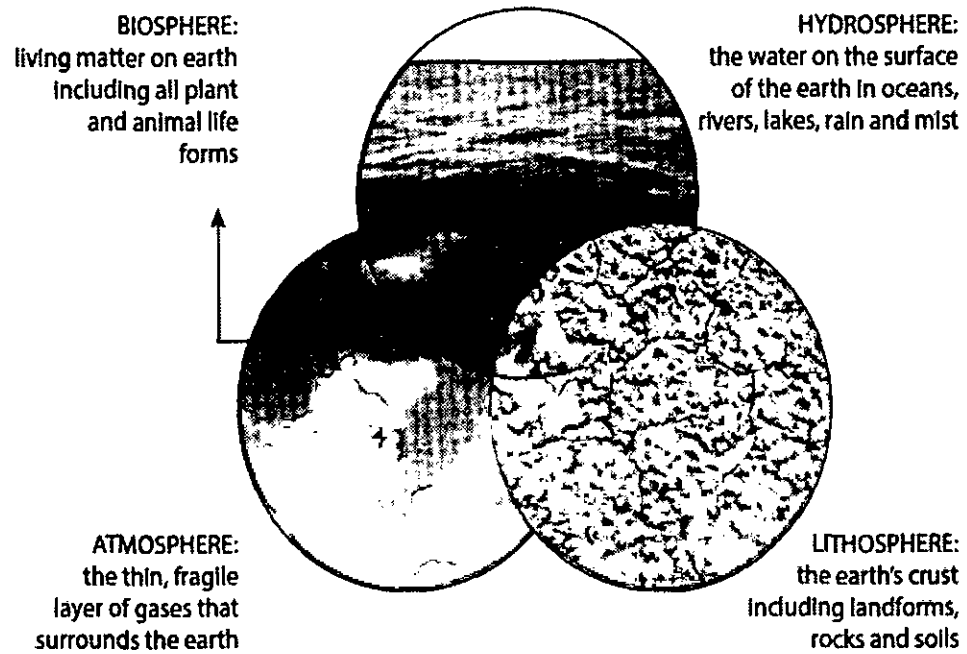
- Understand the concept of biosphere.
- Discuss the types of biosphere.
- Describe the concept of ecosystem.
- Discuss the concept of ecology.

## Objective of the chapter:

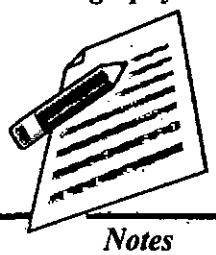
The basic objective of this chapter is to through some light on the initial concepts of biosphere so that the types of biosphere can be learned.

## Introduction

The earth was formed 4.6 billion years ago. Geographers are concerned about the earth and its various spheres. These spheres did not exist on the primitive earth as they are today. They evolved over a long period of time after the earth was formed. There was no life on earth for a very long time. Scientists believe that the first life forms on earth came into existence about 3.5 billion years ago. Which marked, 'The birth of the biosphere'.




Since then, life has multiplied in numbers and varieties and evolved too the In the last 100 years, man has had used, overused and misused the natural resources of the earth. This has





disturbed the ecological balance of the earth. The realization about the damage caused to earth by our action came when we began to experience global warming, desertification, increase in disease and distress and recurrence of severe natural disasters.

It was in 1962 that **Rachel Carson** published the book 'Silent Spring' which inspired an environmental movement that led International agencies to focus their attention on protecting and sustaining the biosphere.

In 1971, UNESCO launched the Man and the Biosphere Programme to study our impact on nature and how it could be minimized. Even after several decades the programme still continues to shape the future of sustainability of the earth.

## Biosphere

The word Biosphere originates from the Greek word's bios = life and sphaira = sphere. Earth is the only planet in the solar system that supports life. There are many reasons that contribute to this and the most important being the earth's distance from the sun, the presence of oxygen in the atmosphere and the presence of water.

The above factors, along with the existence and interaction of the three spheres of the earth (the lithosphere, hydrosphere and atmosphere) gives rise to the fourth sphere which is the life sphere or biosphere (Figure 7.1). The term Biosphere was coined by **Eduard Suess** in 1875. Later contributions to the study of biosphere were from, **Charles Darwin** and many other scientists.

Thus, in the biosphere, life exists on land, water and air and life forms range from microorganisms to plants, animals, birds, amphibians, reptiles and mammals including human beings.

The biosphere is formed of biotic components. It consists of organisms, population, community and ecosystem.

## Ecosystem

**Organism** – includes animals, plants and microorganisms.

**Population** – is a group of similar plants or animals living in an area.

**Community** – refers to all the plants and animals living in an area.

**Ecosystem** – all living and non-living things and their interaction within an area.

Life cannot exist in isolation. It flourishes in an environment which supplies and fulfils its material and energy requirements. A biotic community and its physical environment in which matter and energy flow and cycle is called as ecosystem.

The term ecosystem was first proposed by Arthur George Tansley in 1935. Tansley defined ecosystem as, 'the system resulting from the integration of all living and non-living factors of the environment'. The ecosystems can vary in size. It can be very small, extending to about a few square centimetres or it can extend over many square kilometres. Example, tropical forests.

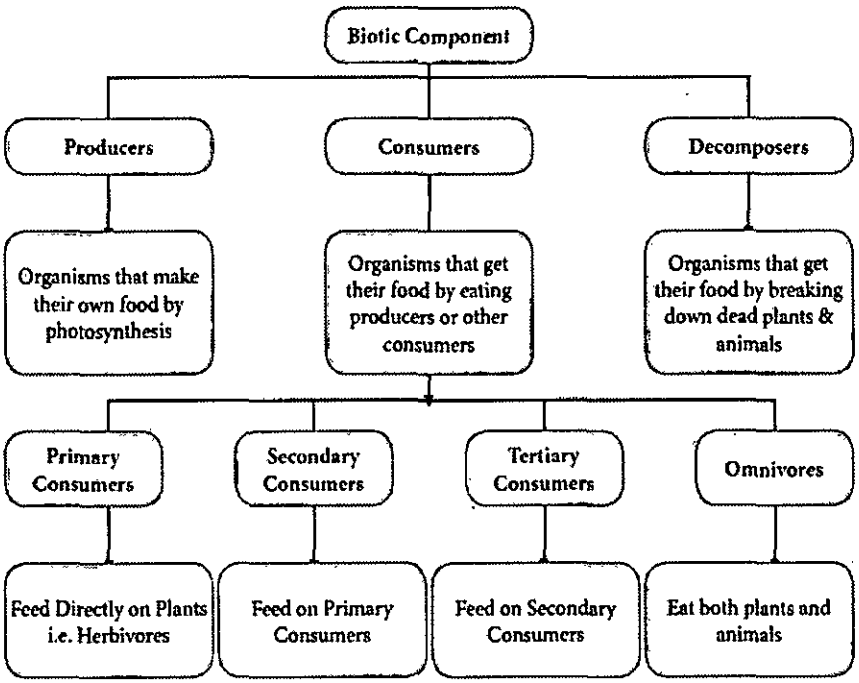
## Major components of an ecosystem

The ecosystem is made up of two main components:

1. Abiotic Component and
2. Biotic Component

A. **Abiotic Component:** This component of the ecosystem includes the non-living substance of the environment. Example; light, air, soil, water, climate, minerals, etc. Sun is the main source of energy for the earth.

B. **Biotic Component:** This includes a variety of living organisms such as microorganisms, plants and animals. The biotic component of an ecosystem can be further divided into producers, consumers and decomposers based on their capacity to sustain themselves (Figure 7.2).




a. **Producers:** Organisms that can produce or manufacture their own food are known as producers. Plants that have green pigments or chlorophyll, produce their own food in the presence of CO2 in the atmosphere, water from the soil and sunlight through a process called 'photosynthesis'. These green plants are called as 'autotrophs' (auto – self; trophs – nourishing) as they manufacture their own food.

b. **Consumers:** Consumers are organisms that cannot manufacture their own food and get their food and nutrients from producers directly or from other organisms. They are called as 'heterotrophs' (hetero – others; trophs – nourishing).

Consumers can be divided into primary, secondary and tertiary consumers.

## 1. Primary Consumers

Organisms that feed on producers (green plants) are called primary consumers. They are also called as 'herbivores' or plant eating organisms. Examples of terrestrial herbivore are grasshopper, sheep, goats, cow, rabbit, deer, elephant etc. Examples of aquatic herbivores are zoo plankton, krill, squid, small fish, sea urchin, etc.

## 2. Secondary Consumers

Animals that kill and eat the herbivores or plant eating animals are called secondary consumers. They are also called as 'carnivores', Example; lion, tiger, foxes, frogs, snakes, spider, crocodiles, etc.

## 3. Tertiary Consumers

They are top predators in a food chain. They are carnivores at the topmost level in a food chain that feed on other carnivores or secondary consumers. Example: an owl eats a snake but an owl is eaten by a hawk, therefore a hawk is a tertiary consumer. Tertiary consumers that occupy the top trophic level, and are not predated by any other animals are called 'apex predators. However, when they die their bodies will be consumed by scavengers besides the decomposers Example; alligator and hawk.

Some organisms eat both plants and animals. These animals are called as 'omnivores. Example; cockroach, foxes, seagull and human.

Some omnivores are 'scavengers', which eat food that other animals have left behind. Example; hyena and vultures.

Plants and animals that live on or inside other plants or animals are called as Parasites. Example; mistletoe lives on other plants. Other examples are tapeworms, round worms, lice, ticks, flea etc.

'Detritivores' are consumers that feed on detritus. Detritus includes fallen leaves, parts of dead trees and faecal wastes of animals. Ants, termites, earthworms, millipedes, dung beetle, fiddler crabs and sea cucumbers are detritivores.

## 4. Decomposers

Decomposers are organisms that help decompose dead or decaying organisms. Decomposers are also heterotrophs. Decomposers are nature's built-in recycling system. By breaking down materials – decomposers return nutrients to the soil. They, in turn, create another food source for producers within the ecosystem. Mushrooms, yeast, mould, fungi and bacteria are common decomposers.

## Food Chain and Food Web

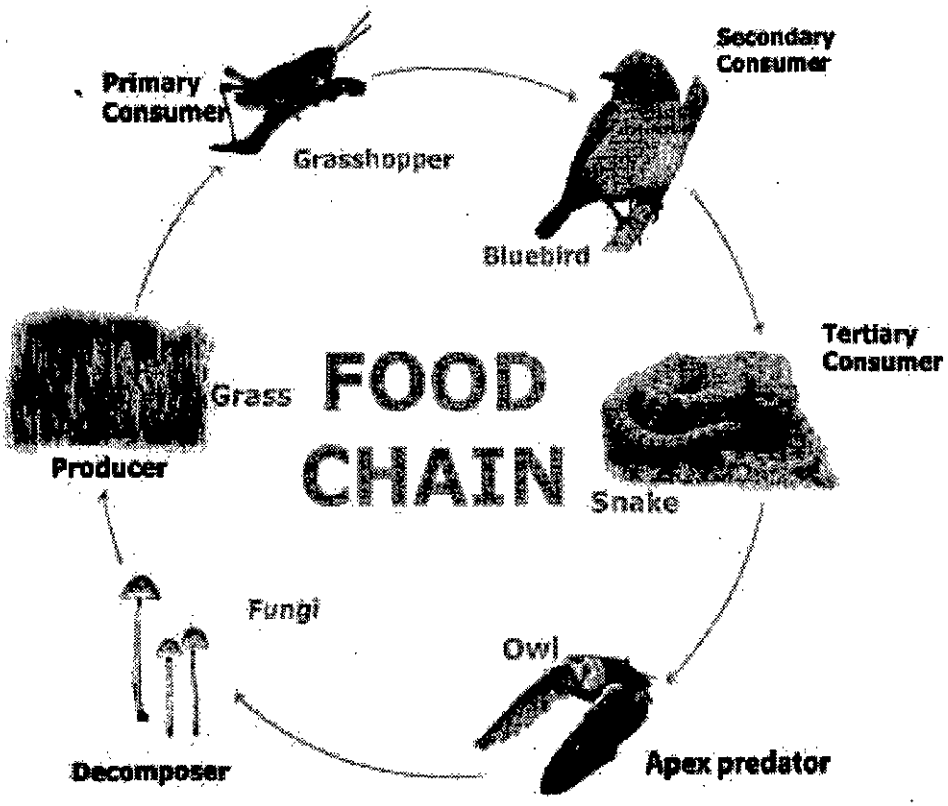
Every living creature in an ecosystem has a role to play. Without producers, the consumers and decomposers would not survive because they would have no food to eat.

Without consumers, the populations of producers and decomposers would grow out of control. And without decomposers, dead producers and consumers would accumulate as wastes and pollute the environment.

All organisms of an ecosystem depend on one another for their survival. Each organism living in an ecosystem plays an important role in the flow of energy within the system. Organisms need energy for respiration, growth, locomotion, and reproduction. This movement of energy is usually understood through food chains or food webs. While a food chain shows one path along which energy can move through an ecosystem, food webs show all the overlapping ways that organisms live with and depend upon one another.

## A. Food Chain

A food chain describes the flow of food in an ecosystem. This flow or feeding structure in an ecosystem is called 'trophic structure'. Each level in this structure is called a trophic level. A food chain starts the movement of energy from one trophic level to the next (Figure 7.3). Example; Plant (primary producer) is eaten by a rabbit (herbivores, primary consumer), rabbit is eaten by a snake (carnivores, consumer or primary carnivore)and the snake is eaten by a hawk (tertiary consumer).




## Food Web

A Food Web is a complex network of interconnected food chains. Food chains show a direct transfer of energy between organisms.

A chain might involve a mouse eating some seeds on the forest floor, a snake eating the mouse and later an eagle eating the snake.

With each step, some of the energy from the sun, which is trapped within the seeds, is getting passed on.

In a food web, the mouse might eat seeds, but it also might eat some grains, or maybe even some grass. The mouse might be eaten by a snake, or the eagle, or even a fox. The snake could be eaten by the eagle, but also might be eaten by a fox in the forest.

Since each organism can eat multiple organisms and be eaten by multiple organisms, a food web is a much more realistic scheme of the transfer of energy within an ecosystem (Figure 7.4).

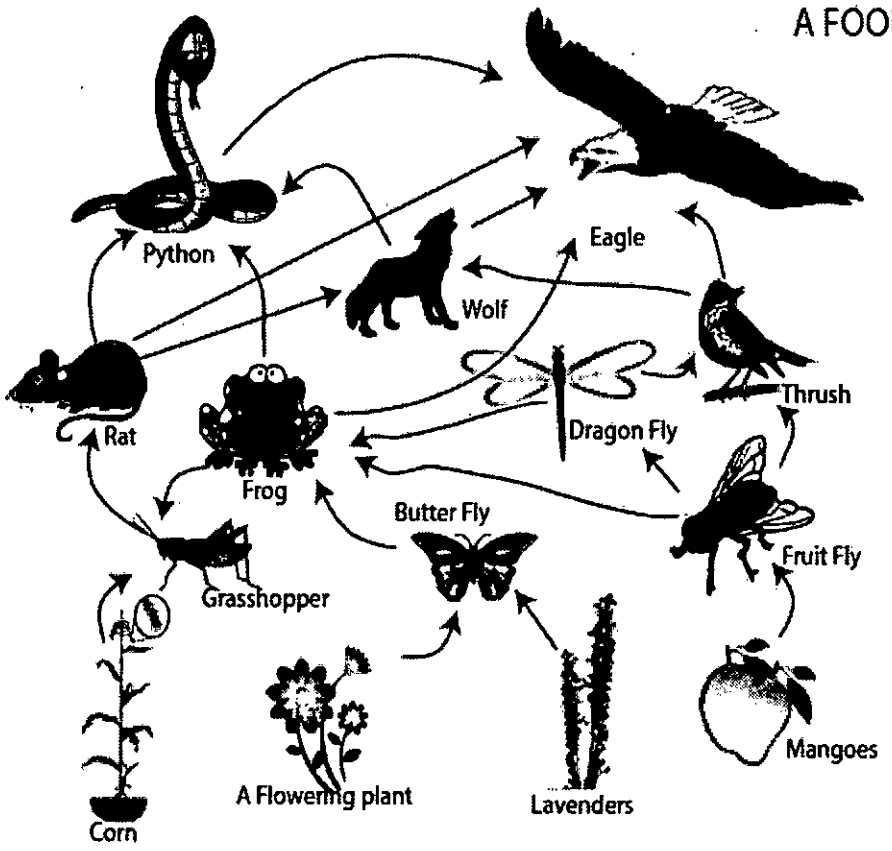
Food chains and food webs are found in both terrestrial and aquatic ecosystems.

Organisms in a food chain or food web are linked and dependent on one another for survival. If organisms in one trophic level become threatened, it impacts the organisms in other trophic levels. Primary consumers get less food due to loss or destruction of habitat.

This in turn means fewer primary consumers for secondary and tertiary consumers to feed on.

The plant and animal species in such an environment could become endangered or even extinct. For this reason, it is vital that an ecosystem remains balanced containing an appropriate proportion of producers and consumers.

A FOOD WEB



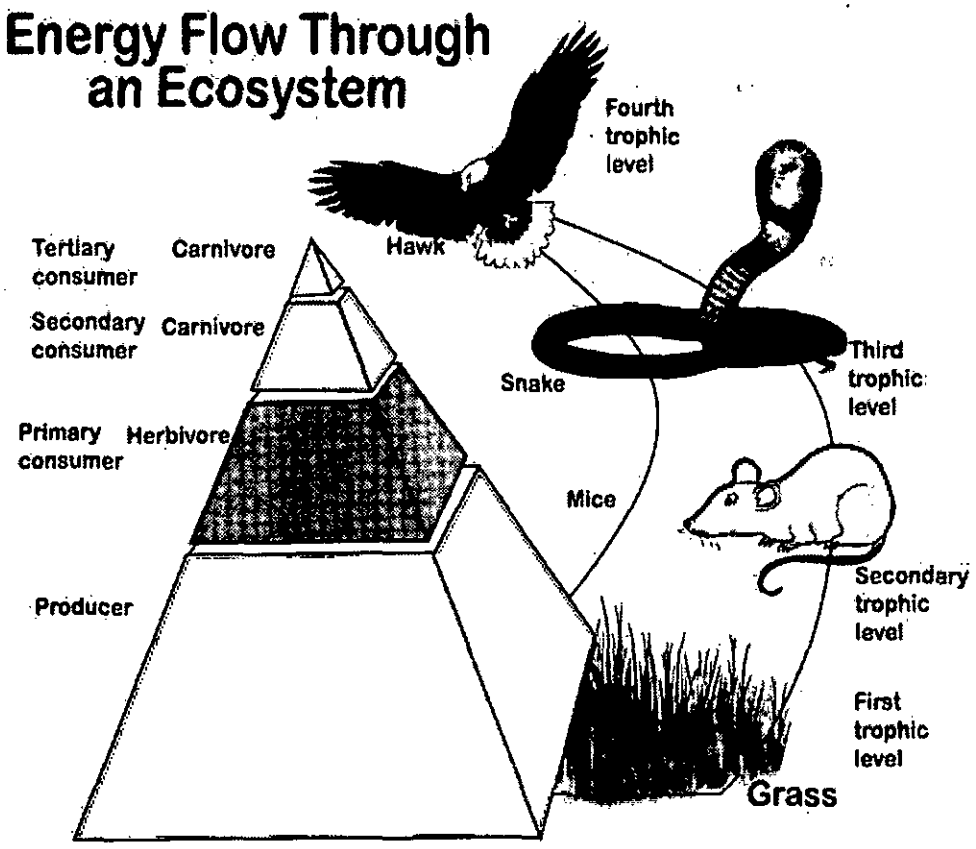

## Energy Flow in an Ecosystem

Energy in an ecosystem flows from producers to consumers. The available energy in a food chain decreases with each step or trophic levels up in the food chain. As such, there is less energy available to support organisms at the top of the food chain. That is why the tertiary and quaternary consumers are far less in number in an ecosystem than organisms at lower trophic levels.

## Energy Pyramids

Energy pyramids are another tool that ecologists use to understand the role of organisms within an ecosystem. As you can see, most of the energy in an ecosystem is available at the producer level. As you move up on the pyramid, the amount of available energy decreases significantly. It is estimated that only about 10% of the energy available at one trophic level gets transferred to the next level of the energy pyramid. The remaining 90 percent of energy is either utilized by the organisms within that level for respiration and other metabolic activities or lost to the environment as heat.

The energy pyramid shows how ecosystems naturally limit the number of each type of organism it can sustain (Figure 7.5).




## Cycles in an Ecosystem

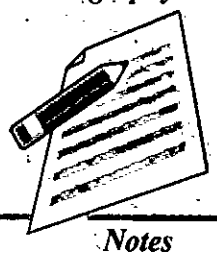
Nutrients move through the ecosystem in cycles is called 'biogeochemical cycles. A biogeochemical cycle is a circuit or pathway by which a chemical element moves through the biotic and the abiotic components of an ecosystem. All life processes are associated with the atmosphere by important cycles such as the Carbon, Oxygen, Nitrogen cycles etc. Through these cycles energy and materials are transferred, stored and released into various ecosystems. Let us discuss one of biogeochemical cycles in detail - the Carbon cycle.

## The Carbon Cycle

Carbon is exchanged, or cycled among all the spheres of the earth. All living organisms are built of carbon compounds. It is the fundamental building block of life and an important component of many chemical processes. Living things need carbon to live, grow and reproduce. Carbon is a finite resource that cycles through the earth in many forms.

Carbon is an essential element in all organic compounds and since there is only a limited amount available it must be recycled continuously. This takes place in the biosphere. Atmospheric carbon is fixed in green plants through photosynthesis.

This carbon is passed on to other living organisms through the food chain. The carbon food compound is utilized and later released to the atmosphere through the process of respiration.





**Question 5:** Process of evapo-transpiration and precipitation is called

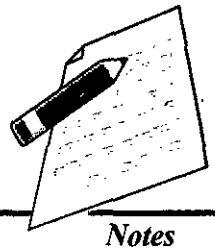
(A) Carbon cycle (B) Nitrogen cycle

(C) Hydrological cycle (D) All the above

**Answer:** (C)

## Review Questions

1. What is biosphere? Describe various components of biosphere with suitable examples.
2. Define eco-system. Explain the energy flow in the ecosystem with appropriate diagrams and examples.
3. What are bio-geochemical cycles? Explain hydrological cycles with suitable diagram.
4. Describe various causes and consequences of global warming?
5. Define sustainable development? Suggest measures to be adopted for achieving sustainable development.



*Notes*

# 12 INDIA–PHYSICAL FEATURES

- Understand the concept of Indian geography.
- Discuss the physical features of India.
- Describe the concept of boundaries.
- Discuss the location of India on world map.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of Indian geography so that the physical features of India can be learned.

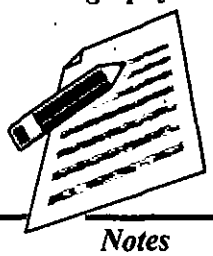
## Introduction

A huge landmass of South Asia is flanked by new fold towering mountains on the northwest, north and northeast. The Arabian sea lies to its southwest, the Bay of Bengal to its southeast andthe Indian Ocean to its south. This well-defined South Asian landmass is called Indian sub-continent. This sub-continent consists of the countries of India, Pakistan, Bangladesh, Nepal and Bhutan including Sri Lanka, an island narrowly separated by the Palk Strait. India alone covers about three fourths of the area of this sub-continent and has common frontier with each one of them. She along with her five neighbours, forms a clearly identifiable geographical unit, with certain common cultural parameters. Since old times, the country has been known by various names such as Aryavarta, Bharat, Hindustan and lately India. The Indian Ocean or Hind Mahasagar has also been named after India - the only country to be so.

## Location

According to the Constitution of India, the country is known as Bharat or India. India lies wholly in the Northern Hemisphere. The Indian mainland extends between 8°4'N to 37°6' N latitudes and from 68°7' E to 97°25' E longitudes. Thus, the latitudinal and longitudinal extent of India is of about 29 degrees. It measures about 3,214 km from north to south, and 2,933 km from east to west. Though the latitudinal and longitudinal extent is almost the same, the actual distances do differ considerably. Why is it so? This is because the east-west distance between two successive meridians of longitude along the equator is at its maximum - 111 km. This, however, goes on decreasing as one moves from the equator to the poles, where it is zero. This is because all the meridians of longitude merge in a single point at the poles - both North and South.

On the other hand, the north-south distance between any two successive parallels of latitude along any meridian of longitude remains almost uniform, i.e., 111 km.





A glance at the globe should help to convince this point. The northern most point of the Indian mainland lies in the state of Jammu and Kashmir and the southernmost point is Kanyakumari in Tamilnadu. However, the southernmost point of the country as a whole lies further south in Andaman and Nicobar Islands. It is now called Indira Point. It is situated at 6°30'N latitude. The westernmost point of India lies in Gujarat and the eastern most in Arunachal Pradesh.

Let us see the impact of such large latitudinal extent upon the lives of the people of India. The northern parts of the country are quite far off from the equator. Therefore, the rays of the sun strike those parts more obliquely. Consequently, this part of the country receives lesser amount of insolation and has cold climate unlike the southern parts.

Secondly, the difference between the length of day and right in southern most part of India is much less only about 45 minutes as they are situated near the equator, this difference between day and night in the northern parts of India steadily goes on increasing till it becomes as much as 5 hours. The Tropic of Cancer passes almost halfway through the country. Thus, half of the country to the south of the Tropic of Cancer is situated in the Tropical or Torrid zone and the other half lying north of the Tropic of Cancer falls in the Sub-tropical zone. The earth takes 24 hours to complete one rotation on its axis.

The Sun rises first in the east and then in the west because the earth rotates from west to east. The earth's longitudinal expanse of 360° is thus covered in 24 hours, at the pace of 15° per hour. As the longitudinal extent of India is nearly 29°, the real time difference in India between its eastern and western extremities is roughly of two hours. While at the eastern extremity of India the day may have just broken out, the western extremity would take nearly another two full hours to do so.

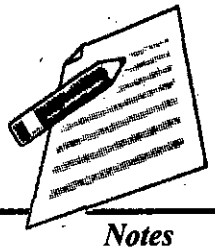
To iron out this big chunk of time difference, India, like all other countries of the world, follows the local time of its relatively central meridian as the standard time for the whole country. For the convenience of all, each country chooses its standard meridian in a multiple of 7°30'. Accordingly, the standard meridian of India has been chosen to be 82°30' E. The north-central part of India is broad while the southern part tapers down towards the Indian Ocean in the south.

Thus, the northern part of the Indian Ocean has been divided into two, by the sheer presence of Indian Peninsula. The western part of northern Indian Ocean is called the Arabian Sea while the eastern part is called the Bay of Bengal. The total length of the coastline of India including the island groups is about 7,516.6 km. The Palk Strait separates Indian mainland from Sri Lanka. Structurally, Sri Lanka is an extension of the peninsular block of India.

## Size

India accounts for 2.42 per cent of the world's total land area; whereas it sustains 16 per cent of the world population. You will know more about it in lesson No. 26 on population of India. The land frontiers of India measure 15,200 km. Pakistan, Afghanistan, China, Nepal, Myanmar and Bangladesh share common boundaries with India. The kingdom of Bhutan is situated in the Eastern Himalaya. It is a small country and the responsibility of its defence rests with India. Most of our boundary with Pakistan and Bangladesh is almost man-made. There is no mountain range or river to form a natural boundary.

The international boundary of India passes through a variety of landforms - barren desert lands, lush green agricultural fields, gushing rivers, snow clad mountains as well as densely forested mountain ranges. The defence of such an international boundary passing through





various kinds of terrains is certainly a difficult job. An Indian soldier is, therefore, exposed to various types of extremely hostile conditions on the course of his duty. Sometime, he is posted on the icy cold glaciers. At times he has to bear the wrath of the burning sun and he has to face in the hot sands of the desert. Often, he is posted in the marshy, riverine, rainy and thickly forested tracts of the northeast. Our country has to spend crores of rupees daily for the defence of such a long and inhospitable boundary that passes through various kinds of terrain.

**India has all major physical features of the earth**, i.e., mountains, plains, deserts, plateaus and islands. The land of India displays great physical variation. Geologically, the Peninsular Plateau constitutes one of the ancient land masses on the earth's surface. The Himalayas and the Northern Plains are the most recent landforms. The northern plains are formed of alluvial deposits.

## Major Physiographic Divisions

The physical features of India are grouped under the following physiographic divisions:

1. The Himalayan Mountains
2. The Northern Plains
3. The Peninsular Plateau
4. The Indian Desert
5. The Coastal Plains
6. The Islands

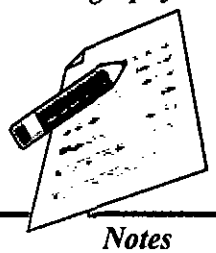
## The Himalayan Mountains

*Himalayan mountains are stretched over the northern borders of India. These mountain ranges* run in a west-east direction from the Indus to the Brahmaputra. The Himalaya consists of 3 parallel ranges in its longitudinal extent.

1. The northern-most range is known as the **Great or Inner Himalayas or the Himadri.** *It is the most continuous range consisting of the loftiest peaks with an average height of* 6,000 metres.
2. The folds of the Great Himalayas are asymmetrical in nature. The core of this part of Himalayas is composed of granite.
3. The range lying to the south of the Himadri forms the most rugged mountain system and is known as **Himachal or lesser Himalaya.**
4. Pir Panjal range forms the longest and the most important range.
5. The outermost range of the Himalayas is called the **Shiwaliks.** These ranges are composed of unconsolidated sediments.
6. The longitudinal valley lying between lesser Himalaya and the Shiwaliks are known as **Duns.** Dehradun, Kotli Dun and Patli Dun are some of the well-known Duns.

The Himalayas have also been divided on the basis of regions from west to east.

1. The part of Himalayas lying between Indus and Satluj has been traditionally known as Punjab Himalaya but it is also known regionally as Kashmir and Himachal Himalaya from west to east, respectively.
2. *The part of the Himalayas lying between* Satluj and Kali rivers is known as **Kumaon Himalayas.**





3. The Kali and Teesta rivers divide the Nepal Himalayas and the part lying between Teesta and Dihang rivers is known as **Assam Himalayas.**
4. The Brahmaputra marks the eastern-most boundary of the Himalayas.
5. Beyond the Dihang gorge, the Himalayas bend sharply to the south and spread along the eastern boundary of India, which is known as the **Purvachal or the Eastern hills and mountains.** The Purvachal comprises the Patkai hills, the Naga hills, the Manipur hills and the Mizo hills.

## The Northern Plain

The northern plain has been formed by the interplay of the 3 major river systems – the Indus, the Ganga and the Brahmaputra along with their tributaries. It spreads over an area of 7 lakh sq. km.

The Northern Plain is broadly divided into 3 sections as mentioned below:

1. The Western part of the Northern Plain is referred to as the **Punjab Plains.** This plain is formed by the Indus and its tributaries – the Jhelum, the Chenab, the Ravi, the Beas and the Satluj.
2. **The Ganga plain** extends between Ghaggar and Teesta rivers. It is spread over the states of North India, Haryana, Delhi, U.P., Bihar, partly Jharkhand and West Bengal.
3. **Brahmaputra plain** lies in the state of Assam.

According to the variations in elevation points, the Northern plains can be divided into 4 regions.

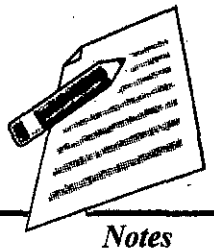
1. The rivers, after descending from the mountains, deposit pebbles in a narrow belt of about 8 to 16 km in width lying parallel to the slopes of the Shiwaliks, which is known as **bhabar.** All the streams disappear in this bhabar belt.
2. The streams and rivers re-emerge and create a wet, swampy and marshy region known as **terai.**
3. The largest part of the northern plain is formed of older alluvium. It lies above the floodplains of the rivers and presents a terracelike feature which is known as **bhangar.**
4. The soil in the bhangar region contains calcareous deposits and is known as **kankar.** The newer, younger deposits of the floodplains are called **khadar.**

## The Peninsular Plateau

The Peninsular plateau is a tableland composed of the old crystalline, igneous and metamorphic rocks. It was formed due to the breaking and drifting of the Gondwana land. One of the distinct features of the Peninsular plateau is the black soil area known as **Deccan Trap.**

This plateau consists of 2 divisions:

1. **The Central Highlands:** The part of the Peninsular plateau lying to the north of the Narmada river, covering a major area of the Malwa plateau, is known as the Central Highlands. The eastward extensions of this plateau are locally known as the Bundelkhand and Baghelkhand.
2. **The Deccan Plateau:** It is a triangular landmass that lies to the south of the river Narmada. An extension of the Plateau is also visible in the northeast, which is known as the Meghalaya, Karbi-Anglong Plateau and North Cachar Hills.





The Western Ghats and the Eastern Ghats mark the western and the eastern edges of the Deccan Plateau respectively.

| Western Ghats | Eastern Ghats |
|---|---|
| Western Ghats lie parallel to the western coast. | The Eastern Ghats stretch from the Mahanadi Valley to the Nigiris in the South. |
| They are continuous and can be crossed through passes only. | They are discontinuous and irregular. They can be dissected by rivers draining into the Bay of Bengal. |
| They are higher than the Eastern Ghats. Their average elevation is 900–1600 metres. | Their average elevation is 600 metres. |
| Anamudi is the highest peak in the Western Ghats. | Mahendragiri (1,501 metres) is the highest peak in the Eastern Ghats. |

## The Indian Desert

The Indian desert lies towards the western margins of the Aravali Hills.

- It is a sandy plain covered with sand dunes.
- This region receives very low rainfall below 150 mm per year.
- It has a dry climate with low vegetation cover.

## The Coastal Plains

A coastal plain is a flat, low-lying piece of land next to the ocean. To the east and west of the peninsular plateau, 2 narrow strips of plain lands are found, which are respectively called Eastern Coastal Plain and Western Coastal Plain.

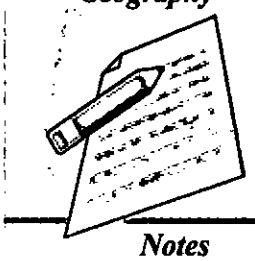
## Eastern Coastal Plain

The Eastern Coastal Plains is a wide stretch of the landmass lying between the Eastern Ghats and the Bay of Bengal. In the northern part, it is referred to as the **Northern Circar,** while the southern part is known as the **Coromandel Coast.** Large rivers, such as the Mahanadi the Godavari, the Krishna and the Kaveri have formed extensive delta on this coast. Lake Chilika is an important feature along the eastern coast.

## Western Coastal Plain

The western coast is sandwiched between the Western Ghats and the Arabian Sea. It is a narrow plain and consists of 3 sections as mentioned below:

- The northern part of the coast is called the **Konkan** (Mumbai – Goa)
- The central stretch is called the **Kannad Plain**
- The southern stretch is referred to as the **Malabar coast**





## The Islands

An island is a piece of sub-continental land that is surrounded by water. Lakshadweep Islands group is composed of small coral isalnds which were earlier known as Laccadive, Minicoy and Amindive.

The entire group of islands is divided into 2 broad categories:

1. The Andaman in the north
2. The Nicobar in the south

These islands lie close to the equator and experience equatorial climate and have thick forest cover.

The diverse physical features of India have immense future possibilities of development because of the following reasons.

- The mountains are the major sources of water and forest wealth.
- The northern plains are the granaries of the country. They provide the base for early civilisations.
- The plateau is a storehouse of minerals, which has played a crucial role in the industrialisation of India.
- The coastal region and island groups provide sites for fishing and port activities.

## SUMMARY

The Indian subcontinent, flanked by the towering mountains in the north and girdled by the seas and the ocean in the south stands distinct from the rest of Asia. This explains why the subcontinent has been able to develop a distinctive culture of its own. India occupies a dominant position in the subcontinent as it alone claims three fourths of the total population. Also, it has fairly long common frontiers with each member of the subcontinent. Being located at the head of the Indian Ocean it is in a very good position to promote trade with the continents of Asia, Africa and Australia. This, however, has been minimised by adopting 82030' E longitude as the standard meridian of India whose local time is taken to be the standard time for the entire country. In terms of area, India stands seventh in the world but in population it ranks second next only to China. It means there is tremendous population pressure on our limited land and water resources. The physiographic divisions of India are very bold and highly contrasting. In fact, each one of them can be presented as an ideal example of its kind - be it a mountain; a plateau or a plain. Besides adding to the diversity, they also stress economic complementarity. They make all these macro regions entirely interdependent on one another, making the whole country a single economic and political entity benefiting each and every part - big or small.

## EXERCISE

### MCQ

1. The northern most range of the Himalayas is known as
   (a) Himadri (b) lesser Himalaya
   (c) Shivalik (d) none of the above.
   **Answer:** (a) Himadri

2. The Kangra and Kullu valley are located in
   (a) Uttarakhand (b) Jammu and Kashmir
   (c) Himachal Pradesh (d) Uttar Pradesh
   **Answer:** (c) Himachal Pradesh

3. Majuli is a riverine island located in the river
   (a) Ganga (b) Brahmaputra
   (c) Yamuna (d) Kaveri
   **Answer:** (b) Brahmaputra

4. Dudhwa National Park is located in the state of
   (a) Assam (b) Uttar Pradesh
   (c) Madhya Pradesh (d) Rajasthan
   **Answer:** (b) Uttar Pradesh

5. The soil containing calcareous deposits is locally known as
   (a) Bhangar (b) Khadar
   (c) Bhabar (d) Kankar
   **Answer:** (d) Kankar

### Review Questions

1. Give a brief account of the Himadri Range under the following headings. (a) Location (b) Their average height and length (c) A few major peaks (d) Few prominent glaciers and (e) Major passes - one each from Jammu & Kashmir, Himachal Pradesh and Sikkim.
2. Differentiate between: (a) Eastern coastal plains and western coastal plains. (b) Western ghat and Eastern ghat. (c) The Himalayan rivers and peninsular rivers.
3. Divide the Great Plateau into two physiographic divisions and describe briefly the Central High Lands under the following heading - (a) Aravalli Hills (b) Malwa plateau and its eastern extensions (c) Vindhyachal Range.
4. Write a brief description of Northern Plains, a sub-division of Great Northern Plains of India; under the following headings. (a) Location and extent (b) Major rivers.
5. Define the following - (a) Standard Meridian of India (b) Rift Valley (c) Drainage System.

# 13 CLIMATE OF INDIA

- Understand the concept of climate.
- Discuss the features of climate of India.
- Describe the types of climate.
- Discuss the features of various types of climate.

## Objective of the chapter:

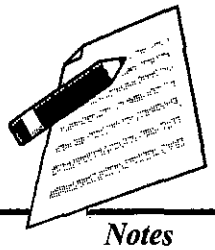
The basic objective of this chapter is to through some light on the initial concepts of Indian climate so that the types and features of Indian climate can be learned.

## Introduction

The **climate of India** comprises a wide range of weather conditions across a vast geographic scale and varied topography, making generalizations difficult. Climate in South India is generally hotter and extremely humid than North India: South India gets more humid due to nearby coasts. Southern half of the nation don›t experience temperatures below 10 °C (50 °F) in winter, and the temperature usually tends to exceed 40 °C (104 °F) during summer. Based on the Köppen system, India hosts six major climatic sub types, ranging from arid deserts in the west, alpine tundra and glaciers in the north, and humid tropical regions supporting rain forests in the southwest and the island territories. Many regions have starkly different microclimates, making it one of the most climatically diverse countries in the world. The country's meteorological department follows the international standard of four seasons with some local adjustments: winter (January and February), summer (March, April and May), monsoon (rainy) season (June to September), and a post-monsoon period (October to December).

India's geography and geology are climatically pivotal: the Thar Desert in the northwest and the Himalayas in the north work in tandem to create a culturally and economically important monsoonal regime. As Earth›s highest and most massive mountain range, the Himalayas bar the influx of frigid katabatic winds from the icy Tibetan Plateau and northerly Central Asia. Most of North India is thus kept warm or is only mildly chilly or cold during winter; the same thermal dam keeps most regions in India hot in summer.

Though the Tropic of Cancer—the boundary that is between the tropics and subtropics—passes through the middle of India, the bulk of the country can be regarded as climatically tropical. As in much of the tropics, monsoonal and other weather patterns in India can be strongly variable: epochal droughts, heat waves, floods, cyclones, and other natural disasters are sporadic, but have displaced or ended millions of human lives. Such climatic events are likely to change in frequency and severity as a consequence of human-induced climate change.





Ongoing and future vegetative changes, sea level rise and inundation of India's low-lying coastal areas are also attributed to global warming.

## Climatic variations in India

You have studied the shape, size, location and latitudinal extent of India. You have also noted the sharply contrasting relief features of India. This has created regional diversities in climatic conditions. The climatic conditions of southern India are a bit different from those of the northern parts with respect to temperature, rainfall and commencement as well as duration of different seasons. Now, let us have a closer look at these climatic variations.

During June, the north western plains experience high temperature around 45°C when areas of Rajasthan desert record day temperatures around 55°C, while the temperatures around Gulmarg or Pahalgam in Kashmir are hardly around 20°C. Similarly, in the month of December, the people of Kargil or Dras(in Jammu & Kashmir) experience biting cold because the night temperatures drop to -40°C, while the inhabitants of Thiruvananthapuram experience temperatures around 27° C. The range of temperature increases as one moves away from coastal areas to interior parts of the country. As a result, the people living along Konkan and Malabar coasts do not experience extremes of temperatures or marked change in seasons.

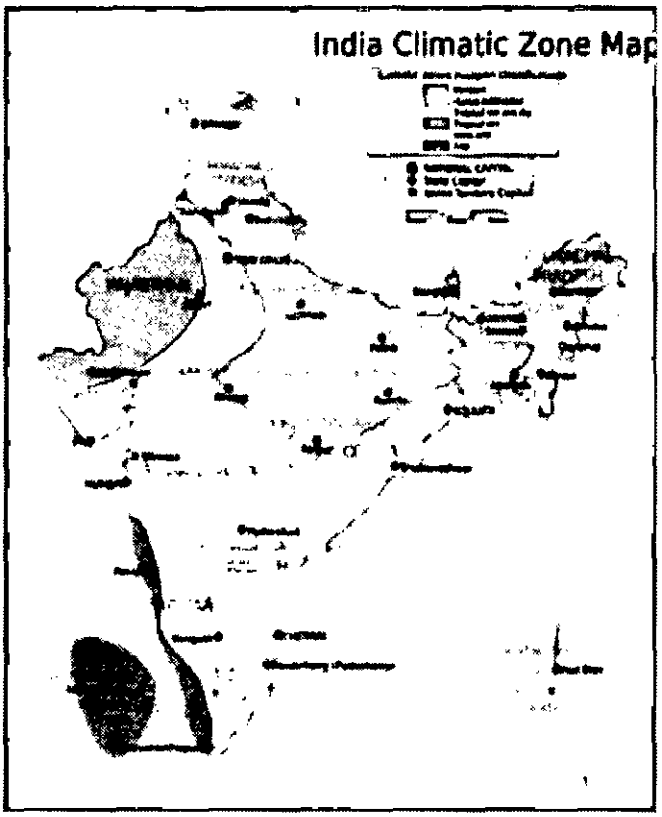
On the other hand, people living in north western parts of India, experience sharp seasonal contrasts. The diversity in rainfall distribution is equally striking. Mausimram, near Cherrapunji in Meghalaya, receives about 1080 cm of rainfall annually, while Jaisalmer in the desert of Rajasthan receives only 20 cm of annual rainfall. The northeastern parts and the coastal plains of Orissa and West Bengal experience spells of heavy rain during July and August while the Coromondel coast of Tamilnadu receive very meager rain during these months which show the dates of onset and withdrawal of Southwest monsoons respectively. This will help you to understand the difference in the duration of rainy season in different parts of India. You will come to the conclusion that the duration of rainy season is the shortest in Northwest India and longest in the South and North eastern parts of the country.

## Climate and Weather

Climate is a total of weather conditions and variations over a large area for a very long period of time of more than thirty years. But how is weather different from climate? Weather refers to the state of the atmosphere over an area at any given period of time. Weather can change throughout the day whereas the climate of a country is the same for many years.

## The Climate of India

The climate of India is described as a monsoon type. This type of climate is found in south and southeast Asia. However, there are variations in climatic conditions in the country itself. The coastal regions of India show the least amount of difference between the temperatures of night and day. In the interior regions, the difference in temperatures of day and night is huge.




## Climatic Controls

Climatic controls are the factors that control the variations in temperature in the climate of India. There are six major climatic controls. They are:

- **Latitude:** As the earth is round, sunlight does not reach everywhere equally. The temperature decreases as we move from the equator to the poles.
- **Altitude:** As we move from the surface of the earth to the higher altitudes, the temperature decreases.
- **Pressure and wind system:** The pressure and wind system of any area depend on the latitude and altitude of that place. Thus, it influences the temperature accordingly.
- **Distance from the sea:** Coastal regions are cooler as compared to interior regions. As the distance from the sea increases, its influence decreases and the people experience extreme weather conditions.
- **Ocean currents:** Cold ocean currents flowing over a region will decrease the temperature of that area whereas warm currents will increase the temperature.
- **Relief features:** Relief features are the barriers that block currents from entering the country. High mountains act as barriers for cold or hot winds.

## Factors affecting the Climate of India

## Latitude

We know that Tropic of Cancer, which separates the tropical areas and the sub-tropical areas of the earth, passes through the middle of Rann of Kuchchh in the west to Mizoram in the east. Therefore, the climate of India has characteristics of both tropical and sub-tropical climates.

## Altitude

India has very tall mountains of about 6000 meters. The Himalayas prevent the cold winds from central Asia from entering India. It is due to this reason that India has a milder winter as compared to central Asia.

## Pressure and Winds

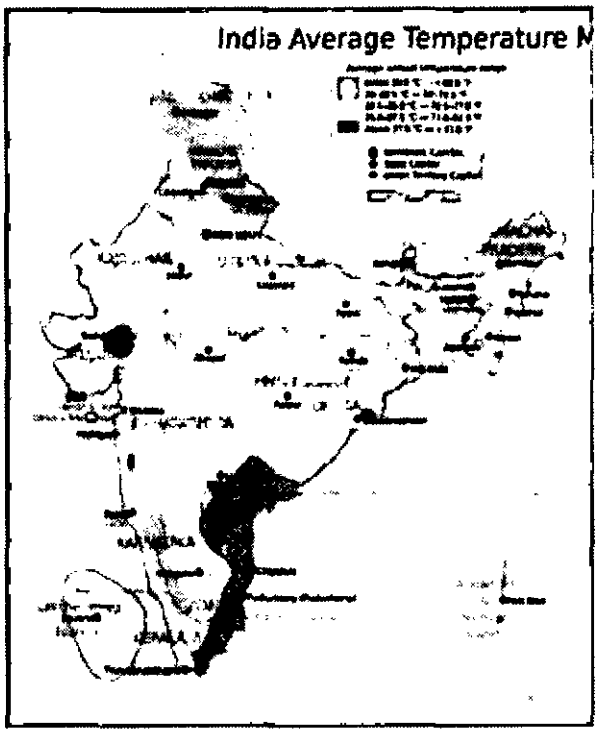
India has unique wind and pressure conditions. During winter, the northern area near the Himalayas has high pressure. Therefore, winds from this region blow to the south where the pressure is lower. In summer, the northern part has lower pressure. Therefore, there is a reversal of wind direction. The winds from the south blow towards the north. These winds greatly affect the climate of India.

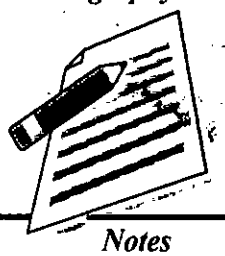
## The Indian Monsoon

The climate of India depends greatly on monsoon winds. The monsoons usually happen due to the differential heating of land and water. You probably know that land heats faster than water. This change in heating leads to a difference in pressures, which in turn leads to currents. Thus, the changes in pressure conditions also affect the monsoons. Normally, there is high pressure in the tropical eastern-south Pacific Ocean and low pressure in the tropical eastern Indian Ocean. But as years have gone by, there has been a reversal in the pressure conditions. Therefore, the eastern Pacific has lower pressure. This periodic change in pressure conditions is known as Southern Oscillations or SO.

## The Seasons

The climate of India has distinct seasonal patterns. The weather conditions change greatly from one season to another. The changes in temperature are extreme in the interior regions. The coastal regions do not experience extreme temperatures.







## The Cold Weather Season (Winter)

The cold weather season in India begins from mid-November and stays until February. December and January are the coldest months. The temperature decreases as we go from south to north. The average temperature in the south in winter is 24° – 25° while in the north, it is between 10° and 15° Celsius.

## The Hot Weather Season (Summer)

The hot weather season in India is from March to May. In May, the temperatures go up to 45° in the northwestern parts of the country. Towards the end of the summer season, there are pre-monsoons showers common in Kerala and Karnataka. They are often referred to as 'mango showers' because they help in the early ripening of mangoes in these states.

## The Advancing Monsoon (Rainy Season)

By early June, the trade winds of the southern winds bring abundant moisture to the country. The windward side of the Western Ghats receives very heavy rainfall, more than 250 cm. The monsoon is known for its uncertainties. While it causes heavy floods in one part, it may be responsible for droughts in the other. It is also irregular in arrival and retreat.

## Retreating Monsoons (Transition Season)

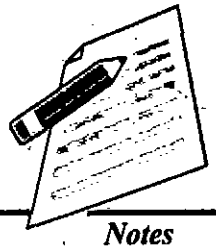
During October-November, the monsoons become weaker. The sun moves towards the south. By the beginning of October, monsoon withdraws from the Northern Plains. There is a transition from hot rainy season to dry winter season.

## Distribution of Rainfall

Some parts of India receive about 400 cm of rainfall annually. However, it is less than 60 cm in Rajasthan and adjoining parts of Gujarat, Haryana, and Punjab. The rest of the country receives moderate rainfall. Owing to this nature of monsoons, the annual rainfall is highly variable from year to year.

## SUMMARY

India is a country of climatic diversities which are expressed in the variations in the distribution of temperature, pressure, winds and amount of precipitation. The factors which are responsible for determining the climate of different regions of India include her location and latitudinal extent, physiography, the role of Himalayan ranges as a climatic divide, the monsoon winds, upper air circulation, western disturbances and cyclonic storms. Derived from Arabic word 'mousim', monsoon implies the rhythm of season and seasonal reversal of winds. Meteorologically, the year in India is divided into four seasons namely the cold weather season, the hot weather season, the advancing southwest monsoon season and the retreating southwest monsoon season. These seasons have different characteristics of weather conditions.





## EXERCISE

### MCQ

1. Monsoons arrive in India approximately in:

   a) early may  b) early June

   c) early July  d) early August

   **Answer:** b)

2. Which region gets first monsoon in summer?

   A. Himalayas  B. Western Ghats

   C. Eastern Ghats  D. Gangetic Plain

   **Answer:** Option B

3. The northeastern hills that block the South West Monsoon winds and cause heavy rains in Assam are

   A. Arakan Yoma and Pegu Yoma

   B. Garo, Khasi and Jaintia hills

   C. Barail and Patkai hills

   D. Khasi and Pegu Yoma

   **Answer:** Option B

4. The average annual temperature of a meteorological station is 26°C, its average annual rainfall is 63 cm and the annual range of temperature is 9°C. The station in question is _____

   A. Allahabad  B. Chennai

   C. Cherapunji  D. Kolkata

   **Answer:** Option B

5. The reason for Rajasthan being deficient in rainfall is _____

   A. The monsoon fails to reach this area

   B. It is too hot

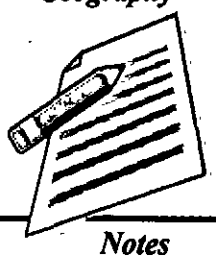
   C. There is no water available and thus the winds remain dry

   D. The winds do not come across any barrier to cause necessary uplift to be cooled

   **Answer:** Option D

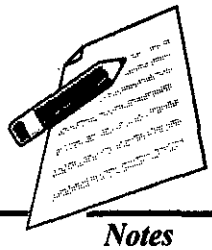
### Review Questions

1. How do western disturbances influence the weather conditions of north west India?
2. Distinguish between: (i) The cold weather season and hot weather season; (ii) The southwest and northeast monsoons.



*Notes*

3. Give reasons : (i) Dras in Kargil is always colder than Thiruvananthapuram. (ii) Winter is dry and cold over greater parts of India. (iii) Southwest monsoons start retreating from northern India after September. (iv) The western coastal plains receive more rainfall compared to the interior plateau region lying east of the Western Ghats.
4. Describe five major factors which influence the climate of India. Illustrate your answer with examples.
5. Explain with suitable examples the uneven distribution of rainfall in India.
6. Identify the characteristics of monsoons in India.
7. Locate and label the following on the outline maps of India (i) Dras and Cherrapunji; (ii) Areas receiving rainfall from 'western disturbances'; (iii) Areas receiving rainfall from northeast monsoons. (iv) Areas receiving annual rainfall less than 20 cm.



# 14 OUR RESOURCES

- Understand the concept of resources.
- Discuss the features of resources.
- Describe the types of resources.
- Discuss the uses of various types of resources.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of resources so that the types and features of resources can be learned.

## Introduction

Etymologically, 'resource' refers to two separate words —'re' and 'source' —that indicate any thing or substance that may occur unhindered many more times. The term 'Resource' had no special significance till the early part of the twentieth century.

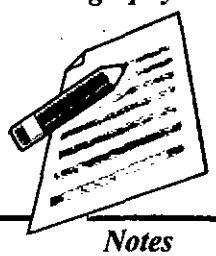
Only in 1933, when the eminent professor of economics Erich W. Zimmermann promulgated his famous **"Concept of Resource"**, the idea became so popular that numerous articles and papers started pouring in the contemporary Economic Geographical literature. Urgent need was felt to identify the new concept as a separate and important branch of study.

## Resource, popularly, signifies:

(a) A source or possibility of assistance.
(b) An expedient.
(c) Means of support.
(d) Means to attain given end.
(e) Capacity to take advantage of opportunities.
(f) That upon which one relies for aid, support or supply.

The above definitions vary markedly and fail miserably to produce any comprehensive universally accepted meaning of resource. However, after critical examinations and analyses all these meanings can be grouped into two, i.e., resources may help us if we are:

(a) Taking advantage of opportunity.
(b) Overcoming obstacles or resistances.





The first is a positive approach, the second role of resource is, surely, negative.

Resource can be subjective as well as objective. Subjective resource denotes internal resource, objective resource is external resource.

Prof. Zimmermann's inimitable definition runs: "The word resource does not refer to a thing or a substance but to a function which a thing or a substance may perform or to an operation in which it may take part, namely, the function or operation of attaining a given end such as satisfying a want. In other words, the word resource is an abstraction reflecting human appraisal and relating to a function or operation".

So, resource satisfies individual human wants or attains social objectives. It also refers to the positive interaction between man and nature. Man is, of course, the most important and integral part of resource creation, as he is situated in the top of the hierarchy of resource consumption. Only the satisfaction of human beings converts anything or a substance into resource.

A thing or substance is not considered as resource when it fails to give satisfaction to human beings. Proven reserves of petroleum in the midst of inaccessible terrain or in the abyss is not considered resource as they fail to yield any satisfaction to either society or individual.

Geo-thermal energy in this contemporary world is considered to be the most useful resource, but, till recently, this heat-flow was not considered as resource—because man was absolutely ignorant about its uses.

## Resource must possess two important properties:

(a) Function ability, and

(b) Utility.

To define anything or substance as resource, one must critically examine whether it has the property of both utility or function ability. The presence of both utility and function ability is mandatory for resource creation. For example, a bottle of poison has function ability but it has got no utility value as food. The function ability is also the function of space and time.

The resource of yesteryears may not be considered as resource today, resource considered by one country may be considered as waste product by another country, e.g., frog is considered as delicious food in Europe while it is not edible in large sections of India. Petroleum was not considered as resource until 27th August 1859, since the world's first commercial oil-well was dug at Titusville, Pennsylvania, U.S.A.

## Resource and Wealth:

In day-to-day life, a common man often uses the terms resource and wealth for same purpose and meaning. Both the words signify the same expression. But, in economics and resource study, these words convey separate meanings.

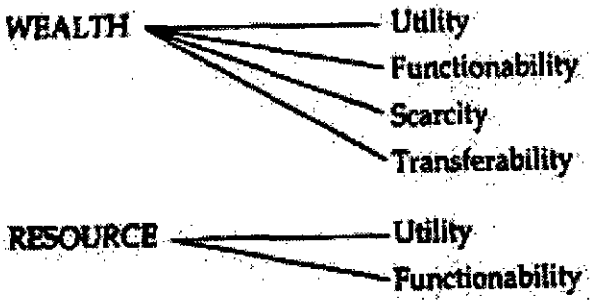
Wealth, as stated by noted economist J. M. Keynes, **"consists of all potentially exchangeable means of satisfying human wants"**. So, wealth must possess Utility, Function ability, Scarcity and Transferability. But wealth is always measurable, i.e., wealth can be expressed in terms of measuring units, like rupees.

In this manner, culture cannot be considered a wealth as it cannot be expressed by any measuring unit.

On the contrary, resource may be tangible as well as intangible substances. Anything satisfying human wants can be termed resource—be it tangible or not.

Wealth is synonymous with valuables, i.e., it should be scarce while resource may be ubiquitous or abundant, e.g., sunshine, air etc.

## Different properties of wealth and resource are:




So, all wealth's are resource but all resources are not wealth. Resource incorporates much more than wealth in a sense that culture, technology, innovative power, skill and different other aspects are included in the realm of resource.

## Some Discarded Ideas and Popular Misconceptions about Resources:

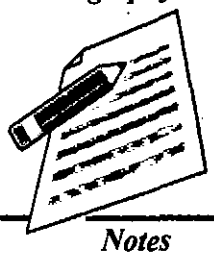
Since time immemorial, consciousness about resource is a part of both individual and society. In fact, when human beings began community life to attain security and opulence- individuals started to gather wealth and power for future resource creation. For the three basic necessities of survival — food, shelter and clothing—man had no other option but to be aware about the resources.

Ever since Industrial Revolution (1760), the values, ethics, culture, community life, agrarian economy all received severe blow. New concepts of social welfare state, ultra-capitalism, economic colonialism affected human life. The increasing gap between 'haves' and 'have-not's enhanced internal social tensions. To combat this, emergence of socialism, communism again increased the differences between different schools of thought.

According to the prevailing changes in society in different era, the concept of resources had also gone through changes —in harmony with space and time.

## The major popular misconceptions about resource in earlier periods were:

1. Substances or tangible things like coal, copper, petroleum etc. are resources.
2. Invisible or intangible aspects — peace, culture, wisdom, policy, decisions, knowhow, knowledge, freedom—cannot be considered as resource.
3. Only natural things or substances, freely bestowed by mother earth, can be considered resource. Resource cannot be created.
4. Human populations were not considered as resource.
5. Only the quantum and magnitude of substances, not their usability or function ability and quality, were measured.
6. Resource was considered as mere 'static' and fixed asset, its mobility, dynamism and expansion ability were totally ignored.
7. The concept of resistance was totally unknown. So, matter full of resistance and no function ability was also considered as resource.





In pre-Zimmermann era, only tangible or material substances were considered resources. Different minerals like iron ore, copper, bauxite, different fuels like coal, petroleum etc. were considered resource while intangible things like peace, culture, wisdom, policy decisions etc., were not considered as resource.

In those days, widespread belief was 'Resource cannot be created'. It is a free gift of nature. Only the natural things or substances can be considered as resource. Creation, modification or extension of resource was practically unknown to that medieval world.

The role of man was grossly underestimated in earlier times. Only after the resource concept was introduced role of man in the overall resource creation process was clearly understood. In this context we can recall the legendary remarks of Prof. Zimmermann: "man's own wisdom is his premier resource—the key resource that unlocks the universe".

Considering resource, a static or fixed asset was another misconception in those days. In reality, the potential ability of resource cannot be measured precisely, as, always, it may increase with improved technological advancement. Zimmermann opined that resource is as dynamic as the civilization itself.

Early geographers were totally ignorant about the property of resistance hidden within things or substances. If resourcefulness is considered as positive aspect of resource, resistance is the opposite to that of resource like assets and liabilities or profit and loss.

## Resource, Resistance and Neutral Stuff:

There is a total antagonistic relationship between resource and resistance—like light and shade. This inverse relationship is the key issue in the overall scheme of resource creation. Anything or any process that restricts substance becoming resource is called neutral stuff. Fertility of soil is resource but barrenness is resistance. Rain may be considered resource but flood is resistance. In the same manner, knowledge is a key resource while ignorance is the worst type of resistance.

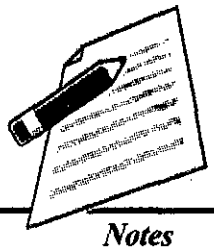
In this connection, the concept of neutral stuff has been introduced by Prof. Zimmermann. Anything or substance, be it tangible or intangible, should be either resource or neutral stuff. If anything, or substance does not contain function ability or utility value, it is termed neutral stuff.

A neutral stuff should not necessarily remain neutral forever. What is considered neutral stuff today may transform into resource tomorrow. Man's knowledge, wisdom and technological innovation may transform neutral stuff into precious resource, e.g., petroleum was not considered resource until 1859, because man was quite ignorant about its uses while, with the development of science and technology, it is now considered as a mainstay for harnessing energy.

The process of economic development is directly proportional with the rate of conversion of neutral stuff into resource. The advancement of modern civilization is synonymous with the transformation of neutral stuff into resource.

If we peep through the windows of history, it reveals that despite having enormous amount of minerals, water resources, human resources, wealth etc., some countries could not develop themselves, while others — without having any significant minerals, water etc. —because of their technology, skill, zeal, national pride and simple endeavour were able to transform their own meagre neutral stuff into resources and ultimately witnessed meteoric rise. Bihar has about double the total resources of Japan. Yet Bihar is one of the (if not the) poorest states in India, while Japan's development is unique!!

So, minimization of resistance is the only way to maximize resource creation.





## Functional Theory of Resources:

"Resources were defined as means of attaining given ends, i.e., individual wants and social objectives. Means take their meaning from the ends which they serve. As ends change, means must change also". This statement of Zimmermann clearly states that resource creation is a function of space and time. With increasing knowledge, function of resource may enhance.

A primitive man may not be able to harness resource from a substance but a supra-animal modern man may, by his scientific Midas touch, transform such simple substance into a precious resource. To a man of animal level resistance plays a very dominant role—where nature poses obstacle for resource creation—but, to a modern Man, knowledge plays a key role to convert neutral stuff into resource.

The tropical Africa is well endowed with huge water resources. Due to backward economy and technological drawbacks, inhabitants of that region cannot convert it into energy. On the contrary, the Japanese were able to produce huge energy from far less water resources. This is because of scientific knowledge, expertise and greater economic development.

The advancement of civilization is the product of expansion of human information base. Information about minerals—coal, petroleum, iron ore, copper etc., about agriculture — HYV seeds, pesticides, insecticides etc., about manufacturing industry—the invention of steam engines, boilers, turbines, converters etc., were possible with the increasing scientific knowledge.

This increasing knowledge reduced the resistances of the natural things or substances and converted them to resources. So, Wesley C. Mitchell had aptly said: "Incomparably greatest among human resources is knowledge".

So, with the efforts of man, through the functional or operational process, resource is dynamically created. Without human effort resource cannot be created because man is the ultimate consumer of resource. Without any operational process, a thing or substance remains neutral, resource cannot be created and what is created now may be enhanced or increased with increasing knowledge. So, resource creation process is highly dynamic in nature.

## Dynamic Concept of Resource:

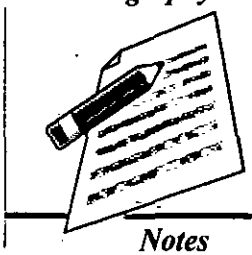
## Prof. Hamilton said:

"It is technology which gives value to the neutral stuffs which it processes; and as the useful arts advance the gifts of nature are remade. With technology on the march, the emphasis of value shifts from the natural to the processed good".

So, resource creation process is not static, it is dynamic in nature. The thing or substance considered as neutral stuff today may be converted into precious resource tomorrow. Since the beginning of civilization, Paleolithic man started devoting his limited knowledge to convert neutral stuff into resource for his own requirement.

With the passage of time, with increasing knowledge, man was able to harness more resource from same amount of stuff. Bowman has rightly remarked: "The moment we give them human association they are as changeful as humanity itself".

With the increasing need, man frantically explored all possibilities or avenues to expand resource base from his existing stock. So, resource creation is a continuous and need-based operation. At the present era, when the world is passing through acute energy crisis, man is exploring possibilities to produce energy from all sources —solar energy, wind energy, geothermal energy etc.





Previously ocean current was never considered as resource but, now, man is able to convert this force into energy. So, the concept of resource is dynamic and resource study is a dynamic science.

## Classification of Resources:

## In general, resources are classified into two groups:

(a) Material resources, and

(b) Non-material resources.

Material resources are tangible substances, e.g., petroleum, iron ore, copper, water etc.

Non-material resources are intangible substances like health condition, culture, ethics, freedom, environmental harmony etc.

Material or tangible resources are direct, i.e., freely bestowed by nature.

Non-material or intangible resources are cultivated by human beings with the help of increasing knowledge.

## Material resources may, again, be sub-divided into two groups:

(i) Organic resources like forest, fish, livestock etc.

(ii) Inorganic resources like iron ore, manganese, mica etc.

## On the basis of durability, resources may be classified into two groups :

1. Fund or exhaustible resources that is, not everlasting, destroyed for ever after use, e.g., coal, petroleum, uranium etc.
2. Flow or inexhaustible resources — supply of resource remains unchanged even after renewed use, e.g., river water, sea-wave, sunshine, airflow etc.

Ownership is another parameter to classify resource.

## On the basis of ownership resource may be divided into following groups:

### (a) International or world resource:

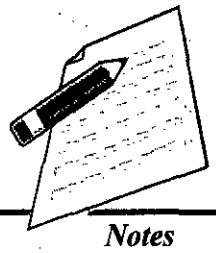
Owned by global population, i.e., the total resources owned by all individuals and nations put together. The sum total of all material and non-material resources comes under this category.

### (b) National resources:

The sum total of resources of the inhabitants of the nation and resources of the nation itself.

### (c) Individual resources:

Both tangible resources, i.e., property, money, wealth, and intangible resources, i.e., knowledge, wisdom, health etc. owned by any individual is known as individual resources.



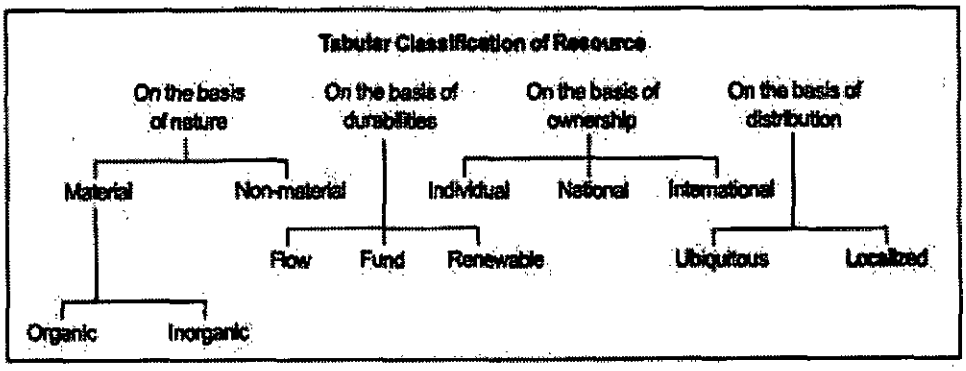


**On the basis of availability of resources, it can be classified into two groups:**

(a) Ubiquitous,

(b) Localized.

Ubiquitous type of raw materials is found everywhere, e.g., sunshine, air etc. while localized raw materials are available only in some places, e.g., petroleum, uranium, iron ore etc.




## Natural Resources

Man lives in nature and depends on the resources of nature. The progress of mankind depends upon the exploitation of different natural resources. The utilization of soil, water, coal, electricity, oil, gas and nuclear energy is very important for the development of a nation. These resources have changed the living standards of man. India contains the world's largest resource of coal and third and fourth largest resource of manganese and iron.

The world is facing an ecological crisis and is degrading her natural resources day by day, due to over exploitation. India is no exception.

Food, shelter and clothing are the primary requirements of man. Early human society has used natural resources, relatively in much less quantity to cover its wants.

## Types of natural resources

Natural resources are classified in different ways. i.e., on the basis of chemical composition, availability and distribution.

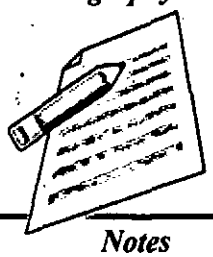
A. Natural resources are of three types on the basis of their chemical composition

1. Inorganic Resources. **e.g., air, water and minerals**
2. Organic Resources **e.g., plants, animals. micro-organisms and fossil fuels.**
3. Mixture of Inorganic and Organic Resources, **e.g., soil**

B. Natural resources are of two types depending upon their availability and abundance.

## 1. Inexhaustible Resources

They are not likely to be exhausted by man's use. They are air, clay, sand, tidal energy etc. Although the air is available in exhaustible quantity, it can be degraded, if its pollution is not checked.





## 2. Exhaustible Resources

They are likely to be exhausted by human use. They are further of two types-renewable and non-renewable.

### a. Renewable Resources

They have inherent capacity to reappear or replenish themselves by quick recycling, reproduction and replacement within a reasonable time. Soil and living organisms are the main renewable resources.

### b. Non- Renewable Resources

They lack the ability for recycling and replacement. The substances with a very long recycling time are also regarded as non-renewable resource e.g., fossil fuels like coal, petroleum and natural gas and minerals.

It is important to note that underground water, forests and wild life are regarded renewable resources but become non-renewable, if they are not used properly.

## Energy resources

**Source:** Ecologically man is only a part of energy flow in nature. Man requires energy for his daily needs. The major energy sources are fuel wood, fossil fuels such as coal, petroleum and natural gas. Apart from these, the other direct energy resources are sunlight, hydroelectric and wind power, tidal, geothermal and nuclear energy.

**Energy Requirement:** During early stages of human civilization, the daily per capita need for energy was just 2,000-4,000 kilo calories. During the agricultural stage, the muscular energy of domestic animals was used for work. The per capita energy consumption gradually increased. In nineteenth century, during the industrial stage of human civilization, the use of fossil fuel started and the per capita energy requirement increased to 70,000 kilo calories per day.

Today we need energy for agriculture, industry, transport, communication, comfort and defence. The per head energy consumption varies from country to country

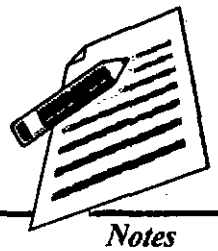
## Depletion of fossil fuels

Today the world's energy resources have reached critical stage. Most of the world's human population uses fossil fuels (coal, petroleum and natural gas). The fossil fuel resources are being rapidly depleted. As a result, these resources may last only another few century. The dwindling stocks of fuels has led to the search of alternate sources of energy.

## Conservation of Natural Resources

Management of the human use of natural resources to provide the maximum benefit to current generations while maintaining capacity to meet the needs of future generations. Conservation includes both the protection and rational use of natural resources. Earth's natural resources are either non-renewable, such as minerals, oil, gas, and coal, or renewable, such as water, timber, fisheries, and agricultural crops.

The combination of growing populations and increasing levels of resource consumption is degrading and depleting the natural resource base. Non-renewable resources, such as fossil





fuels, are replaced over geologic time scales of tens of millions of years. Human societies will eventually use up all of the economically available stock of many non-renewable resources, such as oil.

Conservation entails actions to use these resources most efficiently and thereby extend their life as long as possible. By recycling aluminium, for example, the same piece of material is reused in a series of products, reducing the number of aluminium ore that must be mined. Similarly, energy-efficient products help to conserve fossil fuels since the same energy services, such as lighting or transportation, can be attained with smaller amounts of fuel.

It may be expected that the biggest challenge of resource conservation would involve non-renewable resources, since renewable resources can replenish themselves after harvesting. In fact, the opposite is the case. Historically, when non-renewable resources have been depleted, new technologies have been developed that effectively substitute for the depleted resources. Indeed, new technologies have often reduced pressure on these resources even before they are fully depleted.

Fiber optics, for example, has substituted for copper in many electrical applications, and it is anticipated that renewable sources of energy, such as photovoltaic cells, wind power, and hydropower, will ultimately take the place of fossil fuels when stocks are depleted. Renewable resources, in contrast, can be seriously depleted if they are subjected to excessive harvest or otherwise degraded, and no substitutes are available for, say, clean water or food products such as fish or agricultural crops.

## SUMMARY

Natural resources which satisfy material and spiritual needs of humans are the free gifts of the nature. Any material found on the earth becomes a resource only when it has got some utility. It is therefore human ability and need which create resource value. Resources form the backbone of the economy of a nation. They constitute the natural environment like air, water, forests and various life forms, which are essential for human survival. They are the bases for economic strength and prosperity. There are two types of resources on the basis of their origin - biotic and abiotic. Biotic resources include forests and all forest products, crops, birds, animals, fish and other marine life forms. Abiotic resources include land, water and minerals e.g., iron, copper, gold and silver. About 23 percent of total area of India is covered by forests. About 75,000 species of animals are found in India. Wide climatic variations and a long crop growing season has put an advantage before India to grow variety of crops. India has nearly three-fifths or about 57 percent of the world's buffalo population and 15 percent of the cattle population. Further, the large continental shelf provides large scope for the development of fisheries in India. Vast size of India in itself is the most important resource. Large water resources are found in form of surface water, ground water, rains and oceans. Mineral wealth of India is equally rich. Conservation of resources stands for judicious and planned use of natural resources. It is necessary to create awareness among people about the preservation and conservation of resources. Various methods like afforestation, terrace farming in hilly regions, use of advanced irrigation techniques, efficient utilization of minerals and use of alternative sources of energy should be used to conserve natural resources. Government has adopted various measures to conserve natural resources. Several policies and programmes have been framed and Implemented to conserve the resources. Examples are framing of National forest policy, establishment of National land use and Conservation Board, National water policy, Mineral policy and Agricultural policy.

## EXERCISE

### MCQ

1. Which one represents the regulative function of forests?
   (a) storage and release of gases
   (b) production of essential oils
   (c) production of wood
   (d) conservation of water and soil
   **Answer:** (a)

2. In many industries, tin, steel and copper are being substituted by
   (a) ceramics (b) high-strength glass fibres
   (c) plastics (d) all of these
   **Answer:** (d)

3. Demersal fish is obtained from
   (a) open sea (b) sea bottom
   (c) estuaries (d) lakes
   **Answer:** (b)

4. Deforestation may reduce the chances of
   (a) frequent landslides (b) erosion of surface soil
   (c) rainfall (d) frequent cyclones
   **Answer:** (c)

5. Soil conservation is the process where
   (a) soil is aerated
   (b) soil is protected against loss
   (c) sterile soil is converted to fertile soil
   (d) soil erosion is allowed
   **Answer:** (b)

### Review Questions

1. Define resources and state how they are important to us.
2. Differentiate between biotic and abiotic resources.
3. Give a brief description of distribution of biotic resources in India.
4. Briefly explain the distribution of abiotic resources in India.
5. What do you understand by resource utilization? How is it related to culture?
6. Write a brief note on the extent of resource utilization in India.
7. What do you mean by conservation of resources? Explain various methods of resource conservation

# 15 LAND, SOIL AND VEGETATION RESOURCES IN INDIA

- Understand the concept of land.
- Discuss the features of land resources.
- Describe the types of soil.
- Discuss the uses of various types of vegetation resources.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of land, soil and vegetation resources in India so that the types and features of these resources can be learned.

## Introduction

We depend on natural vegetation and natural resources such as Land, Soil as well as Wildlife Resources for our survival. All these forms the basic components of our ecosystem. Let us know more about the natural resources, their conservation and their role in our ecosystem.

## Ecology and Ecosystem: What's the Difference?

The biotic (living) components that are closely related to as well as interact with the abiotic(non-living) components constitute an ecosystem. Ecosystems are mostly recognized on the basis of their geographical region. The biosphere is the region that is characterized by the presence of life.

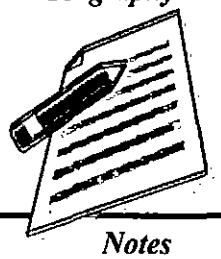
The biosphere is the narrow realm of contact and interaction between the atmosphere, lithosphere as well as hydrosphere. It is a 15 km wide layer extending from the deepest ocean trench to the highest mountain peak. It is the supporter of all life forms. There are chiefly two life forms that exist in the biosphere- the plant kingdom and the animal kingdom.

Whereas ecology is the scientific study of the processes influencing the distribution and abundance of organisms, the interactions among organisms, and the interactions between organisms and the transformation and flux of energy and matter.

## The Natural Resources

These are the materials or substances occurring in nature which can be exploited for economic gains. The most important natural resources include:

- Land
- Water
- Soil





- Natural Vegetation
- Wildlife Resources

## Significance of Land as a Resource

- Among the most important natural resources.
- Covers only about 30% of the earth's surface.
- The supporter of natural vegetation, wildlife, human life, economic activities, transport and communication systems.

## Utilization of Land

The land is an asset of a finite magnitude; therefore, it is important to use the available land for various purposes with careful planning to minimize its exploitation. Land resources are categorized into the following types on the basis of their use:

- Forests
- Non-cultivable Land that includes Barren and wasteland as well as land put to non-agricultural uses, e.g., buildings, roads, factories, etc
- Another uncultivated land (excluding fallow land)
- Fallow land
- Cultivable Land or Net Sown Area

Gross cropped area is the area that is sown more than once in an agricultural year in addition to the net sown area.

## What are Landslides?

Sliding down the slopes from mountains or hills are called a landslide. The things that come down with the sliding land mass include stones, mud, as well as debris. Landslides occurring in the steep mountainous regions are more destructive.

## Effects of Landslides

Landslides result in a lot of destruction which leads to the following

- Flowing of small rivers are checked by landslides.
- Transportation is affected.
- Streams and many plants get submerged.
- Landslides can cause loss of life and damage to property.

## Causes of landslide

The important causes resulting in landslides include

- The constant flowing of water and tides remove soils and create landslides in the mountainous regions and coastal areas.
- When railways, roads and canals are constructed in the steep mountainous areas, the slopes become steeper leading to landslides.
- Collection of loose soil on clay soil layer can enhance steep slope formation, leading to a landslide.

- *Landslides are common in the mining areas. Excavation of earth to reach the ore deposits* deep down can cause landslides.
- Deforestation and deep tilling of the slopes can result in a landslide.

## Soil as a Natural Resource

Another important natural resource is soil. It is the thin layer of a grainy substance which covers the surface of the earth. The important constituents of soil include:

- Organic matter
- Humus
- Silica
- Clay
- Sand

## Factors Affecting Formation of Soil

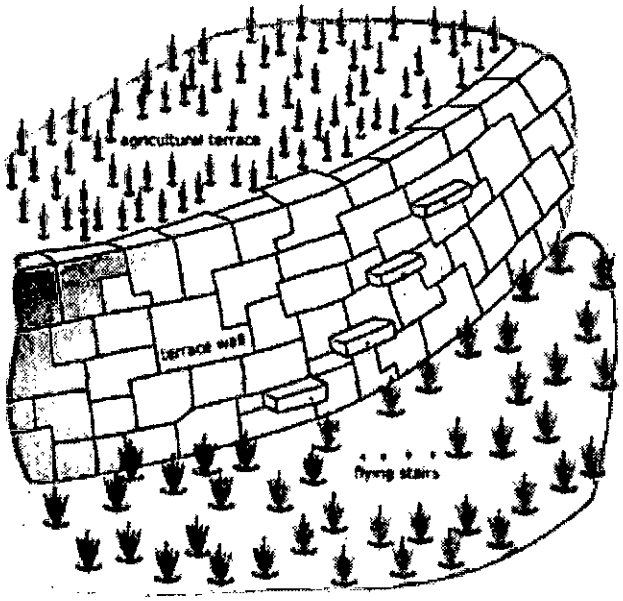
Soils are derived from parent rock material through a process of the breakup or wear and tear. Decomposed vegetal and animal remains, referred to as humus is an important constituent of soil and adds to the fertility of the soil. Besides hummus, silica, clay, and sand are the other factors affecting the formation of soil.

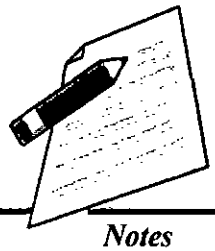
## Soil Erosion and It's Causes

Soil Erosion is the removal of the uppermost layer of soil by water, wind as well as human activities. The human activities that lead to soil erosion include deforestation and mining. It can also be caused as a result of overgrazing by animals. Natural calamities such as droughts or floods can also result in soil erosion.

## Conservation of Soil

**Soil conservation** is the preventing of soil loss from erosion or reduced fertility caused as a result of over usage or acidification, salinization as well as soil contamination caused by chemicals. The various methods that can be employed for the conservation of soil include

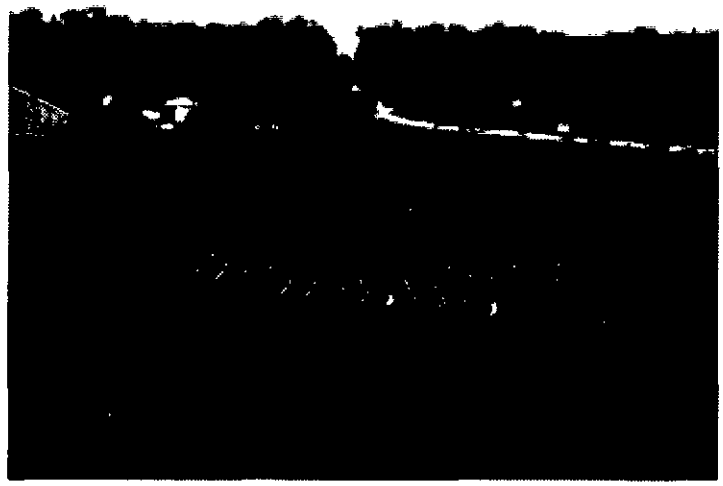






- Terrace farming
- Shelterbelts
- Contour ploughing
- Strip cropping
- Construction of dams
- Plugging gullies
- Planting trees

## Terrace Farming



## Contour Ploughing

## Water as a Natural Resource

About 97% of the earth's water supply is in the ocean. Due to high salt content, it is unfit for human consumption as well as other activities. Out of the remaining 3 percent, 2.3 percent is locked in polar ice caps. Subsequently, balance 0.7 percent is available as freshwater of which 0.66 percent is groundwater.

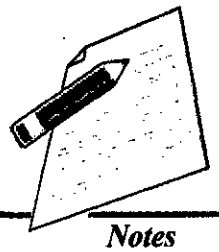
Thus, leaving a mere 0.03 percent available to us as freshwater in rivers, lakes, and streams. Therefore, despite the earth's surface being covered with water, a very small percentage is usable. Thus, there is a need for conservation of water.

## Methods for Conservation of Water

In almost all parts of Rajasthan, different methods are used to conserve water. In the historic times, the kings had built many resources for water conservation. Ponds, lakes, wells as well as step-wells are found in the different districts of Rajasthan highlighting the importance the people of this state give to water conservation.

## Natural Vegetation and Different Forest Categories

Natural vegetation refers to a plant community which has grown naturally without human aid as well as has been left undisturbed by humans for a long time. The following major categories of forests may be identified in our country:





- Tropical Rain Forests
- Montane Forests
- Tropical Deciduous Forests
- Tropical Thorn Forests and Scrubs
- Mangrove Forests

## Need for Conservation of Forests

Conservation preserves the ecological diversity as well as our life support systems such as water, air and soil. It also preserves the genetic diversity of plants and animals for better growth of species as well as their breeding. Forests not only play an effective role in controlling temperature, humidity, and precipitation but also in water percolation thereby maintaining the underground water table.

## Land

A very important natural resource, Land covers 30% of the earth's surface and not every part is habitable. Cause for the uneven population in certain parts is varied characteristics of land and climate.

| **Areas that are sparsely populated or uninhabited** | **Densely populated areas** |
|---|---|
| Rugged topography | Plains |
| Steep slopes of the mountains | River valleys |
| Low-lying areas susceptible to water | These are lands suitable for agriculture |

## Uses of Land

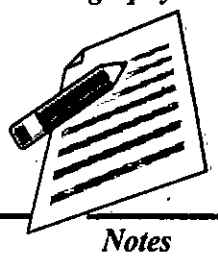
The land is used for different purposes such as agriculture, forestry, mining, building houses, roads and setting up of industries. This is commonly termed as Land use.

- Physical Factors determining the use of land- topography, soil, climate, minerals and availability of water.
- Human Factors that are human determinants of land use pattern- population and technology

Land can also be classified into private land and community land on the basis of ownership. Private land owned by individuals whereas community land is owned by the community for common uses such as the collection of fodder, fruits, nuts or medicinal herbs. Another name for community lands is common property resources. Even though people's demands are ever growing availability of land is limited thus leading people to encroach land to build commercial areas, shopping complexes in urban areas and to expand agricultural land in rural areas. This expansion of agriculture and construction activities also lead to major threats like land degradation, landslides, soil erosion and desertification.

## Conservation of Land Resource

Ever Growing population and their growing demands lead to large scale destruction of forest cover and other natural resources. Meanwhile, given below are the common methods used to conserve land resources:





- Afforestation
- land reclamation
- regulated use of chemical pesticide and fertilisers
- checks on overgrazing

## Soil

The thin layer of grainy substance covering the surface of the earth and closely linked to the land. Landforms determine the type of soil. Soil is made up of organic matter, minerals and weathered rocks found on the earth through the process of weathering. The right mix of minerals and organic matter make the soil fertile.

## Landslides

The mass movement of rock, debris or earth down a slope is known as Landslides and it often takes place in conjunction with earthquakes, floods and volcanoes. Meanwhile, a prolonged spell of rainfall can also cause a landslide.

## Mitigation Mechanism

Development in scientific techniques has empowered us to understand what factors cause landslides and how to manage them. Some of the broad mitigation techniques of landslide are given as follows:

- Hazard mapping to locate areas prone to landslides. Hence, such areas can be avoided for building settlements
- Construction of retention wall to stop the land from slipping
- Increase in the vegetation cover to arrest landslide
- The surface drainage control works to control the movement of a landslide along with rainwater and spring flows

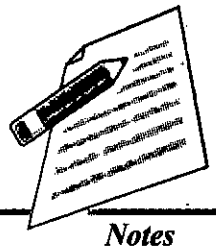
## Factors of Soil Formation

- The nature of the parent rock
- Climatic factors
- Topography
- Role of organic material
- Time taken for the composition of soil formation

## Degradation of Soil and Conservation Measures

Soil erosion and depletion are the major threats to the soil as a resource. Both human and natural factors can lead to degradation of soils. Factors, which lead to soil degradation are:

- deforestation
- overgrazing
- overuse of chemical fertilizers or pesticides
- rain wash
- landslides and floods





Meanwhile, some methods of soil conservation are given below:

**Mulching:** The bare ground between plants is covered with a layer of organic matter like straw and it helps to retain soil moisture

**Contour barriers:** Stones, grass, soil is used to build barriers along contours. Trenches are made in front of the barriers to collect water

**Rock dam:** Rocks are piled up to slow down the flow of water and also help to prevent gullies and further soil loss

**Terrace farming:** Broad flat steps or terraces are made on the steep slopes so that flat surfaces are available to grow crops, thus reducing surface runoff and soil erosion

**Intercropping:** Different crops are grown in alternate rows and are sown at different times to protect the soil from rain wash

**Contour ploughing:** Ploughing parallel to the contours of a hill slope to form a natural barrier for water to flow down the slope

**Shelterbelts:** In the coastal and dry regions, rows of trees are planted to check the wind movement to protect soil cover

## Water

Three fourth of earth's surface is covered with a vital renewable natural resource known as water. Oceans covers about 2/3rds of the earth's surface and supports a rich variety of plant and animal life. However, it is saline and not useful for human consumption. Freshwater accounts for only 2.7% and 70% of these occurs as ice-sheets and glaciers in Antarctica, Greenland and mountain region and they are inaccessible because of their location. Thus, only 1% of freshwater is useful for human consumption.

Water can neither be added nor subtracted from the earth and its total volume remains constant. Its abundance seems to vary only because of the constant motion, cycling through the oceans, the air, the land and back again, through the processes of evaporation, precipitation and run-off. This, as you already know is referred to as the 'water cycle'.

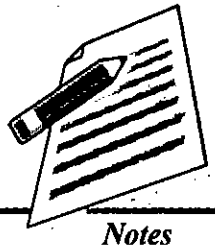
## Problems of Water Availability

Most parts of the world are facing shortages in the freshwater supply. Countries located in climatic zones most susceptible to droughts face great problems of water scarcity. Thus, water shortage may be a consequence of variation in seasonal or annual precipitation or the scarcity is caused by overexploitation and contamination of water sources.

## Conservation of Water Resources

To get access to clean and adequate water sources, steps have been taken to preserve this resource:

- Forest and other vegetation cover slow the surface runoff and replenish underground water Water harvesting is another method to save the surface runoff
- The canals used for irrigating field should be properly lined to minimise losses by water seepage
- Sprinklers effectively irrigate the area by checking water losses through seepage and evaporation
- In dry regions with high rates of evaporation, drip or trickle irrigation is very useful





- The valuable water resource can, therefore, be conserved by adopting these means of irrigation

## Natural Vegetation and Wildlife

Natural vegetation and wildlife exist only in the narrow zone of contact between the lithosphere, hydrosphere and atmosphere that we call the biosphere. In the biosphere living beings are interrelated and interdependent on each other for survival. This life-supporting the system is known as the ecosystem. Wildlife includes animals, birds, insects as well as the aquatic life forms. The birds feed on insects and act as decomposers as well. Vulture due to its ability to feed on dead livestock is a scavenger and considered a vital cleanser of the environment. So, animals big or small, all are integral to maintaining balance in the ecosystem.

## Distribution of Natural Vegetation

The growth of vegetation depends primarily on temperature and moisture. The major vegetation types of the world are grouped as forests, grasslands, scrubs and tundra.

In areas of heavy rainfall- Huge trees thrive- forests are thus associated with areas having abundant water supply. As the number of moistures decreases- the size of trees and their density reduces-short stunted trees and shrubs grow in regions of moderate rainfall. In dry areas- Thorny shrubs and scrubs grow in low rainfall areas.

## Conservation of Natural Vegetation and Wildlife

Changes in climate and human interference can cause the loss of natural habitats for the plants and animals. Deforestation, soil erosion, constructional activities, forest fires, tsunami and landslides are some of the human and natural factors that accelerate the process of extinction of these resources. One other major concern is the poaching that results in a sharp decline in the number of particular species. National parks, wildlife sanctuaries, biosphere reserves are made to protect our natural vegetation and wildlife. Conservation of creeks, lakes, and wetlands is necessary to save the precious resource from depletion.

Awareness programmes like social forestry and Vanamohatasava are also established at the regional and community level. School children are also encouraged to bird watch and visit nature camps so that they appreciate the habitat of varied species. Many countries have passed laws against the trade as well as the killing of birds and animals. In India, killing lions, tigers, deers, great Indian bustards and peacocks is illegal. Meanwhile, an international convention CITES has been established that lists several species of animals and birds in which trade is prohibited.

## SUMMARY

Land is our basic resource. It has different roles like productive economic factor, foundation for social prestige and is the basis of wealth and political power. India is well endowed with cultivable land. It has favourable land-man ratio than Japan, and Netherlands, whereas it is not as favourable as it is in Australia, Canada and the U.S.A. Land use is a dynamic process. It changes over time due to a number of factors including increasing population and changes in cropping pattern and technology. However, bulk of land continues to be used for raising crops. India faces a lot of problems related to land. They are land degradation, tenure or ownership of land and deforestation. India has adopted two broad measures, land reclamation and land



reforms to solve these problems. Soil is defined as upper layer of the earth composed of loose surface material. The soils of India are broadly divided into six groups. They are alluvial, regur or black, red, laterite, desert and mountain soils. Like land, soil also has problems such as soil erosion and soil exhaustion. Various soil conservation methods like contour ploughing terracing, shelter belt formation and afforestation are adopted in India. Natural vegetation implies the assemblage of plant species living in association with one another in a given environment. Diversity in climatic conditions has resulted into a marked diversity in natural vegetation. The important vegetation types in India include the moist tropical evergreen, the moist tropical deciduous, the dry deciduous, the tidal forests and the mountain vegetation.

## EXERCISE

### MCQ

**1.** Which of the following is an anti-forest conservation activity?

(a) preservation of wild animals (b) preservation of fires

(c) clear felling (d) economy in lumbering

**Answer:** (c)

**2.** Soil erosion can be prevented by

(a) Afforestation (b) overgrazing

(c) increasing bird's population (d) removal of vegetation

**Answer:** (a)

**3.** The energy produced by the hydel-power plant is

(a) Non-polluting and non-renewable

(b) Polluting and non-renewable

(c) Non-polluting and renewable

(d) Polluting and renewable

**Answer:** (c)

**4.** This is an example of non-polluting renewable type of energy

(a) tidal (b) wind

(c) solar (d) all of these

**Answer:** (d)

**5.** This group consists of non-renewable organic resources

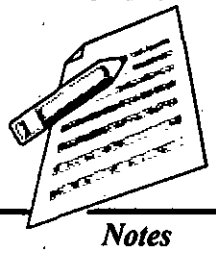
(a) Water, air and minerals

(b) natural gas, oil and coal

(c) wood, water and natural pastures

(d) sand, air and clay

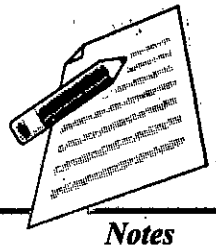
**Answer:** (b)





## Review Questions

1. What are the significant features of land utilization in India?
2. Give a brief description of various types of land use in India.
3. Write two main characteristics of each soil type of India.
4. Describe various measures undertaken for conservation of soils.
5. Differentiate between these: (a) Laterite soil and red soil (b) Soil erosion and soil conservation (c) New alluvium and old alluvium.
6. Define natural vegetation. How is a forest different from it?
7. Distinguish between Tidal vegetation and Mountain vegetation.
8. Give reasons: (i) The Himalayan vegetation belt are defined altitudinally and not horizontally. (ii) The dry regions are covered with thorny trees and bushes.
9. Locate and label the following on an outline map of India: (i) Alluvial soil. (ii) Laterite soil. (iii) Desert soil. (iv) Tidal forests and tropical thorn forest.







# 16 LAND USE AND AGRICULTURE

- Understand the concept of land.
- Discuss the features of land resources.
- Describe the types of land.
- Discuss the uses and distribution of agricultural land.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of land resources in India so that the types and features of agricultural land can be learned.

## Introduction

Land is a natural resource of utmost and ultimate importance. Land supports each and everything. For example natural vegetation, wildlife, human life, economic activities, transport and communication systems. India has land under a variety of relief features, namely; mountains, plateaus, plains, islands and many more.

## Land Utilisation:

Land resources are used for many purposes. The purposes are mentioned below:

(i) Forests

(ii) Land that is not available for cultivation

  a) Barren or wasteland

  b) Land that is put to non-agricultural uses

(iii) Fallow lands

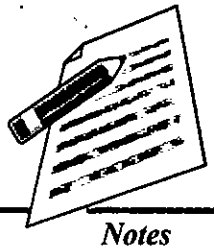
(iv) Other uncultivated lands (excluding fallow land)

(v) Net sown area

## Land Use Pattern in India

The usage of land is determined by both physical and human factors.

- Physical factors: It is dependent on nature variants such as topography, climate, soil types
- Human factors: It completely relies on human activities and usage such as population density, technological capability and culture and traditions etc.





## Explanation:

- The main utilisation and usage of land is set on two different factors physical and human. Physical factors include topography, climatic conditions depending upon the area, soil types Human factors comprises of population density, technological capability and culture and traditions etc.
- The pattern and follow up of the net sown area vary widely from one state to another.
- It is mostly over 80 per cent of the total area in Punjab and Haryana and very less than 10 per cent in Arunachal Pradesh, Mizoram, Manipur and Andaman Nicobar Islands.
- The total area occupied by forest is 33 per cent which is far lower than the estimated geographical area, which was outlined in the National Forest Policy (1952).
- It was considered mandatory for the maintenance of the ecological balance.
- Apart of this, land is termed as wasteland and land that is put up to other non-agricultural uses.
- Wasteland mainly includes rocky, arid and desert areas and land put to other non-agricultural uses includes settlements, roads, railways, industry etc.
- The repeated usage of land over a long period of time without taking adequate measures to conserve and manage has led to degradation of land.

## Land Degradation and measures to conserve land

Human activities have widely affected the land resources. The various activities of humans like deforestation, overgrazing, mining, not treating industrial waste efficiently have contributed significantly and widely to land degradation. The mining sites leave deep scars and traces of over-burdening and exploitation of the land. In recent years, numerous industrial effluents as waste have become a major source of land and water pollution in many areas of the countries.

Given below are some of the ways through which land degradation can be reduced and brought down to a minimum extent:

- Afforestation
- Proper and adequate methods of grazing
- Planting a wide number of shelter belts of plants
- Stabilisation of sand dunes by harnessing thorny bushes
- Proper management of wastelands by constructing public parks, play area for kids etc
- Control and minimise the use of mining activities
- Proper discharge methods of industrial effluents
- Proper disposal of household waste which is generated in tons day by day
- Land is a scarce resource, whose supply is fixed for all practical purposes. At the same time, the demand for land for various competing purposes is continuously increasing with the increase in human population and economic growth.

Land use pattern qt any given time is determined by several factors including size of human and livestock population, the demand pattern, the technology in use, the cultural traditions, the location and capability of land, institutional factors like ownership pattern and rights and state regulation. The land use pattern besides having economic implications has also important ecological dimensions, which if ignored can have disastrous consequences.

**Table 6.1: Land utilisation in India**

(Million hectare.

| Use | Area |
|---|---|
| (1) Area under non-agricultural uses | 23.57 |
| (2) Barren and uncultivable land | 19.26 |
| (3) Net sown area | 141.10 |
| (4) Forest lands under good tree cover | 69.41 |
| (5) Miscellaneous tree crops and groves | 3.37 |
| (6) Cultivable wastelands | 13.66 |
| (7) Current fallow(i.e. land currently left unutilised) | 14.80 |
| (8) Old fallow | 10.19 |
| (9) Permanent pastures and grasing grounds | 10.90 |

The pattern of land utilisation in India is indicated in Table 6.1. The available land is classified into two parts on the basis of its use, viz.

(i) agricultural land and

(ii) non-agricultural land.

## (1) Agricultural land:

Agricultural land (also agricultural area) denotes the land suitable for agricultural production, both crops and livestock. It includes net sown area, current fallows and land under miscellaneous trees crops and groves. Agricultural land in India totals a little over 50 percent of the total geographical area in the country. This is the highest among the large and medium-sized countries of the world.

## This indicates:

i. The influence of favourable physical factors (like size, extent of plains and plateaus, etc.) and

ii. The extension of cultivation to a large proportion of the cultivable land.

But, because of the large population of the country, the per capita arable land (i.e., land suitable for agriculture) is low: 0.16 hectares against the world average of 0.24 hectares. About 15 per cent of the sown area is multi-cropped.

While, most of the multi-cropped area is irrigated, only one-fourth of the gross cropped area is irrigated. The security provided by the irrigation facilities is a major factor in intensive application of labour and other inputs to obtain high yields.

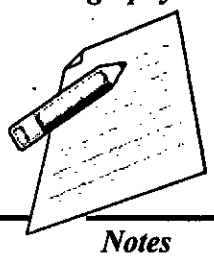
## (2) Non-agricultural land:

This includes:

(i) land under forests and permanent pastures,

(ii) land under other non-agricultural uses (towns, villages, roads, railways, etc.) and

(iii) land classified as cultivable waste as well as barren and uncultivated land of mountain and desert areas.





## Trends in Land Utilisation:

### Land Use Pattern in India, 1950-51 to 1999-2000:

The physical, economic and institutional framework taken together determines the pattern of land use of a country at any particular time. In other words, the existing land use pattern in different regions-in India has been evolved as the result of the action and interaction of various factors taken together, such as the physical characteristics of land, the structure of resources like, capital and labour available and the location of the region in relation to other aspects of economic development, e.g., those relating to transport as well as industry and trade. Table 6.2 depicts the land use trend based on these nine-fold classification from 1950-51 to 1999-2000.

**Table 6.2: Land Use Pattern in India**

| Classification | In Million hectares | | | | | |
|---|---|---|---|---|---|---|
| | 1950-51 | 1960-61 | 1970-71 | 1980-81 | 1990-91 | 1999-2000 |
| Reporting Area for land Utilisation statistics | 284.32 (100.00) | 298.46 (100.00) | 303.76 (100.00) | 304.15 (100.00) | 304.86 (100.00) | 306.54 (100.00) |
| (1) Forest | 40.48 (14.24) | 54.05 (18.11) | 63.91 (21.04) | 67.47 (22.18) | 67.80 (22.24) | 69.02 (22.52) |
| (2) Not available for cultivation | 47.52 (16.71) | 50.75 (17.00) | 44.64 (14.70) | 39.62 (13.03) | 40.48 (13.28) | 42.40 (13.83) |
| (a) Non Agricultural uses | 9.36 (3.29) | 14.84 (4.97) | 16.48 (5.43) | 19.66 (6.46) | 21.09 (6.92) | 22.40 (7.31) |
| (b) Barren and unculturable land | 38.16 (13.42) | 35.91 (12.03) | 28.16 (9.27) | 19.66 (6.46) | 19.39 (6.36) | 19.31 (6.20) |
| (3) Other uncultivated land (Excluding fallow land) | 49.45 (17.39) | 37.64 (12.61) | 35.06 (11.54) | 32.31 (10.62) | 30.22 (9.91) | 28.47 (9.29) |
| (a) Permanent pastures and other grazing land | 6.66 (2.35) | 13.97 (4.68) | 13.26 (4.37) | 11.97 (3.94) | 11.40 (3.74) | 11.04 (3.60) |
| (b) Land under Miscellaneous tree crops and groves not included in net area sown | 19.38 (6.82) | 4.46 (1.49) | 4.30 (1.42) | 3.60 (1.18) | 3.82 (1.25) | 3.61 (1.18) |
| (c) Culturable Waste land | 22.94 (8.07) | 19.21 (6.44) | 17.50 (5.76) | 16.74 (5.50) | 15.00 (4.92) | 13.82 (4.51) |
| (4) Fallow land | 28.12 (9.89) | 22.82 (7.65) | 19.88 (6.54) | 24.75 (8.14) | 23.36 (7.66) | 24.89 (8.12) |
| (a) Fallow land other than Current fallows | 17.44 (6.13) | 11.18 (3.75) | 8.76 (2.88) | 9.92 (3.26) | 9.66 (3.17) | 10.10 (3.29) |
| (b) Current fallows | 10.68 (3.76) | 11.68 (3.91) | 11.12 (3.66) | 14.83 (4.88) | 13.70 (4.49) | 14.79 (4.82) |
| (5) Net area sown (6-7) | 118.75 (41.77) | 133.20 (44.63) | 140.27 (46.18) | 140.00 (46.03) | 143.00 (46.91) | 141.23 (46.07) |
| (6) Gross cropped area | 131.89 (46.39) | 152.77 (51.19) | 165.79 (54.58) | 172.63 (56.76) | 185.74 (60.93) | 189.74 (61.90) |
| (7) Area sown more than once | 13.14 (4.62) | 19.57 (6.56) | 25.52 (8.40) | 32.63 (10.73) | 42.74 (14.02) | 48.51 (15.83) |

## Note:

Figures in parentheses are percentages.

The main conclusions emerging from the analysis regarding trend of land use in India during the period 1950-51 to 1999-2000 are as follows:

Out of the total geographical area of 328 million hectares, the land use statistics were available for roughly 284 million hectares in 1950-51; however, in 1999-2000 the reporting area is around 306 million hectares. The area, for which data on the land use classification are available; is known as the reporting area.

Area under forests includes all lands classed as forest under any legal enactment dealing with forests or administered as forest, whether state-owned or private, and whether wooded or maintained as potential forest land. The area of crops rose in the forest and grazing lands or areas open for grassing within the forests are also included under the forest area.

There has been perceptible increase in the forest area up to the year 1999-2000. It increased from 40.48 million hectares in 1950-51 to 69.02 million hectares in 1999-2000. In percentage terms, the area under forest, which constituted 14.24 per cent of the reporting area, increased to 22.52 per cent in 1999-2000.

It is apparently indicative of a healthy land-use management. However,/ literature indicates that this is not suggestive of a real increase of area under forest "but is due to incremental increase of reporting area under forest".

**Subsistence farming and Commercial farming**– main types of farming depending upon the geographical conditions, demand of produce, labour and level of technology.

**Subsistence farming**- classified as intensive subsistence and primitive subsistence farming.

| **Subsistence farming** | **Intensive subsistence agriculture** | **Primitive subsistence agriculture** |
|---|---|---|
| The type of farming is practised to meet the needs of the farmer's family. | The farmer cultivates a small plot of land using simple tools and more labour. Climate with a large number of days with sunshine and fertile soils permit growing of more than one crop annually on the same plot. | Includes shifting cultivation and nomadic herding.<br>**Shifting Cultivation**– a plot of land is cleared by felling the trees and burning them. The ashes are then mixed with the soil and crops are grown. After the soil loses its fertility, the land is abandoned and the cultivator moves to a new plot. Shifting cultivation is also known as 'slash and burn' agriculture.<br>**Nomadic Herding**-herdsmen move from place to place with their animals for fodder and water, along defined routes. This type of movement arises in response to climatic constraints and terrain. |

*Notes*

| | | |
|---|---|---|
| **Main Crop**<br>**Other Crops** | Rice<br>Wheat, maize, pulses and oilseeds | **Shifting Cultivation**– maize, yam, potatoes and cassava<br>**Nomadic Herding**-Sheep, camel, yak and goats are most commonly reared. They provide milk, meat, wool, hides and other products to the herders and their families. |
| **Areas** | Prevalent in the thickly populated areas of the monsoon regions of the south, southeast and east Asia. | **Shifting Cultivation**-practised in the thickly forested areas of Amazon basin, tropical Africa, parts of Southeast Asia and Northeast India.<br>**Nomadic Herding**– practised in the semi-arid and arid regions of Sahara, Central Asia and some parts of India, like Rajasthan and Jammu and Kashmir. |

**Commercial Farming**– Commercial grain farming, mixed farming and plantation agriculture

| **Commercial Farming** | **Commercial grain farming** | **Mixed Farming** | **Plantation Agriculture** |
|---|---|---|---|
| Crops are grown and animals reared-sale in market. The large area is cultivated and a large amount of capital is used. Work done by machines. | Crops are grown for commercial purposes. These areas are sparsely populated with large farms spreading over hundreds of hectares. Severe winters restrict the growing season and only a single crop can be grown. | The land is used for growing food and fodder crops and rearing livestock | A type of commercial farming where a single crop is grown. Large amount of labour and capital are required. The produce may be processed on the farm itself or in nearby factories. The development of a transport network is thus essential for such farming. |
| **Crops** | Wheat and maize | | Tea, coffee, sugarcane, cashew, rubber, banana or cotton |

| | | | |
|---|---|---|---|
| **Areas** | Temperate grasslands of North America, Europe and Asia | Practised in Europe, eastern USA, Argentina, southeast Australia, New Zealand and South Africa | Major plantations found in the tropical regions of the world. Rubber in Malaysia, coffee in Brazil, tea in India and Sri Lanka |

## Major Crops

- **Major food crops**– wheat, rice, maize and millets.
- **Fibre crops**-jute and cotton
- **Important beverage crops**-tea and coffee

**Rice**- the staple diet of the tropical and sub-tropical regions-needs high temperature, high humidity and rainfall-grows best in alluvial clayey soil, which can retain water-Leading producers of rice are China, followed by India, Japan, Sri Lanka and Egypt-In favourable climatic conditions like West Bengal and Bangladesh 2 to 3 crops are grown in a year.

**Wheat**– requires moderate temperature and rainfall during the growing season- bright sunshine at the time of harvest- thrives best in well-drained loamy soil-grown extensively in USA, Canada, Argentina, Russia, Ukraine, Australia and India- grown in winter in India.

**Millets**– known as coarse grains-can be grown on less fertile and sandy soils-a hardy crop that needs low rainfall and high to moderate temperature and adequate rainfall- Jowar, bajra and ragi are grown in India-also in Nigeria, China and Niger.

**Maize**-requires moderate temperature, rainfall and lots of sunshine-needs well-drained fertile soils- grown in North America, Brazil, China, Russia, Canada, India, and Mexico.

**Cotton**– requires high temperature, light rainfall, 210 frost-free days and bright sunshine to grow-grows best on black and alluvial soils-Leading producers of cotton are China, USA, India, Pakistan, Brazil and Egypt-main raw materials for the cotton textile industry.

**Jute**-known as the 'Golden Fibre'-grows well on alluvial soil- requires high temperature, heavy rainfall and humid climate- grown in the tropical areas-Leading producers of Jute are India and Bangladesh.

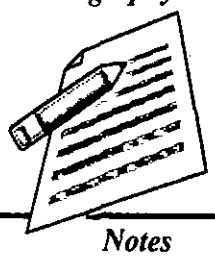
**Coffee**– requires a warm and wet climate and well-drained loamy soil-Hill slopes are more suitable for the growth of crop-Leading producers are Brazil followed by Columbia and India.

**Tea**– a beverage crop grown on plantations-requires cool climate and well-distributed high rainfall throughout the year for the growth of its tender leaves-needs well-drained loamy soils and gentle slopes-Kenya, India, China, Sri Lanka produce the best quality tea in the world.

## Agricultural Development

Efforts made to increase farm production in order to meet the growing demand of the increasing population-achieved in many ways such as increasing the cropped area, the number of crops grown, improving irrigation facilities, use of fertilisers and high yielding variety of seeds-ultimate aim of agricultural development is to increase food security.

Developing countries with large populations practice intensive agriculture where crops are grown on small holdings mostly for subsistence-larger holdings are popular for commercial agriculture.





## Cattle Farming

Cattle farming involves rearing and management of two types of animals- one group for food requirements like milk and another for labour purposes like ploughing, irrigation, etc. Animals which provide milk are called milch/dairy animals. For example, goats, buffalo, cows, etc. Animals which are used for labour are called draught animals.

Since dairy animals are cared and bred for milk, we need to improve the milk production to meet the requirements. The period after the birth of a calf, when a cow starts to produce milk, is called lactation period. We can enhance milk production by increasing this lactation period. But along with milk production, quality must also meet. Dairy farm management is the management of the milch animals with the goal of enhancing the quantity and quality of the milk produced. For this reason, high yielding and disease resistant breeds are developed.

## Cross-breeding in Cattle Farming

For example, the foreign breeds like Jersey, Holstein-Friesian, Brown Swiss, have long lactation period while local breeds like Red Sindhi, Sahiwal, and Gir are known for their disease-resistant trait. The breeding of these two varieties helped us to enhance the quantity and quality of the milk produced.

## Farm Management

Cattle farming are not all about milk or meat production. It has some responsibilities to do. To meet the human requirements, we need to take good care and need proper management of livestock.

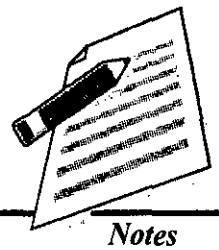
## Shelter

In cattle farming, animals are maintained in a strictly hygienic manner with proper housing. For the maintenance, we need to follow some routines.

- Animals and their sheds need to be cleaned at a regular interval.
- Animals should be brushed regularly to remove the dirt and bugs in their body.
- The shed should be well-ventilated and roofed so that animals are protected from rain, heat, and cold.
- A proper drainage system should be there to remove animal waste.

## Food

Food requirements of animals are also a part of cattle farming. To maintain high yielding and disease-resistant breeds, they must be provided with an adequate water supply and nutrient-rich fodder regularly according to their needs. In cattle farming, two factors are considered regarding the food of cattle. The food that is provided must keep the animal health as well as it should meet the farming requirement. Hence, the animal feed includes roughage (high fibre content) and concentrates (high proteins and nutrient content). In addition to this, supplements containing micronutrients are also provided to animals. An adequate proportion of these rations promote healthy and high output animals.





## Disease Management

The third responsibility of cattle farming management is to maintain disease-free breeds. Animals are not an exception to disease. They also suffer from numerous diseases. This may affect the health as well as productivity of animals; even cause their death. Parasites, bacteria, and viruses are the major villains here. These microbes infect the cattle externally as well as internally. Vaccination is the one solution for the protection against bacterial and viral infections.

## Fishing

Fish are a very high source of proteins and have great nutritional value. Fish production was initially dependent on fish capturing. However, most of the captured fish were used for industrial purposes and were hardly consumed by man. Therefore, an alternative method to increase fish production was devised that includes farming and husbandry of economically important aquatic organisms. This is known as aquaculture.

## Methods of Fish Production

Fish production can be done in two ways:

## Capture Fishery

Naturally occurring fish are harvested by capture fishery. Capture fishery is sometimes also known as wild fishery.

## Culture Fishery

This is the controlled cultivation of fish in water bodies. It can also be referred to as fish farming or pisciculture. Note that pisciculture is a form of aquaculture as aquaculture is the scientific rearing and management of all aquatic animals.

*Fishery is further divided into:*

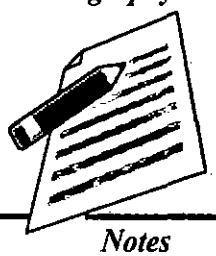
- Inland Fishery
- Marine Fishery

## Inland Fishery

- In this, fishing is done in freshwater bodies, such as lakes, ponds, rivers, and tanks. Reservoirs where freshwater bodies and seawater bodies join also form inland fisheries.
- The method incorporated here is generally pisciculture, as the yield of capture fishery is not very high.
- 5-6 species are reared in one water body. This selection of species is such that they have different food habits yet there is no competition for food.
- Common varieties reared are Rohu, Catla, Grass Carp, Common Carp, etc.

## Marine Fishery

- With the Indian landmass being a peninsula, we have been blessed with a coastline of 7517 km. Thus, fishing is a source of livelihood for 14 million people. These 14 million people cast their fishing nets in marine fisheries, i.e., in marine waters- the sea and the ocean.





- These are further divided into coastal fisheries that are near the shore and off-shore or deep-sea fisheries that are deeper in the sea.
- Sardines, mackerel, hilsa, tuna, Pomfret, mussels, prawns, oysters, etc. are some common types.
- The use of echo-sounders and satellites for the location of large fish to increases the yield.

## Culture Fishery

Culture fishery is also known as fish farming. Let us have a detailed look at the process of fish production by fish farming, and its advantages.

## Fish Farming

About half the fish consumed today is raised globally through fish farming. Some of the common fish species that are farmed include tuna, salmon, halibut, cod, and trout. The aquafarms can be in the form of mesh cages submerged in water or concrete enclosures on land. However, the fish farms can damage the ecosystem by introducing diseases, pollutants and invasive species.

## Methods of Fish Farming

Fish farming involves the following methods:

## Extensive Fish Farming

In this type of farming, economic and labour inputs are low. The natural food production plays a major role in this type of farming. Fertilizers may be added to increase the fertility and hence, the production of fish.

## Semi-intensive Fish Farming

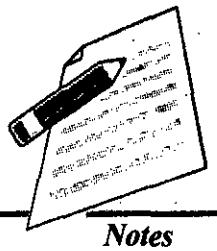
This method implies moderate levels of economic and labour inputs. The production can be increased by supplementary feeding or addition of fertilizers. Thus, the production of fish is higher.

## Intensive Fish Farming

In this method, the fish are stocked with as many fish as possible. The fish are fed with supplementary feed.

## Advantages of Fish Farming

1. The farmed fish provides high quality protein for human consumption.
2. Fish farming can be integrated into the existing farm to create additional income and improve its water management.
3. The farmers can select the fish species with desired characteristics to raise.
4. Fish in a pond are not accessible to everyone. Thus, they are secured and are harvested at will.
5. Fish in a pond are nearby.
6. Some of the major problems and their possible solutions have been discussed as follows. Indian agriculture is plagued by several problems; some of them are natural and some others are manmade.





## 1. Small and fragmented land-holdings:

The seemingly abundance of net sown area of 141.2 million hectares and total cropped area of 189.7 million hectares (1999-2000) pales into insignificance when we see that it is divided into economically unviable small and scattered holdings.

The average size of holdings was 2.28 hectares in 1970-71 which was reduced to 1.82 hectares in 1980-81 and 1.50 hectares in 1995-96. The size of the holdings will further decrease with the infinite Sub-division of the land holdings.

The problem of small and fragmented holdings is more serious in densely populated and intensively cultivated states like Kerala, West Bengal, Bihar and eastern part of Uttar Pradesh where the average size of land holdings is less than one hectare and in certain parts it is less than even 0.5 hectare.

Rajasthan with vast sandy stretches and Nagaland with the prevailing 'Jhoom' (shifting agriculture) have larger average sized holdings of 4 and 7.15 hectares respectively. States having high percentage of net sown area like Punjab, Haryana, Maharashtra, Gujarat, Karnataka and Madhya Pradesh have holding size above the national average.

Further it is shocking to note that a large proportion of 59 per cent holdings in 1990-91 were marginal (below 1 hectare) accounting for 14.9 per cent of the total operated area. Another 19 per cent were small holdings (1-2 hectare) taking up 17.3 per cent of the total operated area.

Large holdings (above 10 hectare) accounted for only 1.6 per cent of total holdings but covered 17.4 per cent of the operated area (Table 22.1). Hence, there is a wide gap between small farmers, medium farmers (peasant group) and big farmers (landlords).

The main reason for this sad state of affairs is our inheritance laws. The land belonging to the father is equally distributed among his sons. This distribution of land does not entail a collection or consolidated one, but its nature is fragmented.

Different tracts have different levels of fertility and are to be distributed accordingly. If there are four tracts which are to be distributed between two sons, both the sons will get smaller plots of each land tract. In this way the holdings become smaller and more fragmented with each passing generation.

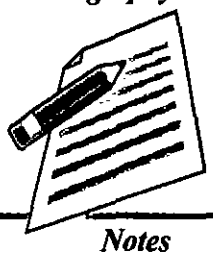
Sub-division and fragmentation of the holdings is one of the main causes of our low agricultural productivity and backward state of our agriculture. A lot of time and labour is wasted in moving seeds, manure, implements and cattle from one piece of land to another.

Irrigation becomes difficult on such small and fragmented fields. Further, a lot of fertile agricultural land is wasted in providing boundaries. Under such circumstances, the farmer cannot concentrate on improvement.

The only answer to this ticklish problem is the consolidation of holdings which means the reallocation of holdings which are fragmented, the creation of farms which comprise only one or a few parcels in place of multitude of patches formerly in the possession of each peasant.

But unfortunately, this plan has not succeeded much. Although legislation for consolidation of holdings has been enacted by almost all the states, it has been implemented only in Punjab, Haryana and in some parts of Uttar Pradesh.

Consolidation of about 45 million holdings has been done till 1990-91 in Punjab, Haryana and western Uttar Pradesh. The other solution to this problem is cooperative farming in which the farmers pool their resources and share the profit.





## 2. Seeds:

Seed is a critical and basic input for attaining higher crop yields and sustained growth in agricultural production. Distribution of assured quality seed is as critical as the production of such seeds. Unfortunately, good quality seeds are out of reach of the majority of farmers, especially small and marginal farmers mainly because of exorbitant prices of better seeds.

In order to solve this problem, the Government of India established the National Seeds Corporation (NSC) in 1963 and the State Farmers Corporation of India (SFCI) in 1969. Thirteen State Seed Corporations (SSCs) were also established to augment the supply of improved seeds to the farmers.

High Yielding Variety Programme (HYVP) was launched in 1966-67 as a major thrust plan to increase the production of food grains in the country.

The Indian seed industry had exhibited impressive growth in the past and is expected to provide further potential for growth in agricultural production: The role of seed industry is not only to produce adequate quantity of quality seeds but also to achieve varietal diversity to suit various agro-climatic zones of the country.

The policy statements are designed towards making available to the Indian farmer, adequate quantities of seed of superior quality at the appropriate time and place and at an affordable price so as to meet the country's food and nutritional security goals.

Indian seeds programme largely adheres to limited generation system for seed multiplication. The system recognises three kinds of generation, namely breeder, foundation and certified seeds. Breeder seed is the basic seed and first stage in seed production. Foundation seed is the second stage in seed production chain and is the progeny of breeder seed.

Certified seed is the ultimate stage in seed production chain and is the progeny of foundation seed. Production of breeder and foundation seeds and certified seeds distribution have gone up at an annual average rate of 3.4 per cent, 7.5 per cent and 9.5 per cent respectively, between 2001-02 and 2005-06).

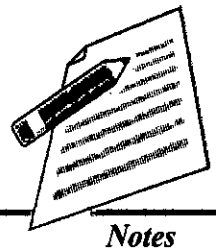
## 3. Manures, Fertilizers and Biocides:

Indian soils have been used for growing crops over thousands of years without caring much for replenishing. This has led to depletion and exhaustion of soils resulting in their low productivity. The average yields of almost all the crops are among t e lowest in the world. This is a serious problem which can be solved by using more manures and fertilizers.

Manures and fertilizers play the same role in relation to soils as good food in relation to body. Just as a well-nourished body is capable of doing any good job, a well-nourished soil is capable of giving good yields. It has been estimated that about 70 per cent of growth in agricultural production can be attributed to increased fertilizer application.

Thus, increase in the consumption of fertilizers is a barometer of agricultural prosperity. However, there are practical difficulties in providing sufficient manures and fertilizers in all parts of a country of India's dimensions inhabited by poor peasants. Cow dung provides the best manure to the soils.

But its use as such is limited because much of cow dung is used as kitchen fuel in the shape of dung cakes. Reduction in the supply of fire wood and increasing demand for fuel in the rural areas due to increase in population has further complicated the problem. Chemical fertilizers are costly and are often beyond the reach of the poor farmers. The fertilizer problem is, therefore, both acute and complex.





It has been felt that organic manures are essential for keeping the soil in good health. The country has a potential of 650 million tonnes of rural and 160 lakh tonnes of urban compost which is not fully utilized at present. The utilization of this potential will solve the twin problem of disposal of waste and providing manure to the soil.

The government has given high incentive especially in the form of heavy subsidy for using chemical fertilizers. There was practically no use of chemical fertilizers at the time of Independence As a result of initiative by the government and due to change in the attitude of some progressive farmers, the consumption of fertilizers increased tremendously.

In order to maintain the quality of the fertilizers, 52 fertilizer quality control laboratories have been set up in different parts of the country. In addition, there is one Central Fertilizer Quality Control and Training Institute at Faridabad with its three regional centres at Mumbai, Kolkata and Chennai.

Pests, germs and weeds cause heavy loss to crops which amounted to about one third of the total field produce at the time of Independence. Biocides (pesticides, herbicides and weedicides) are used to save the crops and to avoid losses. The increased use of these inputs has saved a lot of crops, especially the food crops from unnecessary wastage. But indiscriminate use of biocides has resulted in wide spread environmental pollution which takes its own toll.

## 4. Irrigation:

Although India is the second largest irrigated country of the world after China, only one-third of the cropped area is under irrigation. Irrigation is the most important agricultural input in a tropical monsoon country like India where rainfall is uncertain, unreliable and erratic India cannot achieve sustained progress in agriculture unless and until more than half of the cropped area is brought under assured irrigation.

This is testified by the success story of agricultural progress in Punjab Haryana and western part of Uttar Pradesh where over half of the cropped area is under irrigation! Large tracts still await irrigation to boost the agricultural output.

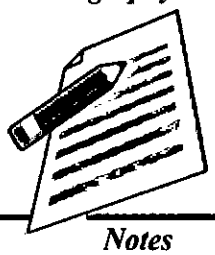
However, care must be taken to safeguard against ill effects of over irrigation especially in areas irrigated by canals. Large tracts in Punjab and Haryana have been rendered useless (areas affected by salinity, alkalinity and water-logging), due to faulty irrigation. In the Indira Gandhi Canal command area also, intensive irrigation has led to sharp rise in sub-soil water level, leading to water-logging, soil salinity and alkalinity.

## 5. Lack of mechanisation:

In spite of the large-scale mechanisation of agriculture in some parts of the country, most of the agricultural operations in larger parts are carried on by human hand using simple and conventional tools and implements like wooden plough, sickle, etc.

Little or no use of machines is made in ploughing, sowing, irrigating, thinning and pruning, weeding, harvesting threshing and transporting the crops. This is specially the case with small and marginal farmers. It results in huge wastage of human labour and in low yields per capita labour force.

There is urgent need to mechanise the agricultural operations so that wastage of labour force is avoided and farming is made convenient and efficient. Agricultural implements and machinery are a crucial input for efficient and timely agricultural operations, facilitating multiple cropping and thereby increasing production.





Some progress has been made for mechanising agriculture in India after Independence. Need for mechanisation was specially felt with the advent of Green Revolution in 1960s. Strategies and programmes have been directed towards replacement of traditional and inefficient implements by improved ones, enabling the farmer to own tractors, power tillers, harvesters and other machines.

A large industrial base for manufacturing of the agricultural machines has also been developed. Power availability for carrying out various agricultural operations has been increased to reach a level of 14 kW per hectare in 2003-04 from only 0.3 kW per hectare in 1971-72.

This increase was the result of increasing use of tractor, power tiller and combine harvesters, irrigation pumps and other power operated machines. The share of mechanical and electrical power has increased from 40 per cent in 1971 to 84 per cent in 2003-04.

Uttar Pradesh recorded the highest average sales of tractors during the five-year period ending 2003-04 and/West Bengal recorded the highest average sales of power tillers during the same period.

Strenuous efforts are being made to encourage the farmers to adopt technically advanced agricultural equipment's in order to carry farm operations timely and precisely and to economise the agricultural production process.

## 6. Soil erosion:

Large tracts of fertile land suffer from soil erosion by wind and water. This area must be properly treated and restored to its original fertility.

## 7. Agricultural Marketing:

Agricultural marketing still continues to be in a bad shape in rural India. In the absence of sound marketing facilities, the farmers have to depend upon local traders and middlemen for the disposal of their farm produce which is sold at throw-away price.

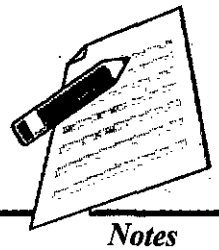
In most cases, these farmers are forced, under socio-economic conditions, to carry on distress sale of their produce. In most of small villages, the farmers sell their produce to the money lender from whom they usually borrow money.

According to an estimate 85 per cent of wheat and 75 per cent of oil seeds in Uttar Pradesh, 90 per cent of Jute in West Bengal, 70 per cent of oilseeds and 35 per cent of cotton in Punjab is sold by farmers in the village itself. Such a situation arises due to the inability of the poor farmers to wait for long after harvesting their crops.

In order to meet his commitments and pay his debt, the poor farmer is forced to sell the produce at whatever price is offered to him. The Rural Credit Survey Report rightly remarked that the producers in general sell their produce at an unfavourable place and at an unfavourable time and usually they get unfavourable terms.

In the absence of an organised marketing structure, private traders and middlemen dominate the marketing and trading of agricultural produce. The remuneration of the services provided by the middlemen increases the load on the consumer, although the producer does not derive similar benefit.

Many market surveys have revealed that middlemen take away about 48 per cent of the price of rice, 52 per cent of the price of groundnuts and 60 per cent of the price of potatoes offered by consumers.





In order to save the farmer from the clutches of the money lenders and the middle men, the government has come out with regulated markets. These markets generally introduce a system of competitive buying, help in eradicating malpractices, ensure the use of standardised weights and measures and evolve suitable machinery for settlement of disputes thereby ensuring that the producers are not subjected to exploitation and receive remunerative prices.

## 8. Inadequate storage facilities:

Storage facilities in the rural areas are either totally absent or grossly inadequate. Under such conditions the farmers are compelled to sell their produce immediately after the harvest at the prevailing market prices which are bound to be low. Such distress sale deprives the farmers of their legitimate income.

The Parse Committee estimated the post-harvest losses at 9.3 per cent of which nearly 6.6 per cent occurred due to poor storage conditions alone. Scientific storage is, therefore, very essential to avoid losses and to benefit the farmers and the consumers alike.

At present there are number of agencies engaged in warehousing and storage activities. The Food Corporation of India (F.C.I.), the Central Warehousing Corporation (C.W.C.) and State Warehousing Corporation are among the principal agencies engaged in this task. These agencies help in building up buffer stock, which can be used in the hour of need. The Central Government is also implementing the scheme for establishment of national Grid of Rural Godowns since 1979-80.

This scheme provides storage facilities to the farmers near their fields and in particular to the small and marginal farmers. The Working Group on additional storage facilities in rural areas has recommended a scheme of establishing a network of Rural Storage Centres to serve the economic interests of the farming community.

## 9. Inadequate transport:

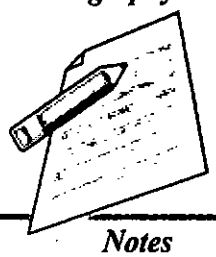
One of the main handicaps with Indian agriculture is the lack of cheap and efficient means of transportation. Even at present there are lakhs of villages which are not well connected with main roads or with market centres.

Most roads in the rural areas are Kutcha (bullock- cart roads) and become useless in the rainy season. Under these circumstances the farmers cannot carry their produce to the main market and are forced to sell it in the local market at low price. Linking each village by metalled road is a gigantic task and it needs huge sums of money to complete this task.

## 10. Scarcity of capital:

Agriculture is an important industry and like all other industries it also requires capital. The role of capital input is becoming more and more important with the advancement of farm technology. Since the agriculturists' capital is locked up in his lands and stocks, he is obliged to borrow money for stimulating the tempo of agricultural production.

The main suppliers of money to the farmer are the money-lenders, traders and commission agents who charge high rate of interest and purchase the agricultural produce at very low price. All India Rural Credit Survey Committee showed that in 1950-51 the share of money lenders stood at as high as 68.6 per cent of the total rural credit and in 1975-76 their share declined to 43 per cent of the credit needs of the farmers.





This shows that the money lender is losing ground but is still the single largest contributor of agricultural credit. Rural credit scenario has undergone a significant change and institutional agencies such as Central Cooperative Banks, State Cooperative Banks, Commercial Banks, Cooperative Credit Agencies and some Government Agencies are extending loans to farmers on easy terms.

There has been a steady increase in the flow of institutional credit to agriculture over the years (Table 22.3).

## Table 22.3 Institutional Credit to Agriculture:

| Institutions | 1999-00 | 2000-01 | 2001-02 | 2002-03 | 2003-04 |
|---|---|---|---|---|---|
| Co-operative Banks | 18,363 | 20,801 | 23,604 | 24,296 | 26,959 |
| Share (per cent) | 40 | 39 | 38 | 34 | 31 |
| Regional Rural Banks | 3,172 | 4,219 | 4,854 | 5,467 | 7,581 |
| Share (per cent) | 7 | 8 | 8 | 8 | 9 |
| Commercial Banks | 24,733 | 27,807 | 33,587 | 41,047 | 52,441 |
| Share (per cent) | 53 | 53 | 54 | 58 | 60 |
| Total | 46,268 | 52,827 | 62,045 | 70,810 | 86,981 |
| Per cent increase | 26 | 14 | 17 | 14 | 22 |

## SUMMARY

India has different types of land uses. About 47 per cent of its total area is under cultivation leaving very little scope for brining further land under cultivation. food for rapidly growing population can be provided only by improving productivity per hectare of land as cultivable land in India is only 13 per cent. There is need of increasing forest land for ecological balance. Animal rearing is important economic activity in India. It accounts for a quarter of the total agricultural output. India has the highest number of livestock but the quality of livestock is very poor. Efforts are being made to improve the quality of animals through operation flood. As a result, India is now leading in milk production in the world. Fisheries is also an important occupation in India. Rice, wheat, sugarcane, cotton and tea are important crops grown in India. Efforts are being made to increase production of fruits, vegetables, spices and flowers. The importance of these crops has increased due to global opportunities in export of agricultural commodities. India can earn a sizable number of foreign exchanges with export of these items. The government of India has formulated a new agricultural policy in 2000 in the light of economic liberalization. In the new agricultural policy emphasis have been placed on privatization of agriculture, increasing animal products, aquaculture, flowriculture, improving domestic and international market systems and facilitating credit flow to the farmers.

## EXERCISE

### MCQ

**1 :** Which of the following was not introduced in India as part of land reforms ?

a) Zamindari abolition
b) Land ceiling
c) Rent regulation
d) Rural industrialization

**Answer :** d

**2 :** Before independence, which land revenue system gave ownership rights to Zamindars ?

a) Permanent Settlement system
b) Ryotwari system
c) Mahalwari system
d) None of the above

**Answer :** a

**3 :** Which of the following factors did not hamper the introduction of rent regulation in Indian agriculture ?

a) Higher socioeconomic status of Zamindars
b) Oral agreements between tenants and landowners
c) Lack of security of tenure
d) Demand by tenant to reduce rent

**Answer :** d

**4 :** The ownership rights over land could not be transferred to peasants because

**1)** The purchase price offered could not be afforded by many tenants
**2)** Threat by landowners
**3)** Resumption of personal cultivation by Zamindars
**4)** Oral tenancy agreement

Select the correct answer using the codes given below :

a) 1 and 2 only
b) 2, 3, and 4
c) 1 and 4 only
d) 1, 2, 3, and 4

**Answer :** d

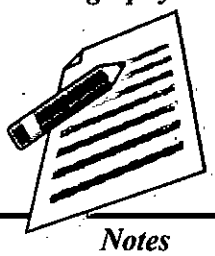
**5 :** As part of Zamindari abolition, which of the following activities were covered under the definition of personal cultivation ?

**1)** Self- supervision to agricultural operations
**2)** Cultivation by members of the family
**3)** Supervision by any member of the family of Zamindar

Select the correct answer using the codes given below :

a) 1 only
b) 1 and 2 only
c) 2 only
d) 1, 2, and 3

Answer : d



*Notes*

## Review Questions

1. Discuss changing pattern of cropping in India.
2. What is meant by Green Revolution? Write its impact on agricultural production and environment.
3. What is the impact of globalization on agricultural sector in India?
4. Show the sugarcane and tea producing areas on an outline map of India.
5. Write short notes on following:- (a) Eco-farming/organic farming (b) White Revolution (c) Blue Revolution (d) Agricultural policy of India.

# 17 DEVELOPMENT OF MINERAL AND ENERGY RESOURCES

- Understand the concept of minerals.
- Discuss the features of minerals resources.
- Describe the types of minerals.
- Discuss the concept of energy.
- Discuss the types of energy resources.
- Discuss the uses and distribution of minerals and energy resources.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of minerals and energy resources in India so that the types and features of these resources can be learned.

## Introduction

Minerals are naturally occurring substances with definite chemical and physical properties.

## Uses of minerals

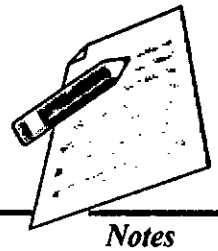
Mineral is an element or inorganic compound that occurs naturally. The main uses of minerals are as follows:

Development of industrial plants and machinery Generation of energy e.g., coal, lignite, uranium Construction, housing, settlements

Défense equipment's- weapons, settlement Transportation

Communication-telephone wires, cables, electronic devices Medical system- particularly in Ayurvedic System Formation of alloys for various purposes

Agriculture- as fertilizers, seed dressings and fungicides Jewellery- e.g., Gold, silver, platinum, diamond





## Table 3.1 Distribution and uses of major reserves and metals

**Table 3.1 Distribution and uses of major reserves and metals**

| Metals | Major world reserves | Major uses |
|---|---|---|
| Aluminum | Australia, Jamaica | Packing food items, transportation, utensils, electronics |
| Chromium | CIS(The common wealth of Independent states), South Africa | For making high strength steel alloys, in textiles and tanning industries |
| Copper | U.S.A, Canada, CIS | Electronic and electrical goods, building, construction, vessels |
| Iron | CIS, Canada, U.S.A | Heavy machinery, steel production transportation means. |
| Manganese | South Africa, CIS | For making high strength heat resistant steel alloys |
| Platinum | South Africa, CIS | Use in automobiles, catalytic converters, electronics, medical uses. |
| Gold | South Africa, CIS, Canada | Ornaments, medical use, electronic use, in acrospace |
| Silver | Canada, South Africa | Photography, electronic jewellery. |
| Nickel | CIS, Canada | Chemical industry, steel alloys |

**Table 3.2 Major uses of some of the non metallic minerals**

| Non-metal mineral | Major uses |
|---|---|
| Silicate minerals | Sand and grovel for construction, bricks, paving etc. |
| Limestone | Used for concrete, building stone, used in agriculture for neutralizing acid soils, used in cement industry |
| Gypsum | Used in plaster wall-board, in agriculture |
| Potash, phosphorite | Used as fertilizers |
| Sulphur pyrites | Used in medicine, car battery, industry |

## 2 Environmental impacts of mineral extraction

Major mines which are known for causing severe problems are given below: Jaduguda Uranium Mine, Jharkhand- exposing local people to radioactive hazards.

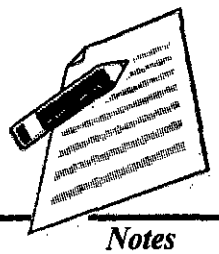
Jharia coal mines, Jharkhand- underground fire leading to land subsidence and forced displacement of people.

Sukinda chromite mines, Orissa- Seeping of hexavalent chromium into river posing serious health hazard, Cr6+ being highly toxic and carcinogenic.

Kudremukh iron ore mine, Karnataka- causing river pollution and threat to biodiversity. East coast Bauxite mine, Orissa-Land encroachment and issue of rehabilitation unsettled. North-Eastern Coal Fields, Assam-Very high sulphur contamination of groundwater.

## 3 Impacts of mining

Mining is done to extract minerals from deep deposits in soil. Environmental damages caused by mining activities are as follows:





**Devegetation and defacing of lands:** Mining requires removal of vegetation along with underlying soil mantle and overlying rock masses. This results in destruction of landscape in the area.

**Subsidence of land:** Subsidence of mining areas results in tilting of buildings, cracks in houses, buckling of roads, bending of rail tracks and leaking of gas from cracked pipe lines leading to serious disasters.

**Groundwater contamination:** Mining pollutes the groundwater. Sulphur, usually present as an impurity in many ores is known to get converted into sulphuric acid through microbial action, thereby making the water acidic.

**Surface water pollution:** The acid mine drainage often contaminates the nearby streams and lakes. The acidic water, radioactive substances like uranium, heavy metals also contaminate the water bodies and kill aquatic animals.

**Air pollution:** In order to separate and purify the metal from other impurities in the ore, smelting is done which emits enormous quantities of air pollutants. Oxides of sulphur, arsenic, cadmium and lead etc. shoot up in the atmosphere near the smelters and the public suffers from several health problems.

**Occupational Health Hazards:** Miners working in different type of mines suffer from asbestosis, silicosis, black lung disease.

## 4 Remedial measures

Adopting eco-friendly mining technology

Utilization of low-grade ores by using microbial – leaching technique. In this method, the ores are inoculated with the desired strains of bacteria like Thiobacillus ferroxidans, which remove the impurities and leave the pure mineral.

Re-vegetating mined areas with appropriate plants Gradual restoration of flora

Prevention of toxic drainage discharge.

# Energy resources

## 1 Definition

Energy may be defined as, "any property, which can be converted into work." (or) Energy is defined as, "the capacity to do work."

Forms of energy, some of immediately used to do work; others require some process of transformation Life is unthinkable without energy.

All the developmental activities in the world are directly or indirectly dependent upon energy.

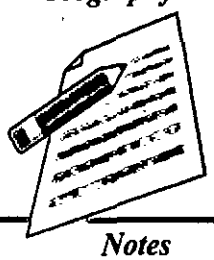
Energy production and energy utilization are the indicators of a country's progress.

## 2 Development of energy

The first form of energy is the fire.

The early man discovered fire and used it for cooking and heating purposes Wood is the main source of energy, which is later replaced by coal.

Coal is now being replaced by the oil and gas.





Now due to insufficient availability and price hike, people started of thinking and using several alternative sources of energy.

Wood --> coal --> oil --> alternate energy (solar, wind, tidal energy)

## 3 Growing energy Needs

Energy is essential to all human societies.

All industrial process like, mining, transport, living, heating and cooling in buildings, all require energy.

With the demands of growing population, the world is facing further energy deficit,

Our life style is also changing from al simple way of life to luxurious life style. At present 95% of the commercial energy is available only from the fossil fuels like coal, oil and natural gas, and are not going to last for many years. It would be really ironic if fuel becomes more expensive than food.

## 4 Energy Distribution –World Scenario

U.S.A and Canada 5% of the world's population- consume 25% of the available world's energy resources.

It has been observed, that in U.S.A and Canada an average person consumes 300 GJ (Giga Joules; equal to 60 barrels of oil) per year.

But in poor countries like Bhutan, Nepal and Ethiopia, an average person consumes less than 1 GJ per year.

So, a person in a developed country consumes almost as much energy in a single day as one person consumes in a whole year in a poor country.

From the above scenario it is clear that our life style and standard of living are closely related to energy needs.

## 1. Renewable energy resources (or) non-conventional energy resources

Natural resources can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner.

Example: Wood, solar energy, wind energy, hydropower energy, etc.,

## Merits of renewable energy resources

Unlimited supply.

provides energy security.

Fits into sustainable development concept.

Reliable and the devices are modular in size.

Decentralized energy production.

## 2. Non- Renewable energy resources (or) Conventional energy resources

Natural resources which cannot be regenerated once they are exhausted. They cannot be used again. Example: Coal, petroleum, natural gas, and nuclear fuels.

Even our renewable resources can become non-renewable if we exploit them to such extent their rate of consumption exceeds their rate of regeneration.

Wood is renewable resources but not coal-why?

Wood is renewable resources because we can get new wood by growing sapling into a tree within 15-20 years.

But the formation of coal from trees has taken millions of years and cannot be regenerated in our life time.

## Renewable energy resources

Renewable resources are parts of our natural environment and form our eco-system

## Solar energy

The energy that we get directly from the sun is called solar energy.

The nuclear fusion reactions occurring inside the sun release enormous amount of energy in the form of heat and light.

The solar energy received by the near-earth space is approximately3.4 kJ/s/m2 known as solar constant.

## *Methods of Harvesting Solar Energy*

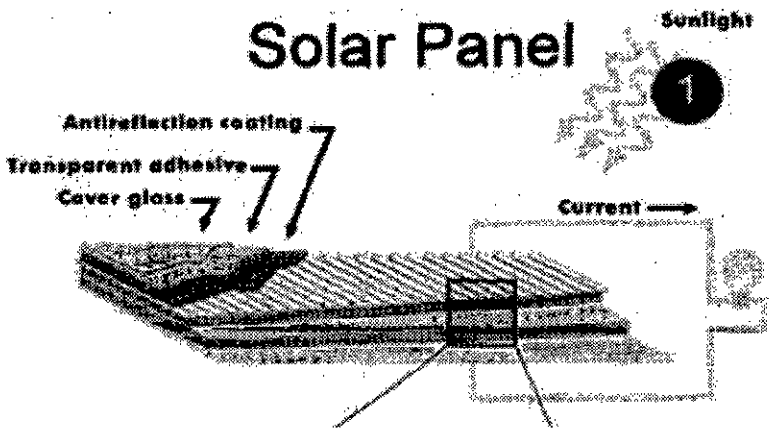
## 1. Solar cells (or) photovoltaic cells (or) PV cells

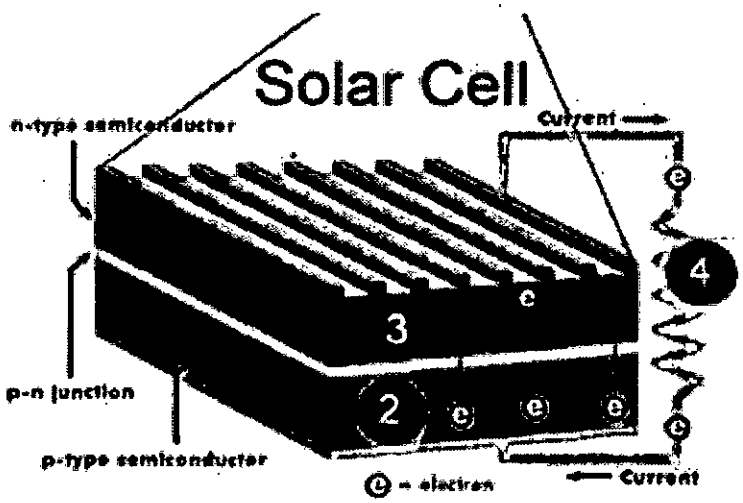
Solar cells consist of a p-type semiconductor (such as Si doped with B) and n-type semi-conductor (Si doped with P).

They are in close contact with each other.

When the solar rays fall on the top layer of p-type semi-conductor, the electrons from the valence band get promoted to the conduction band and cross the p-n junction into n-type semi-conductor.

There by potential difference between two layers is created, which causes flow of electrons (i.e., an electric current)






## cell Uses

Used in calculators, electronic watches. Street lights, water pumps to run radios and TVs.

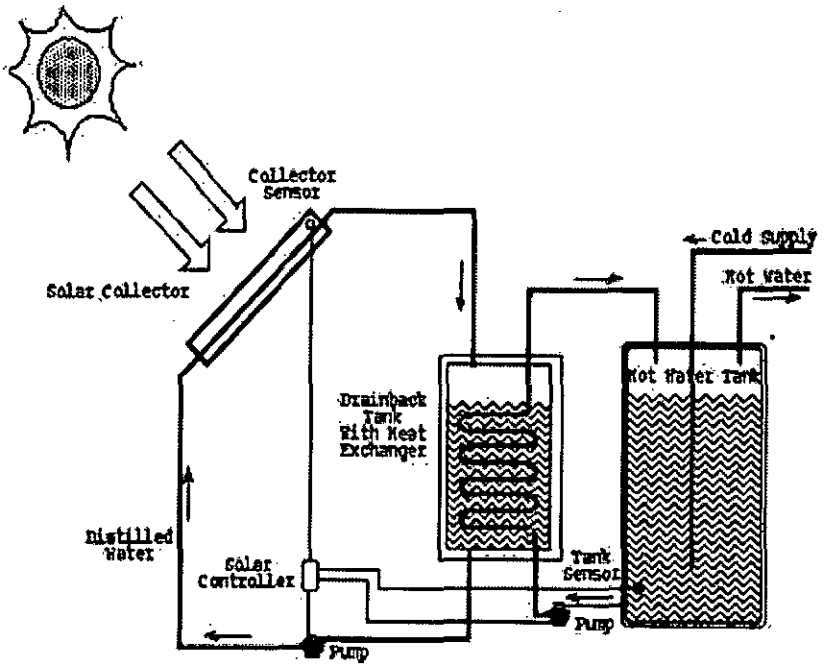
## Solar Battery

When a large number of solar cells are connected in series it forms a solar battery.

Solar battery produces more electricity which is enough to run water pump, to run street-light, etc., They are used in remote areas where conventional electricity supply is a problem.

## 2. Solar heat collectors

Solar heat collectors consist of natural materials like stones, bricks, (or) materials like glass, which can absorb heat during the day time and release it slowly at night.



## Uses

Used in cold places, where houses are kept in hot condition using solar heat collectors.

## 3. Solar water heater

It consists of

An insulated box inside of which is painted with black paint. Provided with a glass lid to receive and store solar heat.

Inside the box it has black painted copper coil, through which cold water is allowed to flow in, which gets heated up and flows out into a storage tank.

From the storage tank water is then supplied through pipes.

## Wind energy

## Definition

Moving air is called wind.

Energy recovered from the force of the wind is called wind energy.

The energy possessed by wind is because of its high speed.

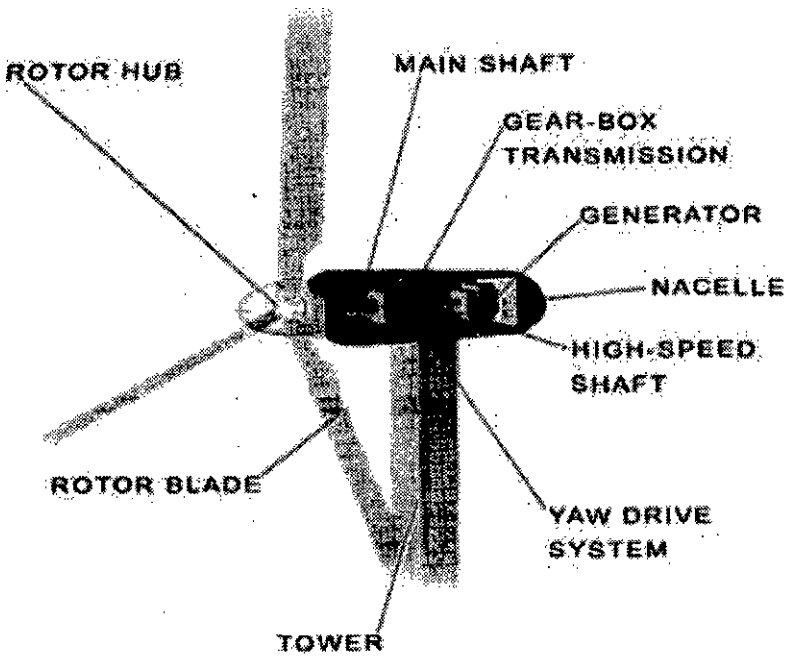
The wind energy is harnessed by making use of wind mills.

## Harvesting of wind energy

## 1. Wind Mills

The strike of blowing wind on the blades of the wind mill makes it rotating continuously.

The rotational motion of the blade drives a number of machines like water pump, flour mills and electric generators.



## 2. Wind farms

When a large number of wind mills are installed and joined together in a definite pattern it forms a wind farm.

The wind farms produce a large amount of electricity.

## Conditions

The minimum speed required for satisfactory working of a wind generator is 15 km/hr.

## Advantages

It does not cause any air pollution

It is very cheap.

## Ocean energy

It can be generated by following ways.

## 1. Tidal energy (or) Tidal power

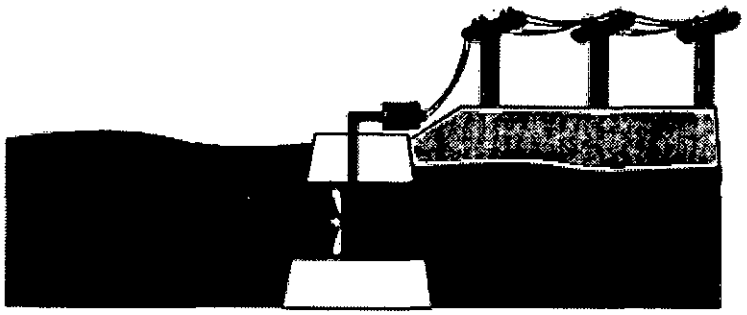
Ocean tides, produced by gravitational forces of sun and moon, contain enormous amount of energy.

The "high tide" and "low tide" refer to the rise and fall of water in the oceans.

The tidal energy can be harnessed by constructing a tidal barrage.

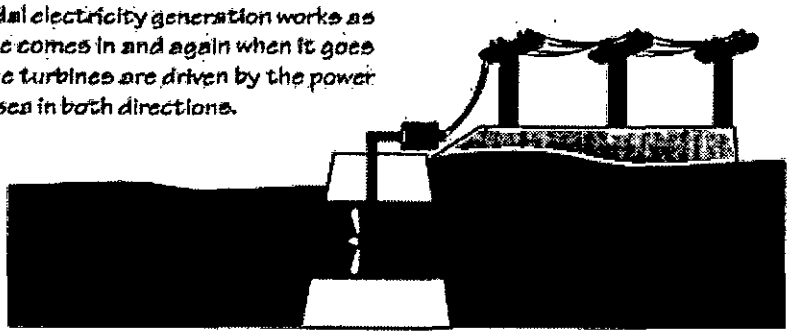
During high tide, the sea-water is allowed to flow into the reservoir of the barrage and rotates the turbine, which intern produces electricity by rotating the generators.

During low tide, when the sea level is low, the sea water stored in the barrage reservoir is allowed to flow into the sea and again rotates the turbine.



TIDE COMING IN

This tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both directions.



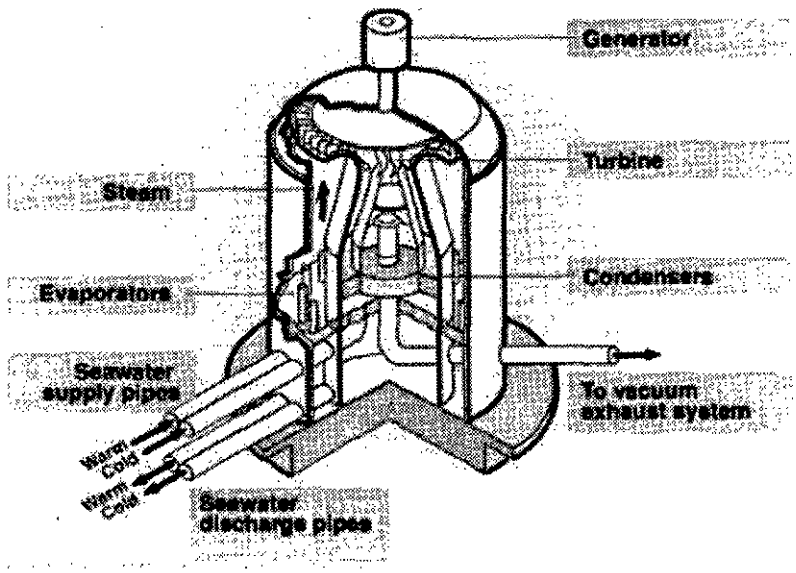
TIDE GOING OUT

## 2. Ocean thermal energy (OTE)

There is often large temperature difference between the surface level and deeper level of the tropical oceans.

This temperature difference can be utilized to generate electricity.

The energy available due to the difference in temperature of water is called ocean thermal energy.




### Condition

The temperature difference should be of 200C or more is required between surface water and deeper water.

### Process

The warm surface water of ocean is used to boil a low boiling liquid like ammonia.

The high vapour pressure of the liquid, formed by boiling is then to turn the turbine of the generator and generates electricity.

The cold water from the deeper ocean is pumped to cool and condense the vapour into liquid.

## 3. Geo-thermal Energy

Temperature of the earth increases at a rate of 20-750C per km, when we move down the earth surface.

High temperature and high-pressure steam fields exists below the earth's surface in many places.

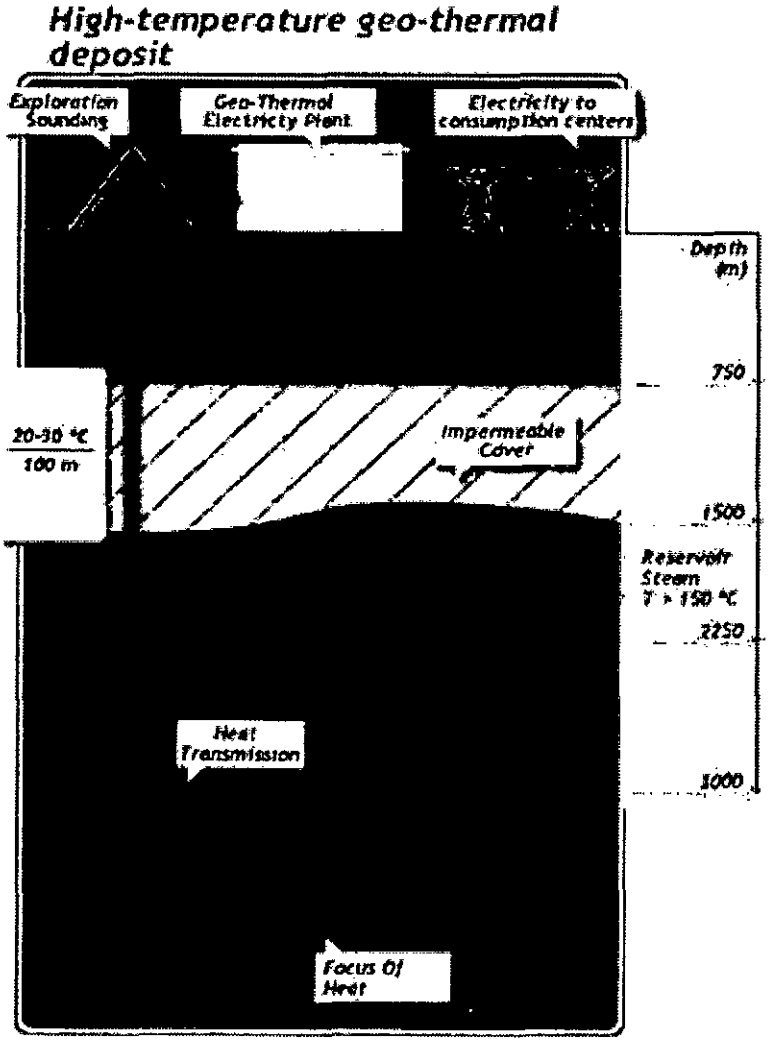
The energy harnessed from the high temperature present inside the earth is called geothermal energy.

### 1. Natural geysers

In some places, the hot water (or) steam comes out of the ground through cracks naturally in the form

## 2. Artificial geysers

In some places, we can artificially drill a hole up to the hot region and by sending a pipe in it; we can make the hot water or steam to rush out through the pipe with very high pressure. Thus, the hot water (or) steam coming out from the natural (or) artificial geysers is allowed to rotate the turbine of a generator to produce electricity.




## Biomass energy

Biomass is the organic matter, produced by plants or animals, used as sources of energy. Most of the biomass is burned directly for heating, cooling and industrial purposes.

E.g.: Wood, crop residues, seeds, cattle dung, sewage, agricultural wastes.

## Biogas

Mixture of methane, carbon dioxide, hydrogen sulphide, etc. It contains about 65% of methane gas as a major constituent.

Biogas is obtained by the **anaerobic fermentation** of animal dung or plant wastes in the presence of water.

## 2. Bio fuels

Biofuels are the fuels, obtained by the **fermentation** of biomass.

E.g.: Ethanol, Methanol

## (a)Ethanol

Ethanol can be easily produced from the **sugarcane**. Its calorific value is less when compared to petrol, and produces much less heat than petrol.

## (b)Methanol

*Methanol can be easily obtained from* **ethanol or sugar**-containing plants.

Its calorific value is also too low when compared to gasoline and diesel.

## (c)Gasohol

Gasohol is a mixture of **ethanol+gasoline.**

In India trial is being carried out to use Gasohol in cars and buses.

Gasohol is common fuel in Brazil and Zimbabwe for running cars and buses.

*Methanol is very useful since it burns at a lower temperature than gasoline or diesel.* Due to its high calorific value, hydrogen can serve as an excellent fuel.

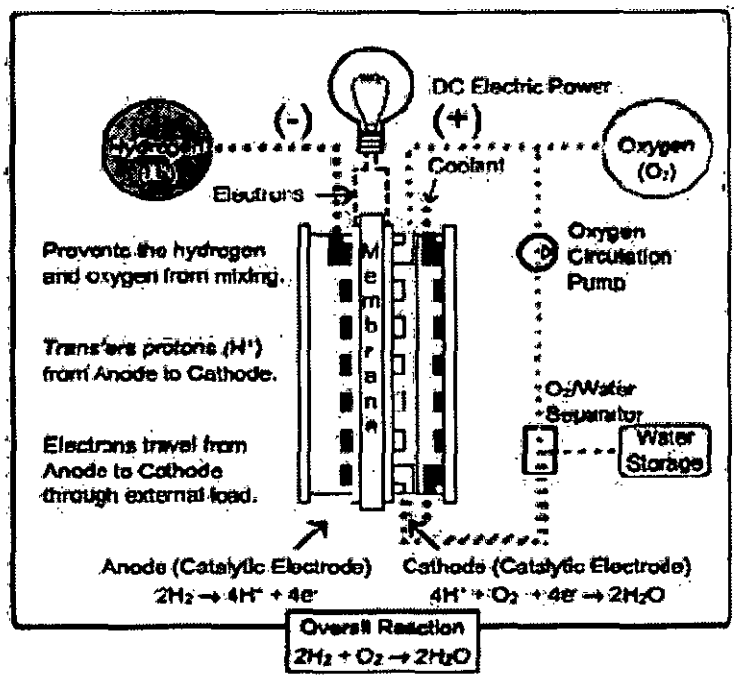
Moreover, it is non-polluting and can be easily produced.

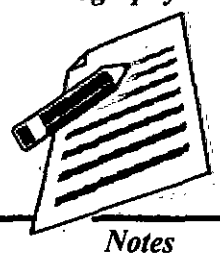
Presently H2 is used in the form of liquid hydrogen as a fuel in spaceships.

## Hydrogen Fuel

Hydrogen can be produced by **thermal dissociation** or **photolysis** or **electrolysis** of water. It possesses high calorific value.

It is non-polluting, because the combustion product is water. 2H2+O2---->2H2O+150KJ





*Notes*

## Disadvantages of hydrogen fuel

Hydrogen is highly inflammable and explosive in nature

Safe handling is required

It is difficult to store and transport.

## NON-RENEABLE ENERGY SOURCES

### 1 Coal

Coal is a solid fossil fuel formed in several stages as buried remains of land plants that lived 300-400 million years ago were subjected to intense heat and pressure over millions of years.

### Various stages of coal

1. The carbon content of Anthracite is 90% and its calorific value is 8700 k.cal.
2. The carbon content of bituminous, lignite and peat are 80, 70 and 60% respectively
3. India has about 5% of world's coal. Indian coal is not good because of poor heat capacity.

### Disadvantages

1. When coal is burnt it produces CO2 causes global warming
2. Since coal contains impurities like S and N, it produces toxic gases during burning.

### 2 Petroleum

Petroleum or crude oil = hydrocarbons +small amount S, O, N.

### Occurrence

The fossil fuel formed by the decomposition of dead animals and plants that were buried under lake and ocean at high temperature and pressure for million years

### Fractional distillation

Hydrocarbons are separated by fractioning the crude oil.

### Petroleum World Scenario

1. 67% oil reserves.
2. 25% of the oil reserves in Saudi Arabia.

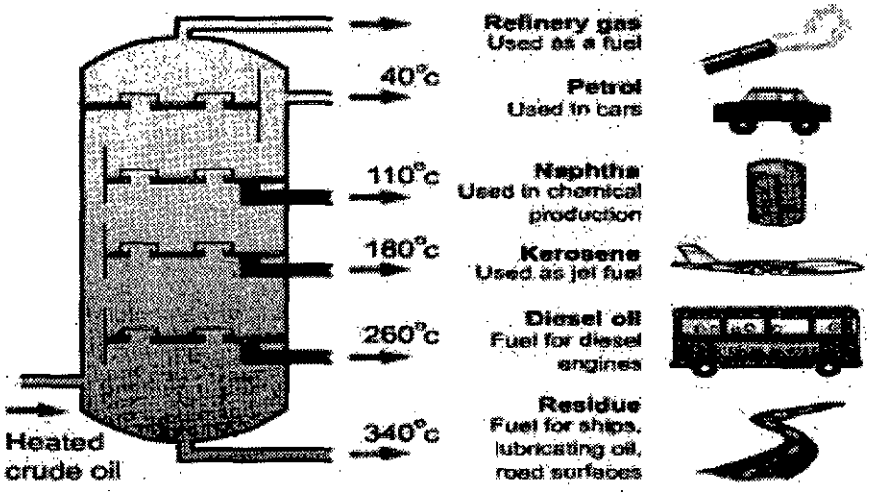
At the present rate of usage, the world's crude oil reserves are expected to get exhausted in just 40 years.

### 3 LPG (Liquefied Petroleum Gas)

1. The petroleum gas, **converted into liquid** under high pressure as LPG
2. LPG is colourless and odourless gas.
3. During bottling some **mercaptans** is added, to detect leakage of LPG from the cylinder.

## 4 Natural Gas

1. Mixture of **50-90% methane** and small amount of other **hydrocarbons.**
2. Its calorific value ranges from 12,000-14,000 k-cal/m3.




### (i)Dry gas

If the natural gas contains lower hydrocarbons like methane and ethane, it is called dry gas.

### (ii)Wet gas

If the natural gas contains higher hydrocarbons like propane, butane along with methane it is called wet gas.

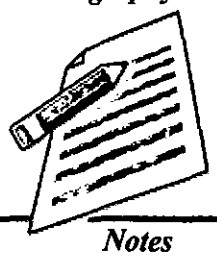
### Occurrence

Formed by the decomposition of dead animals and plants, those were buried under lake and ocean, at high temperature and pressure for millions of years

### Nuclear Energy

Geothermal Energy - Decay of radioactive elements has produced heat throughout Earth history. It is this heat that causes the temperature to increase with depth in the Earth and is responsible for melting of mantle rocks to form magmas. Magmas can carry this upward into the crust. Groundwater circulating in the vicinity of igneous intrusions carries the heat back toward the surface. If this hot water can be tapped, it can be used directly to heat homes, or if trapped at great depth under pressure it can be turned into steam which will expand and drive a turbine to generate electricity.

Direct Nuclear Energy - Radioactive Uranium is concentrated and made into fuel rods that generate large amounts of heat as a result of radioactive decay. This heat is used to turn water into steam. Expansion of the steam can then be used to drive a turbine and generate electricity. Once proposed as a cheap, clean, and safe way to generate energy, Nuclear power has come under some disfavour. Costs of making sure nuclear power plants are clean and safe and the problem of disposing of radioactive wastes, which are unsafe, as well as questions about the safety of the plants under human care, have contributed to this disfavour In the above list, sources of energy that require geological knowledge for exploitation. While using direct





solar energy to heat water and homes does not require geologic knowledge, the making of solar cells does, because the material to make such cells requires knowledge of specific mineral deposits. Hydroelectric energy requires geologic knowledge in order to make sure that dams are built in areas where they will not collapse and harm human populations. Finding fossil fuels and geothermal energy certainly requires geologic knowledge. Direct nuclear energy requires geologists to find deposits of uranium to generate the fuels, geologists to find sites for nuclear power plants that will not fall apart due to such things as earthquakes, landslides, floods, or volcanic eruptions, and requires geologists to help determine safe storage sites for nuclear waste products. In this course we will concentrate on Fossil Fuels.

## Fossil Fuels

The origin of fossil fuels, and biomass energy in general, starts with photosynthesis. Photosynthesis is the most important chemical reaction to us as human beings, because without it, we could not. Photosynthesis is the reaction that combines water and carbon dioxide from the Earth and its atmosphere with solar energy to form organic molecules that make up plants and oxygen essential for respiration. Because all life forms depend on plants for nourishment, either directly or indirectly, photosynthesis is the basis for life on Earth. The chemical reaction is so important, that everyone should know it as it is the way plants produce food from inorganic materials and is the basis for the vast majority of the food chain.

$$nCO_2 + nH_2O + \text{Energy} \longrightarrow C_nH_{2n}O_n + nO_2$$

Carbon Dioxide + Water (from atmosphere) — Solar Energy — Simple Sugar (Plant matter) + Oxygen to atmosphere

Note that if the reaction runs in reverse, it produces energy. Thus, when oxygen is added to organic material, either through decay by reaction with oxygen in the atmosphere or by adding oxygen directly by burning, energy is produced, and water and carbon dioxide return to the Earth or its atmosphere. To produce a fossil fuel, the organic matter must be rapidly buried in the Earth so that it does not oxidize (react with oxygen in the atmosphere). Then a series of slow chemical reactions occur which turn the organic molecules into hydrocarbons. Hydrocarbons are complex organic molecules that consist of chains of hydrogen and carbon. Petroleum (oil and natural gas) consists of many different such hydrocarbons, but the most important of these are a group known as the paraffins. Paraffins have the general chemical formula: $C_nH_{2n+2}$

As the value of n in the formula increases, the following compounds are produced:Formation of Petroleum

The organic matter that eventually becomes petroleum is derived from photosynthetic microscopic organisms, like plankton and bacteria, originally deposited along with clays in the oceans. The resulting rocks are usually shales, yet, most petroleum occurs in much more permeable rocks like sandstones, limestones, or highly fractured rock. Thus, it is apparent that petroleum migrates, like groundwater, and accumulates in these more permeable rocks. The process of petroleum formation involves several steps:

Organic matter from organisms must be produced in great abundance.

This organic matter must be buried rapidly before oxidation takes place.

Slow chemical reactions transform the organic material into the hydrocarbons found in petroleum.

As a result of compaction of the sediments containing the petroleum, the oil and natural gas are forced out and migrate into permeable rock. Migration is similar to groundwater flow.

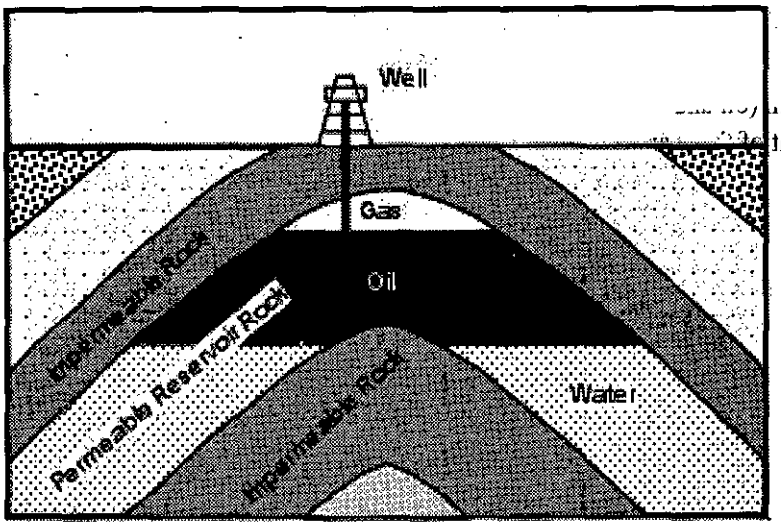
The petroleum must migrate into a reservoir rock that is in some way capped by impermeable rocks to prevent the petroleum from leaking out to the surface of the Earth. Such a geologic structure is called a trap.

All of these processes must occur within a specific range of temperatures and pressures. If higher pressures and temperatures are encountered as a result of metamorphism or igneous activity, the petroleum will be broken down to other non-useful forms of hydrogen and carbonOil Traps

Because oil and natural gas have a low density they will migrate upward through the Earth and accumulate in a reservoir only if a geologic structure is present to trap the petroleum. Geologic structures wherein impermeable rocks occur above the permeable reservoir rock are required. The job of petroleum geologists searching for petroleum reservoirs, is to find conditions near the Earth's surface where such traps might occur. Oil traps can be divided into those that form as a result of geologic structures like folds and faults, called structural traps, and those that form as a result of stratigraphic relationships between rock units, called stratigraphic traps. If petroleum has migrated into a reservoir formed by one of these traps, note that the petroleum, like groundwater, will occur in the pore spaces of the rock. Natural gas will occur above the oil, which in turn will overly water in the pore spaces of the reservoir. This occurs because the density of natural gas is lower than that of oil, which is lower than that of water.

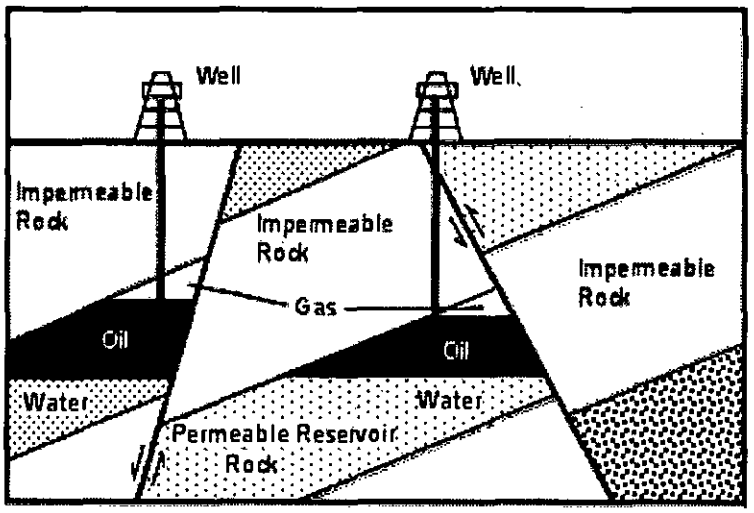
## Structural Traps

Anticlines - If a permeable rock like a sandstone or limestone is sandwiched between impermeable rock layers like shales or mudstones, and the rocks are folded into an anticline, petroleum can migrate upward in the permeable reservoir rocks, and will occur in the hinge region of the anticline.

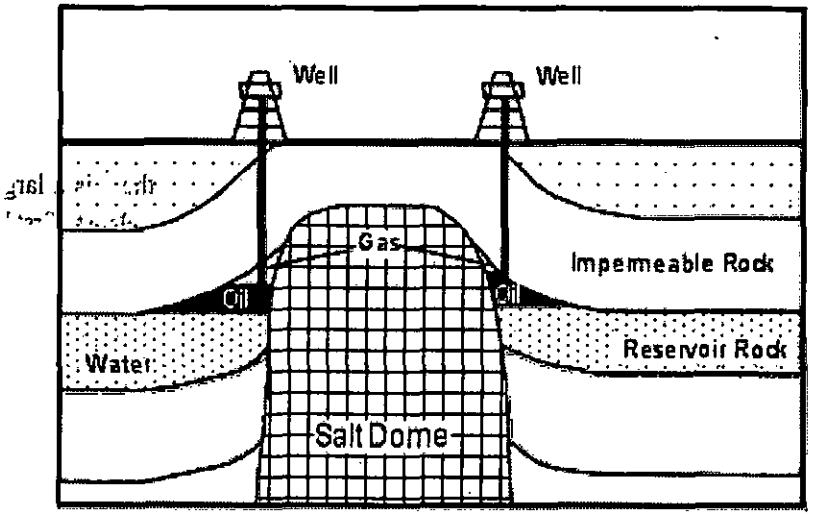



Since anticlines in the subsurface can often be found by looking at the orientation of rocks on the surface, anticlinal traps were among the first to be exploited by petroleum geologists.

Note that synclines will not form an oil trap because oil must rise on top of the trapped water. Faults - If faulting can juxtapose permeable and impermeable rocks so that the permeable rocks always have impermeable rocks above them, then an oil trap can form. Note that both normal faults and reverse faults can form this type of oil trap. Since faults are often exposed at the Earth's surface, the locations of such traps can often be found from surface exploration.




Salt Domes - During the Jurassic Period, the Gulf of Mexico was a restricted basin. This resulted in high evaporation rates & deposition of a thick layer of salt on the bottom of the basin. The salt was eventually covered with clastic sediments. But salt has a lower density than most sediments and is more ductile than most sedimentary rocks. Because of its low density, the salt moved upward through the sedimentary rocks as salt domes. The intrusion of the salt deforms the sedimentary strata along its margins, folding it upward to create oil traps. Because some salt domes get close to the surface, surface sediments overlying the salt dome are often domed upward, making the locations of the subsurface salt and possible oil traps easy to locate.

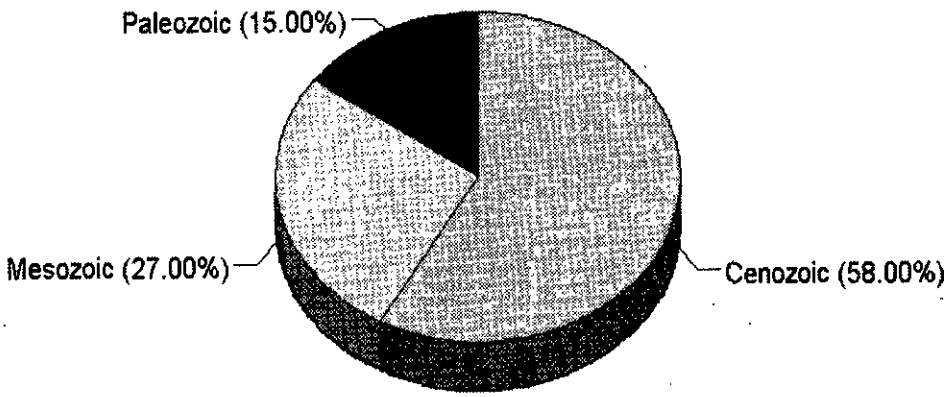



## Distribution of Petroleum

The distribution of rocks containing petroleum widespread. Still, since reservoirs of petroleum result from upward migration and since older rocks have had more time to erode

or metamorphose, most reservoirs of petroleum occur in younger rocks. Most petroleum is produced from rocks of Cenozoic age, with less produced from rocks of Mesozoic and Paleozoic age.

**Petroleum Production from Strata of Different Ages**



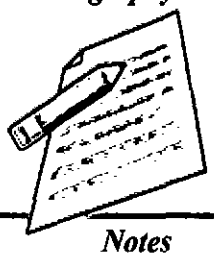

## Oil Shale and Tar Sands

- Oil shale is shale that contains abundant organic matter that has not decomposed completely to produce petroleum. Oil can be extracted from oil shales, but they must be heated to high enough temperatures to drive the oil out. Since this process requires a lot of energy, exploitation of oil shales is not currently cost-effective, but may become so as other sources of petroleum become depleted. Known deposits of oil shale are extensive.
- Tar Sands are sandstones that have thick accumulations of viscous oil in their pore spaces. Extraction of this oil also requires heating the rock and is therefore energy intensive and not currently cost effective

## Coal

Coal is a sedimentary/metanorphic rock produced in swamps where there is a large-scale accumulation of organic matter from plants. As the plants die, they accumulate to first become peat. Compaction of the peat due to burial drives off volatile components like water and methane, eventually producing a black- coloured organic- rich coal called lignite. Further compaction and heating results in a more carbon- rich coal called bituminous coal. If the rock becomes metamorphosed, a high-grade coal called anthracite is produced. However, if temperatures and pressures become extremely high, all of the carbon is converted to graphite. Graphite will burn only at high temperatures and is therefore not useful as an energy source. Anthracite coal produces the most energy when burned, with less energy produced by bituminous coal and lignite.

Coal is found in beds called seams, usually ranging in thickness from 0.5 to 3m, although some seams reach 30 m. Two major coal producing periods are known in geologic history. During the Carboniferous and Permian Periods, the continents were





apparently located near the equator and covered by shallow seas. This type of environment favoured the growth of vegetation and rapid burial to produce coal. Known reserves of coal far exceed those of other fossil fuels, and may be our best bet for an energy source of the future. Still, burning of the lower grades of coal, like lignite and bituminous coal, produces large amounts of waste products that pollute the atmosphere. This problem needs to be overcome before we can further exploit this source of energy. Mineral and power resources play an important role in the industrial development of a nation. They provide the industrial raw materials and fuel.

## SUMMARY

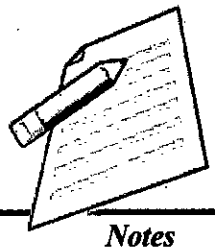
Minerals are classified into metallic and non-metallic minerals. Metallic minerals can be further grouped into ferrous and non-ferrous. Mineral fuels are coal, petroleum, and natural gas. India's position is particularly good in the metallic minerals of ferrous group. It is well endowed with iron ore of high quality. India has rich deposits of mica and bauxite. It is also one of the leading producers of mica in the world. Coal is the primary source of power in India. It occurs in the rock formations of Gondwana and Tertiary age. Gondwana coal fields account for 96% of the total reserves and production in India. India's position is not satisfactory in the reserves as well as production of petroleum. Assam belt and Gujarat-Cambay and Bombay High belt are the two important petroleum producing regions in India. Uranium and thorium are the two important atomic minerals in India. The major problems faced by mineral resources are depletion of mineral resources, ecological problems, pollution and social problems. Various methods are adopted for conservation of mineral resources. The measures are reclamation, recycling, substitution and more efficient uses. Recently some on-shore as well as off-shore oil fields has been discovered. On-shore oil fields are discovered in the state of Rajasthan whereas offshore oil fields are discovered along the coast of Tamil Nadu and Andhra Pradesh. Natural gas is emerging as an important source of commercial energy because in recent years more and more reserves are discovered at eastern coast namely Krishna, Godavari and Mahanadi basins.

## EXERCISE

### MCQ

1. Uranium and thorium used for generating nuclear power are found in
   (a) Godavari Basin
   (b) Gulf of Cambay
   (c) Manikarn in Himachal Pradesh
   (d) Aravalli ranges of Rajasthan
   **Answer:** d

2. Which of the following is an offshore oil field?
   (a) Ankaleshwar (b) Digboi
   (c) Kalol (d) Mumbai High
   **Answer:** d





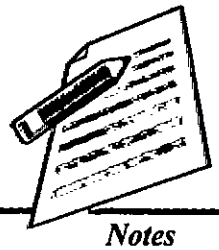
3. Which one of the following minerals is formed by decomposition of rocks, leaving a residual mass of weathered material?
   (a) Coal (b) Bauxite
   (c) Gold (d) Zinc
   **Answer:** b

4. Koderma, in Jharkhand, is the leading producer of which one of the following minerals?
   (a) Bauxite (b) Mica
   (c) Iron ore (d) Copper
   **Answer:** b

5. Minerals are deposited and accumulated in the stratas of which of the following rocks?
   (a) Sedimentary rocks (b) Igneous rocks
   (c) Metamorphic rocks (d) None of the above
   **Answer:** a

## Review Questions

1. Describe the position of India in mineral resources.
2. Describe the distribution and production of the following minerals and mineral fuels in India: (a) Iron Ore (b) Coal (c) Petroleum.
3. What are the problems associated with exploitation of mineral resources?
4. Describe various methods of conservation of mineral resources.
5. Answer in briefly: (i) Name three important sources of energy which are non-renewable and also pollution free. (ii) Differentiate between thermal, hydel and nuclear energy. State the share of each in the total production of energy. (iii) Mention two advantages of non-conventional sources of energy. (iv) Describe the role of biogas as an energy for the rural areas.
6. Distinguish between (i) Conventional and Non-conventional sources of power. (ii) Solar energy and Wind energy.
7. On an outline map of India show the following (i) Jharia and Raniganj coal fields. (ii) Ankaleswar and Digboi oil fields. (iii) Mathura and Panipat oil refineries. (iv) Talcher and Korba thermal power plants. (v) Kaiga and kota atomic power plants. (vi) Bhakra and Nagarjuna Sagar hydro-electric plants.





# 18 INDUSTRIAL DEVELOPMENT

- Understand the concept of industries.
- Discuss the features of industries.
- Describe the types of industries.
- Discuss the pattern of industrial development.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of industrial development so that the types and pattern of industrial development can be learned.

## Introduction

The basic needs of humankind are food, clothing and shelter. For food, humans cultivate several different crops and produce food. The cultivation of crop is generally referred to as agriculture. Humans process these agricultural products through flour mills and preserving industries into palatable food products. The industries involved here are food processing industries. For clothing, humans produce cotton, jute, silk and wool and manufacture clothing in the factories. This is called textile industry. They also manufacture building materials such as bricks, iron and steel products, cement and the like. Therefore, we may define 'industry' as that activity which produces what human beings need in their lives and living.

When humans were primitive, their needs were but a few. Industry was not extensive. With modernisation, the necessities were increasing. With population increases, consumption was on the rise. Humans could not meet their needs only by manual production. Hence, the need to discover machines arose. With the industrial changes in the eighteenth century, industrial activities grew rapidly. As a consequence, humans have developed a multitude of industries to satisfy their needs.

The industries so developed until now could be classified as the four following industries, on the basis of their state of production:

1. Primary industries.
2. Secondary industries.
3. Tertiary industries.
4. Quaternary industries.

## Primary Industries

The industries that help extract resources directly from nature are collectively called 'primary industries'. These are fundamental to other allied industries. Hunting, fishing,

cultivation of crops and mining are 'the primary industries'. It is the primary industries that provide the food the humans need. They also provide for the raw materials the secondary industries demand.

## Secondary Industries

Industries which transform natural resources into products that humans could consume are called ‹the secondary industries›. For instance, cotton from agriculture is transformed into clothing in these industries. Likewise, resources obtained from mining industries are converted into products that humans need.

## Tertiary Industries

The products of the primary and secondary industries reach the people in different parts of the world through transport, trade and allied institutions such as banks, telecommunications, recreation and tourism and such are then called 'the tertiary industries'

## Quaternary Industries

These are industrial activities that help the activities under the earlier three sectors. These are called 'the quaternary industries'. These include education, research, administration, financial management, legal activities and medicine besides several others. The activities of this group of industries are not linked to commodities and products, rather these are linked to people. In these, high quality skills and training are especially needed.

All products that we consume are produced and provided by the four industries above. For example, the raw materials needed to manufacture bicycles that we use for transport are from the four industries: iron ore and sandstones that form the basis for glass come from mining industries and rubber comes from plantations. These are then transformed into steel pipes and glasses and tyres and tubes by the secondary industries. Bicycles are then manufactured to be sold in the market. It is in the sale of these bicycles that the tertiary industries are important. For performing activities related to the refinement, promotion and sale are aided by the quaternary industries. In fact, all consumer products that we consume are produced with the help of all the four industries.

## Industry

Industry refers to economic activities, which are connected with conversion of resources into useful goods. The production side of business activity is referred as industry. Generally, the term industry is used for activities in which mechanical appliances and technical skills are involved. These include activities relating to producing or processing of goods as well as breeding and rising of animals.

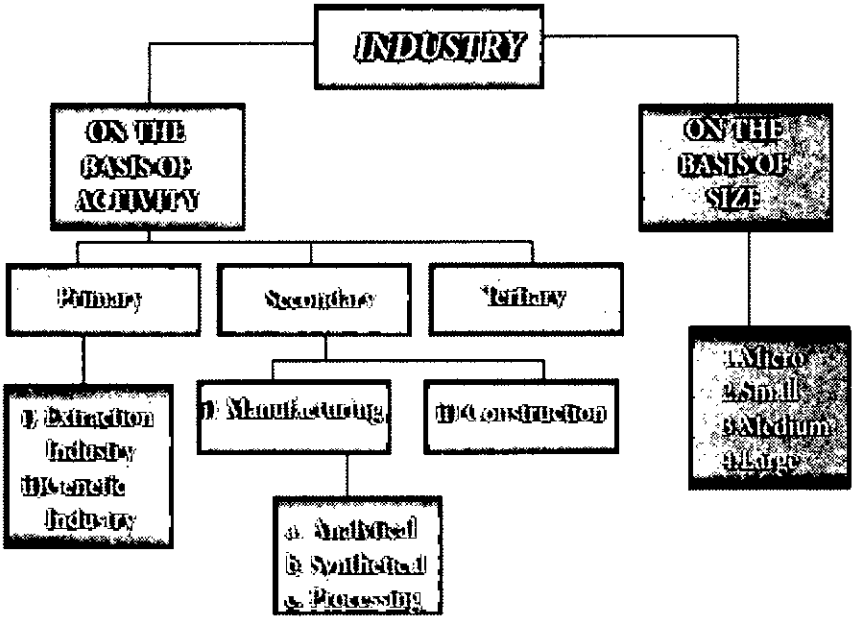
The term industry is also used to mean group of firms producing similar or related goods. For example, cotton textile industry refers to all manufacturing units producing textile goods from cotton. Similarly, electronic industry would include all firms producing electronic goods, and so on. Further, in common parlance, certain services like banking and insurance are also referred to as industry, say banking industry, insurance industry etc.

## Kinds of Industries

Industries may be classified into two broad categories,

A. On the Basis of Activities and

B. On the Basis of Size




A. On the Basis of Activities

Industries may be divided into three wide categories namely 1. primary industries, 2. secondary industries and 3.tertiary industries.

### 1. Primary Industries

Primary industry is concerned with production of goods with the help of nature. It is a nature-oriented industry, which requires very little human effort, For example Agriculture, farming, forestry, fishing, horticulture, etc. These industries may be further sub divided as follows:

### (i) Extractive Industries

These industries extract or draw out products from natural sources. Extractive industries supply some basic raw materials that are mostly products of geographical or natural environment.

Products of these industries are usually transformed into many other useful goods by manufacturing industries. Important extractive industries include farming, mining, oil drilling, hunting and fishing operations.

## (ii) Genetic Industries

These industries remain engaged in breeding plants and animals for their use in further reproduction. The seeds, nursery companies, poultry, diary, piggery, hatcheries, nursery, fisheries, apiary etc are classic examples of genetic industries.

## 2. Secondary Industries

These are concerned with using the materials which have already been extracted at the primary stage. These industries process such materials to produce goods for final consumption or for further processing by other industrial units. For example, mining of an iron ore is a primary industry, but manufacturing of steel by way of further processing of raw irons is a secondary industry. Secondary industries may be further divided as follows:

## (i) Manufacturing Industries

These industries are engaged in producing goods through processing of raw materials and thus creating form utilities. They bring out diverse finished products, which we consume or use, through the conversion of raw materials or partly finished materials in their manufacturing operations. Manufacturing industries may be further divided into four categories on the basis of method of operation for production.

a. **Analytical Industry** which analyses and separates different elements from the same materials, as in the case of oil refinery.

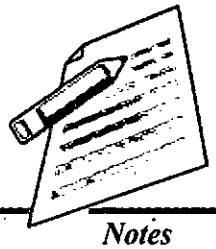
b. **Synthetic Industry** which combines various ingredients into a new product, as in the case of cement.

c. **Processing Industry** which involves successive stages for manufacturing finished products, as in the case of sugar and paper.

d. **Assembling Industry** which assembles different component parts to make a new product, as in the case of television, car, computer, etc.

## (ii) Construction Industries

These industries are involved in the construction of building, dams, bridges, roads, as well as tunnels and canals.





## 3. Tertiary industries or Service industries

They do not produce goods. These industries produce utility services and sell them at a profit. They help trade, industry and commerce. This term also includes auxiliaries to trade like banking, insurance, warehouse, advertisement etc.

## Classification of Tertiary Industries

i. **Personalised service:** Individuals and private institutions selling their services to others. E.g., plumber, servant maid, etc.

ii. **Public Service:** Government hospitals, schools, police, Government offices, etc. provide services to the people on behalf of the Government without profit motive.

iii. **Distributive Service:** Transportation, warehousing, logistics, salesmanship, etc. come under this type of service.

iv. **Financial Service:** Banking, factoring, accounting, and insurance, etc. are grouped under this type of service.

v. **Quaternary Service:** Professional or specialised skills and high technology are used to provide this type of service. E.g., Software development, Auditing, Research and Development, etc.

vi. **Quinary Service:** New ideas are generated, new technologies are evolved, new policies are implemented by selected individual experts. Their decisions influence nations, international institutions, etc. i.e., Inventors.

## B. On the basis of Size

On the basis of size or scale of operations industries may be classified as follows

1. Micro Industries
2. Small Industries
3. Medium Industries and
4. Large Industries

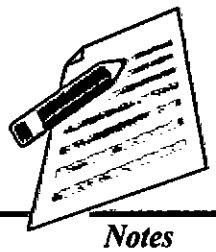
## *Patterns of Industrial Development*

The pre-independent India, mostly characterised by backwardness, did not have an organized industrial sector. The Second World War made small beginning in the industrial development. Still the share of industries in the country's national income was relatively small.

There had been a marked shift in the advancement of the industries after the implementation of five-year Plans in the independent India. The significant role of industrialization as the major channel of rapid economic growth and all-round development has been recognized by the planners of modern India.

Besides rapid growth and prosperity, the Indian strategy of development planning, inspired by economic nationalism, aimed at achieving self-sufficiency under the direction of public sector. It also aimed to translate the economic growth into improved standard of living of the masses. Maximum production and full employment, and the attainment of economic equality were the long-term objectives declared by the First Five Pear Plan.

The policies aimed at achieving economic growth with distributive justice. Then the rapid development of industries and their diversification are considered to be absolutely necessary for development.





The experience of state dominated development planning for a period of more than five decades has brought out many significant achievements in the growth and structure of Indian industries.

'Growth with social justice' has been the main objective of planning since 1951. It has been defined to be inbuilt in the production process so that the major beneficiaries of the development planning are the majority of the people and the rapid and diversified industrialization serves the needs of the masses by generating adequate employment and income distribution.

The new policy environment focused on a mixed economy framework where the public sector will play a major role in building the industrial base of the economy with the objectives of accelerating growth, generating employment, reducing regional disparities, checking concentration of economic power and achieving self-reliance.

## SUMMARY

The processing of natural resources into more useful items is called manufacturing. Economic development of a country is directly linked with the level of industrial development. In India the share of manufacturing industries in GDP has been increasing, over the period, especially in post-economic reforms period. Before independence, India was industrially less developed. But after independence India initiated industrial development in a planned manner during its Five-Year Plans. Today, India exports a large number of industrial goods to different countries of the world. Industries can be classified into different categories on the basis, such as of sources of raw material, ownership, functions, size of industry and weight of raw material and finished products. Since India is still an agricultural country, it has developed various agro-based industries such as cotton textile, woollen textile, jute textile and sugar industry. Cotton textile industry is the largest organised sector industry in India. India is also endowed with various minerals, enabling the country to establish various mineral based industries such as iron and steel, heavy engineering, automobiles, chemicals and petro chemical industry. The Government of India framed policies which have made India self-reliant in various sectors of industries. Liberalization, globalization and privatization have helped in bringing foreign capital and modern technology into the country. Private enterprise is being allowed to enter into various core sectors. This, has resulted into the faster growth of industrial sector.

## EXERCISE

### MCQ

1. Oil refinery and sugar mill are classified under which industries?

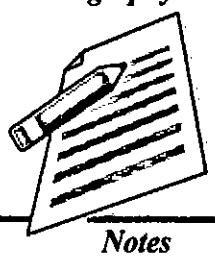
   A. Primary  B. Secondary
   C. Tertiary  D. None of the above

   **Answer** B

2. Identify the activity which does not support trade.

   A. Banking  B. Warehousing
   C. Insurance  D. Mining

   **Answer** D





3 In which occupation do people get salary or wages in return for their work?

A. Employment B. Business
C. Profession D. None of the above

Answer A

4. Which item does not cause any business risk?

A. Breakdown of machinery B. Efficient management
C. Riot D. Changing government policy

Answer D

5. In which business, the support service activities are categorized?

A. Commercial industries B. Primary industries
C. Secondary industries D. Tertiary industries

Answer D

## Review Questions

1. Why is the cotton textile industry mainly concentrated in and around Mumbai? Give four reasons.
2. State three reasons for the shifting of sugar industry from north India to south India.
3. Giving suitable examples, classify industries on the basis of ownership.
4. Define industrial self-reliance. Why does India need industrial self-reliance?
5. Describe any four factors responsible for the concentration of iron and steel industry in and around Chhotanagpur plateau.
6. Differentiate between agro-based and mineral based industries. Give two examples of each

# 19 POPULATION DENSITY, DISTRIBUTION AND GROWTH IN INDIA

- Understand the concept of population.
- Discuss the features of population.
- Describe the concept of population density.
- Discuss the concept of population growth.

## Objective of the chapter:

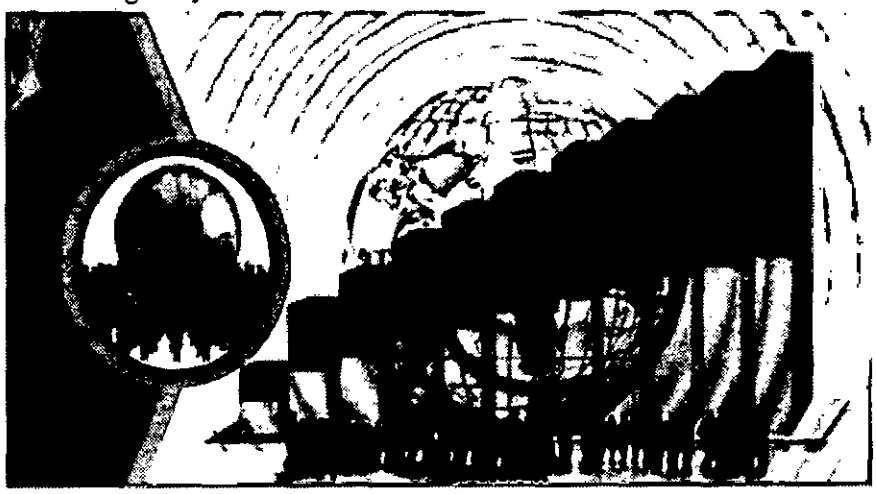
The basic objective of this chapter is to through some light on the initial concepts of population so that the types and distribution of population density can be learned.

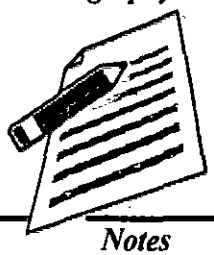
## Introduction

Do you know that 3,60,000 persons born every day in the world? Four births take place every second in the world. 'Professor Stephen Hawking thinks the human species will have to populate a new planet within 100 years if it is to survive,' the BBC confirmed.

'With climate change, overdue asteroid strikes, epidemics and population growth, our own planet is increasingly precarious,' the news outlet continued.

Human being is an important element of the environment and is probably the latest occupant of the earth, as its evolution took place less than two million years ago. Although distribution and growth of human population are influenced greatly by the physical environment, they have tremendous capacity to modify the physical environment. **Demography** is the statistical study of human population. It includes the study of size, structure and distribution of population as well as changes in time and location in response to birth, migration, aging and death. **'Population explosion'** is one of the greatest challenges that we are facing today.







## Distribution of world population

People have inhabited the earth for several thousands of years, but for a long period of time, their numbers remained limited. It is only during last few hundred years that human population has increased at an alarming rate.

Population is spread unevenly across the continents. Only a few areas support large concentration of people while vast areas support few people. A large number of factors influence the distribution and growth of population over the earth's surface.

## The factors influencing the distribution of population

### 1. Relief

Rugged mountains pose various obstacles such as unsuitable conditions for the construction of rail-roads and highways, unfavourable conditions for agricultural crops because of short growing season, lack of cultivable land and snowy winters do not encourage large settlement areas. Hence, the mountainous areas support a few people. On the other hand, a large concentration of population is found in the fertile lowlands such as the Ganges and Brahmaputra in India, Hwang-Ho in China and plains of North-Western Europe and the USA. This is mainly due to flat level land which is fertile, favourable conditions for agriculture, long growing seasons and suitable condition for the settlement.

### 2. Accessibility

Areas with well-developed transport infrastructure and links through road, rail, shipping, canals and air are likely to be more densely populated than areas which are poorly connected with transport network.

In earlier times, in the absence of water transport, all islands remained virtually uninhabited. One of the reasons why mountains are not inhabited by people is lack of accessibility.

### 3. Adequate water supply

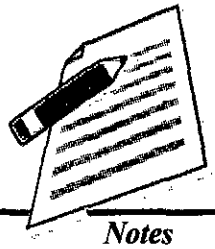
Population distribution is affected very much by the presence or absence of water in any region. Water supply is essential for human survival and development. Areas which have sufficient water tend to have denser population than areas which are dry or suffer from regular drought. Well-watered regions of the Great Northern plains of India are densely populated whereas drought prone areas of Sahara are sparsely populated.

### 4. Soil

Fertile alluvial soils of river valleys throughout the world have encouraged dense settlement of population because they support agricultural activities. The high density of population in parts of East and South- East Asia is dependent mainly on fertile soil. For example, dense population is found in the Ganges valley of India, in Indus valley of Pakistan and Hwang-Ho valley of China. On the other hand, desert soil of Sahara region is sparsely populated.

### 5. Economic and political factors

Unfavourable economic condition, unemployment, religious intolerance, conflicts and wars do not favour more population.





## The patterns of Population Distribution

The analysis of the pattern of population distribution and density is fundamental to the study of demographic characteristics of any area. The population distribution refers to the way the people are spread over the earth's surface. The population distribution is uneven worldwide. **Ten most populous countries** of the world together make up nearly **60%** of the world's population.

## Density of Population

Absolute numbers do not give any indication of the impact of population on the land and its resources. The number of persons living per unit of land areas gives a better picture. This is expressed in the form of density of population per sq.km of land area.

## Density of population = Total population / Total area of the country

It is obtained by dividing the total land area by the total population, the quotient being the number of people per square kilometre. Compared with simple arithmetic density, physiological or nutritional density is a more refined method of calculating man-land ratios.

**Physiological or Nutritional** density is the ratio between total population and total cropped area. The total arable land in the world is **13.3%** and the nutritional density of the world is **325 per sq.km** of land. The total percentage of arable land is 48.83 in India and its nutritional density is 753 per sq.km of land. **Singapore** has the highest nutritional density of population of **440,998 per sq.km** of land the world. The areas of density of population can be divided into three as follows:

## 1. High density areas of population

Fertile plains with favourable climate and highly industrialised and urbanised areas are generally densely populated. There are four major areas of high density of population with **more than 100 persons** per sq.km. Areas include:

a. Eastern Asia, including china, Japan and Republic of Korea.
b. Southern Asia, comprising India, Bangladesh and Sri Lanka.
c. North-Eastern part of the United States of America.
d. Central and North-Western Europe.

Of the four regions given, the first two i.e., Eastern Asia and South Asia have high density of population due to favourable environmental conditions such as favourable climate, fertile soil and large areas of plains which encourage the growth of agriculture. The plains and river valleys of India and China are densely populated. In the last two groups i.e., North Eastern United States of America and North – Western Europe which are densely populated due to the concentration of manufacturing industries.

## 2. Moderate density areas of population

The areas of moderate density of population have **between 10 and 80 persons** per sq.km. The areas of moderate density of population include Central part.of the United States of America, Tropical Western Africa, Western blocks of Russia, Eastern Europe, Deccan Plateau of India, Central China, Southern portion of the Plateau of Mexico, North -Eastern Brazil and Central Chile, The above areas are characterised by the well-developed agricultural activities, favourable climate, fertile soils, fishing, etc,

## 3. Low density areas of population

About half the area of the world has population **less than 10 persons** per sq.km. Certain vast areas remain completely uninhabited. The main areas are

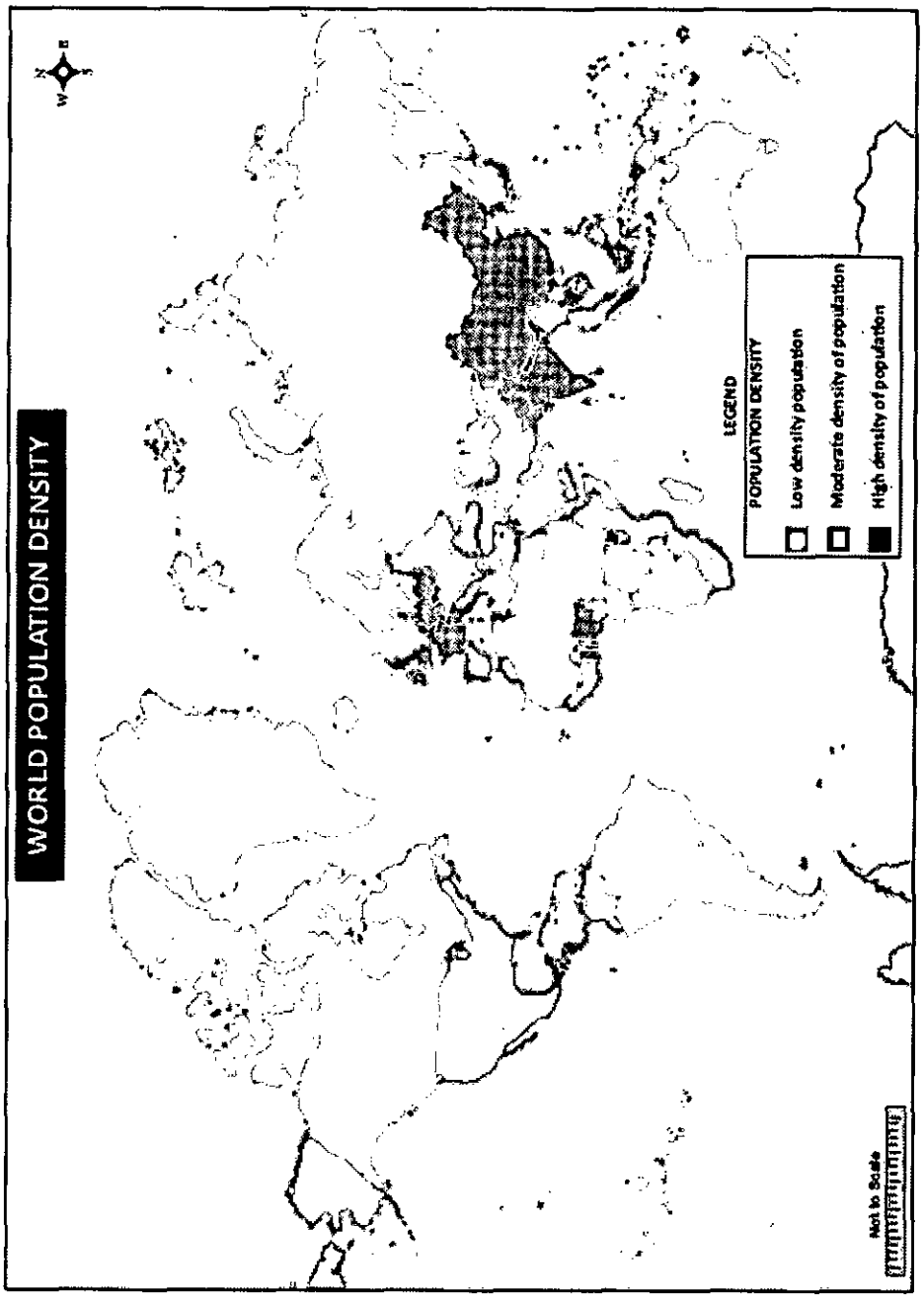
a) Amazon forest region of South America and Congo forest region of Africa.

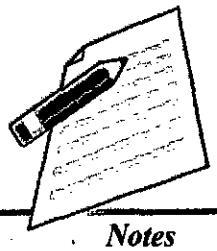
b) Arctic area of Canada, Greenland and the Polar regions.

c) Great deserts of the world i.e., Sahara, Kalahari, Arabia, Great desert of Australia, Atacama Desert of South America, desert regions of Western United States and Thar Desert of India.

d) High mountainous regions in all continents.

e) Antarctica.







**Australia** with an average density of population of **2 persons per sq.km** is one of the most sparsely populated countries of the world. However, inhabitants of these areas have high standard of living. The reasons for low density of population are

a) Bad and unfavourable environment conditions for human settlement.

b) Lack of economic activities.

c) Lack of transport and communication.

d) Government policy.

## Terms related population

1. **Population:** A group of individuals of the same species occupying a particular geographic area.
2. **People:** The members of a particular nation, community, or ethnic group.
3. **Crude Birth rate (Natality Rate):** Number of live births per thousand people in a year.
4. **Crude Death Rate (Mortality Rate):** Number of deaths per thousand people in a year.
5. **Net Migration Rate:** the formula for net migration rate is simple:

   $N = 1000 \times (I - E) / P$

   N= net migration rate

   E= number of people emigrating out of the country

   I= number of people immigrating into the country

   P= the estimated mid-year population
6. **Fertility Rate:** is the number of live births expected per 1000 women in their life times in a specified geographic area and for a specific point in time, usually a calendar year. **Niger** has **the highest fertility rate of 6.49** while **Singapore** has the **lowest fertility rate of 0.83.** Can you guess why there is variation between these countries?
7. **Dependency ratio:** Number of dependents in a population divided by the number of working age people. It's a calculation which groups those aged under 15 with those over 65 years as the 'dependants' and classifying those aged 15-64 years as 'the working-age population'.
8. **Growth Rate:** = CBR – CDR +/- Net Migration Rate/ 1000

   **South Sudan** has the highest population growth rate of 3.83% in 2017.
9. ***Rate of Natural Increase (RNI)*** = CBR-CDR (No Migration)

   CBR>CDR = ↑ population

   RNI usually expressed as % e.g., 2% = 2/100 = 20/1000

   RNI ≠ population growth if migration significant
10. **Adult Literacy Rate:** The Adult literacy index (ALI) is a statistical measure used to determine how many adults can read and write in a certain area or nation. Adult literacy is one of the factors in measuring the Human Development Index (HDI) of each nation, along with life expectancy, education, and standard of living. Burkina faso has the lowest literacy rate of 21.8% ( 2015). How does literacy rate affect the standard of living of a country?
11. **Life expectancy rate:** Life expectancy equals the average number of years a person born in a given country is expected to live. As of 2015, the country with the highest life expectancy is Monaco at 89.52 years; the country with the lowest is Chad at 49.81 years.

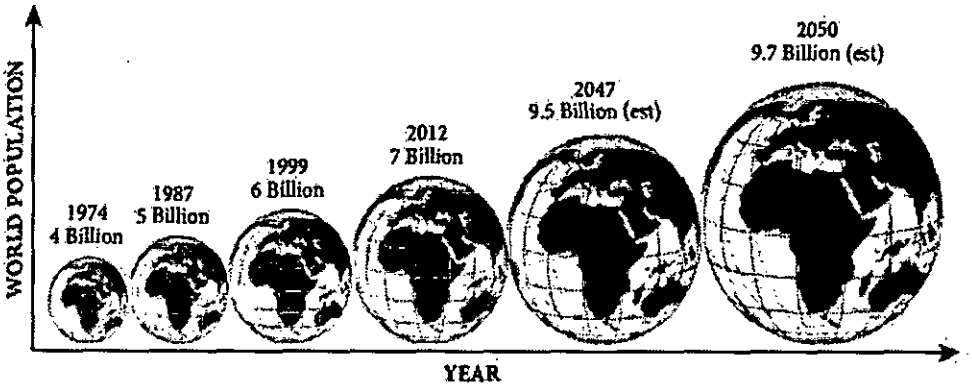
## Growth of world population

After the introduction of agriculture about 8,000 to 12,000 years ago, the size of population was small, roughly 8 million. In the first century (C.E) it was below 300 million. The expanding world trade during the sixteenth and seventeenth century, set the stage for rapid population growth. Around 1750, at the dawn of Industrial Revolution, the world population was 550 million. World population exploded in the eighteenth century after the Industrial Revolution. Technological advancement achieved so far helped in the reduction of birth rate and provided a stage for accelerated population growth.

The current **world population of 7.6 billion** is expected to reach 8.6 billion in 2030, 9.8 billion in 2050 and 11.2 billion in 2100, according to a new United Nations report being launched. With roughly **83 million people being added to the world's population every year**, the upward trend in population size is expected to continue, even assuming that fertility levels will continue to decline.

The current world population, according to UN Department of Economic and Social Affairs, Feb, 2019, is 7,685,036,620.

The new projections include some notable findings at the country level.



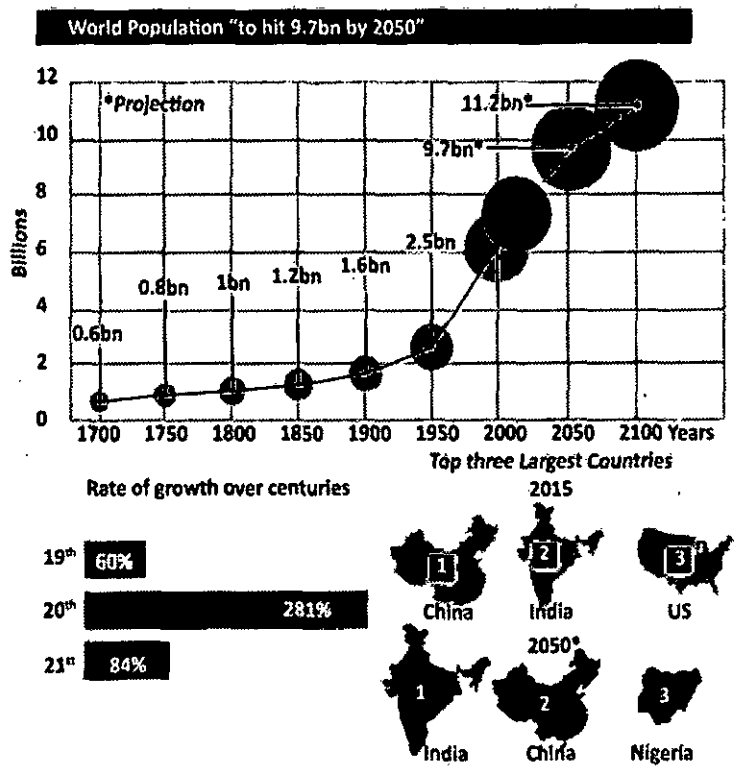

China (with 1.4 billion inhabitants) and India (1.3 billion inhabitants) remain the two most populous countries, comprising 19% and 18% of the total global population respectively. In roughly seven years, around 2024, the population of India is expected to surpass that of China.

Among the ten largest countries worldwide, **Nigeria** is growing the most rapidly. Consequently, the population of Nigeria, currently the world's 7th largest, is projected to surpass that of the United States and become the third largest country in the world shortly before 2050.

Most of the global increase is attributable to a small number of countries.

From 2017 to 2050, it is expected that half of the world's population growth will be concentrated in just nine countries: India, Nigeria, Congo, Pakistan, Ethiopia, the United Republic of Tanzania, the United States of America, Uganda and Indonesia (ordered by their expected contribution to total growth).

The group of 47 least developed countries (LDCs) continues to have a relatively high level of fertility, which stood at 4.3 births per woman in 2010-2015. As a result, the population of these countries has been growing rapidly, at around 2.4 % per year. Although this rate of increase is expected to slow significantly over the coming decades, the combined population of the LDCs, roughly one billion in 2017, is projected to increase by 33 % between 2017 and 2030, world population will reach 9.7 billion in 2050.




Similarly, Africa continues to experience high rates of population growth. Between 2017 and 2050, the populations of 26 African countries are projected to expand to at least double their current size.

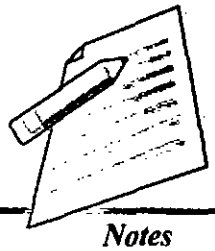
The concentration of global population growth in the poorest countries presents a considerable challenge to governments in implementing the 2030 Agenda for Sustainable Development, which seeks to end poverty and hunger, expand and update health and education systems, achieve gender equality and women's empowerment, reduce inequality and ensure that no one is left behind.

Population in the world is currently ( 2019) growing at a rate of around 1.09% per year (down from 1.12% in 2017 and 1.14% in 2016). It is estimated to reach 1% by 2023, less than 0.5% by 2052, and 0.25% in 2076. In 2100, it should be only 0.09% or an addition of only 10 million people to a total population of 11.2 billion. World population will, therefore, continue to grow in the 21st century.

## Doubling Time of population

**Doubling time** is the amount of time it takes for a given quantity of population to double in size at a constant growth rate. We can find the doubling time for a population undergoing exponential growth by using the Rule of 70. It is because the population of a country becomes double in 70 years if the growth rate is 1%. Thus, we divide 70 by the growth rate and we get the doubling time of population growth rate. For example, if the growth rate is 2.08, divide 70 by 2.08 and we get 33.6 years as the doubling time of population.

World population has doubled in 40 years from 1959 ( 3 billion) to 1999 ( 6 billion). It is now estimated that it will take another nearly 40 years to increase by another 50% to become 9 billion by 2037. The latest world population projections indicate that world population will reach 10 billion persons in the year 2055 and 11 billion in the year 2088.





## World Population Milestones

According to the United Nations, the 6 billion figures was reached on October 12, 1999 (celebrated as the Day of 6 Billion). World population reached 7 Billion on October 31, 2011. The current world population is 7.7 billion as of Feb 2019 according to the most recent United Nations estimates. The United Nations projects world population to reach 8 billion in 2023 and 10 billion in the year 2056.

## Regional division on the basis of growth rate

On the basis of the growth rate of population the world can be divided into the following three types of areas:

### 1. Areas of Low Growth Rate

Developed countries like US, Canada, Japan, Australia, New Zealand and countries of western Europe have a low growth rate of population in these countries is due to low birth rates and low death rates. The difference between the birth rate and the death rate in these countries is the lowest.

### 2. Areas of Moderate Growth Rate

This category includes the developing countries like Pakistan, Afghanistan, Brazil, Bolivia, Mongolia, Indonesia and many other Africa and South American countries, where the growth rate of nearly 2 % is also included among these countries though the growth rate here has started declining.

### 3. Areas of High Growth Rate

Countries like Mexico, Iran, Colombia, Venezuela, Peru, Libya, Algeria, Sudan, Kenya and Kuwait make this category. In fact, most of the African countries with a growth rate of 3% fall in this category.

## Population Concepts

**Over population:** situation whereby the population is considered too large for the available resources.

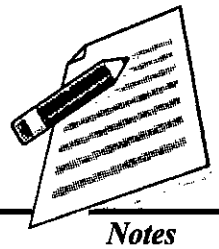
**Under – population:** a situation where the population is less than the available resources of a country.

**Optimum – population:** a situation where the number of people that can be supported is the same as the available resources.

## Migration

Migration means the movement of people from one place to the other. It is an important control of population growth after fertility and mortality. Migration of people into an area from outside is called immigration or in-migration while movement out of an area to other regions is called emigration or out-migration.

Immigration leads to an increased growth rate of population; emigration lowers the growth rate of population in the source region. Mexico's emigration problem is a unique one, with more than 98% of all Mexican migrants living in the U.S.A, the country with which





Mexico shares a border that runs 3110 km in length. The Mexican emigration rate increased substantially since the 1960s and, with more than 11% of Mexicans living abroad, **Mexico is the country with the largest number of emigrants in the world.** According to estimates from the UN 2015 report, in 2013, the **United States, Germany** and **Russia** had the largest number of immigrants of any country, while **Tuvalu** and **Tokelau** had the lowest immigrant.

## Types of migration

### 1 Net Migration

Net Migration is the difference between immigration (in-migration) and emigration (out-migration).

Positive value of net migration is that more people coming in and population growth, for example, 44% of North America and 88% of Europe. Negative value of migration is more people coming out and population decline.

### 2 International Migration

Emigration is an indicator of economic and or social failures of a society. It is a crossing of a national boundary. It is easier to control and monitor. There are laws to control or inhibit these movements. Between 2 million and 3 million people emigrate each year. Between 1965 and 2000, 175 million people have migrated: it accounts for 3% of the global population.

### 3 Internal Migration

It occurs within a country. It is crossing of population within domestic jurisdictional boundaries. It is the movement of people between states or provinces. There is little government control over internal migration.

### 4 Local Migration

Local migration is the migration of the people within state or district. No state boundaries are crossed in the local migration. It happens for several reasons such as buying a new house in the same town or city, difficult to research since they are usually missed in census data. It is based on change of income or lifestyle. Americans change residence every 5 to 7 years.

### 5 Voluntary migration

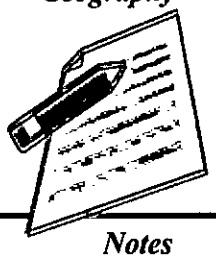
Voluntary migration is where the migrant makes the decision to move. Most migration is voluntary.

### 6 Involuntary migration

It is a forced migration in which the migrant has no role in the decision-making process. It includes mostly slavery. It is estimated that about 11 million African slaves were brought to the Americas between 1519 and 1867. In 1860, there were close to 4 million slaves in the United States. People involve in the involuntary migration are refugees due to military conscription, children of migrants, people in the situations of divorce or separation.

### Brain Drain

Brain drain is related to educationally specific selective migrations. Some countries are losing the most educated segment of their population. It can be both a benefit for the receiving country and a problem to the country of origin.





**Receiving country:** it is getting highly qualified labour which is contributing to the economy right away. It promotes economic growth in strategic sectors: science and technology. It does not have to pay education and health costs, for example, 30% of Mexicans with a PhD are in the US.

**Country of origin:** Education and health costs are not paid back to the country of origin. It is losing potential leaders and talent: Between 15 and 40% of a graduating class in Canada will move to the US. It has long term impact on economic growth. It has the possibility of getting remittances. Many brain drain migrants have skills which they can't use at home: The resources and technology may not be available there. The specific labour market is not big enough.

## Causes of Migration

We can divide factors causing migrations into two groups of factors as push and pull Factors.

## Push and Pull factors

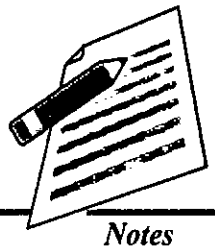
Push and pull factors are those factors which either forcefully push people into migration or attract them. A push factor is forceful, and a factor which relates to the country from which a person migrates. A pull factor is something concerning the country to which a person migrates. It is generally a benefit that attracts people to a certain place. Push and Pull factors are usually considered as north and south poles on a magnet.

**Push Factors:** Not enough jobs, few opportunities, desertification, famine/ drought, political fear/ persecution, poor medical care, loss of wealth, natural disasters, death threats, slavery, pollutions, poor housing, landlords, bullying and poor chances of finding courtship

**Pull Factors:** job opportunities, better living conditions, political and or religious freedom, enjoyment, education, better medical care, security, family links, industry, better chances of finding courtship.

## SUMMARY

Human resource is the most important resource in an area. It is the quality rather than quantity of this resource which is important for the economic development of a country. India is the second most populous country of the world after China. The distribution of population is generally studied in terms of density. The density of population in India is not uniform. On the basis of density of population, India can be divided into three broad regions of high density, the areas of moderate density, and the areas of low density. The factors which affect density and distribution can be grouped into two categories. They are physical factors and socio-economic factors. The population of India has been increasing very rapidly since 1921 and the rate of growth has been increasing. The growth rate of population is determined by the birth rate, death rate and migration of an area. Like density and distribution, the growth rate is also not uniform throughout the country. Migration is an important factor for the growth rate of population. Migration can be divided into various types. It can be divided as permanent and temporary. On the basis of source of origin and destination of migrant population, it can be divided into rural to rural, rural to urban, urban to urban and urban to rural. These four types can be grouped under two categories i.e., inter-state migration and intrastate migration. People move from one place to other under the influence of economic, socio-political and demographic factors. The causes of migration can be studied in terms of push and pull factors. The consequences of migrations are numerous and they can be studied in terms of economic,





social and demographic consequences. The migrants involve themselves in extra marital relation and drug abuse due to their loneless since they have left their family at their source.

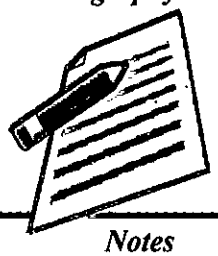
## EXERCISE

### MCQ

1. Migrations change the number, distribution and composition of the population in
   (a) the area of departure
   (b) the area of arrival
   (c) both the area of departure and arrival
   (d) none of the above
   **Answer:** (c) both the area of departure and arrival
2. A large proportion of children in a population is a result of
   (a) high birth rates (b) high life expectances
   (c) high death rates (d) more married couples
   **Answer:** (a) high birth rates
3. The magnitude of population growth refers to
   (a) the total population of an area
   (b) the number of persons added each year
   (c) the rate at which the population increases
   (d) the number of females per thousand males
   **Answer:** (a) the total population of an area
4. According to the census 2001, a 'literate' person is one who
   (a) can read and write his/her name
   (b) can read and write any language
   (c) is 7 years old and can read and write any language with understanding
   (d) knows the 3'R's (readings, writing, arithmetic)
   **Answer:** (c) is 7 years old and can read and write any language with understanding
5. Which one of the following countries has higher population density than India?
   (a) Bangladesh (b) Nepal
   (c) Korea (d) Canada
   **Answer:** (a) Bangladesh

### Review Questions

1. Discuss in brief the distribution of population in India. Outline some of the areas of high, moderate and low density of population.
2. What are the major trends in population growth in India? Discuss the factors responsible for it with suitable examples.
3. What is meant by migration? Define various types of migration with suitable examples.
4. Explain the major causes and consequences of migration.



*Notes*

# 20 POPULATION COMPOSITION IN INDIA

- Understand the concept of population.
- Discuss the features of population.
- Describe the concept of population composition.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of population so that the population composition in India can be learned.

## Introduction

Important characteristics of a population, besides its size and growth rate, are the way in which its members are distributed according to age, sex, and urban/rural status.

## 1. Age Structure:

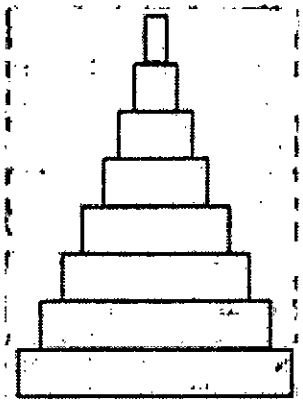
The age structure of a population refers to the number of people in different age groups.

A larger size of population in the age group of 15-59 years indicates the chances of having a larger working population. On the other hand, if the number of children in the population is high, the dependency ratio will be high. Similarly, a growing population in the age group of 60 plus indicates greater expenditure on the care of the aged.

There are three types of age structures, viz., (i) the West European type in which children constitute less than 30 per cent, and 15 per cent of the population are old; (ii) the North American type where 35-40 per cent of the population are children and ten per cent, old people; and (iii) the Brazilian type where 45-55 per cent of the population are children, and old people constitute only four-eight per cent of the total population. The type of age structure has a direct influence on the future of a nation, since both extremes, i.e., old age dependency as well as young age dependency proves to be a severe burden on the economy of a country.

Demographers use population pyramids to describe age distribution of populations. A population pyramid is a bar chart/graph in which the length of each bar represents the number (or percentage) of persons in an age group. We may take the youngest segment of the population at the base, and move on to the older segments till the oldest comes at the top.

### Youthful populations are represented by pyramids with a broad base and a narrow apex of older people:



The principal factor contributing to a change in the age distribution of a population is the rate of fertility: a change in fertility affects the number of people in the single age group of age zero, or the newly born. Hence a decline or increase in fertility has a significant effect at one end of the age distribution and can thereby influence the overall age structure. This means that youthful age structures correspond to highly fertile populations, typical of developing countries. The older age structures are those of low-fertility populations, more common to the industrialised nations.

## 2. Sex Composition:

Another structural feature of populations is the relative numbers of males and females. Defined as the number of females per 1000 males in the population, sex ratio is an important social indicator of the equity prevailing between males and females at a given point of time. Factors influencing the sex ratio are, mainly, the differentials in mortality, sex selective migration, and sex ratio at birth and, at times, the sex differential in population enumeration.

By nature, slightly more males are born than females (a typical ratio being 105/106 males for every 100 females). However, males experience higher mortality at virtually all ages after birth. By implication, during childhood males outnumber females of the same age; the different decreases as age increases; at some point in the adult life span, the numbers of males and females become equal; as higher ages are reached, the number of females becomes quite large.

India shows an uneven composition of population as compared to most of the developed countries. The reasons put forward for such a state of affairs are: high maternal mortality, female infanticide, sex-selective female abortions, neglect of the girl child leading to a higher mortality among girls at a young age, and change in sex ratio at birth.

The sex composition of the population in India is a matter of concern, being much lower than 950 for a long time.

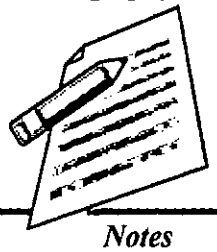
It is interesting to note that rural-urban differentials in sex ratios in the US and in Western European countries are just the opposite of those in developing countries, such as India. In developing countries, the males outnumber the females in urban areas and the females outnumber the males in rural areas.

In the western countries, reverse is the case. There, farming in rural areas remains largely a masculine occupation. In the western countries, there is an influx of females from rural areas to avail of the vast employment opportunities in urban areas.

## 3. Rural-Urban Composition:

The division between rural and urban areas is significant in terms of geographical distribution of population. The percentage of rural population is higher in farm-based agricultural countries, while industrially, developed regions have higher share of urban population.

For a long time now, there has been a nearly universal flow of population from rural into urban areas. The most highly urbanised societies in the world are these of western and northern Europe, Australia, New Zealand, temperate South America, and North America: in all of these, the proportion of urban population exceeds 75 per cent.





In many of the developing countries of Asia and Africa, the urbanisation process has only recently begun; less than one-third of the population lives in urban areas. But the rate of growth of urban areas has shown a great increase. The general rule for developing countries is that the rate of growth of urban areas is twice that of the population as a whole.

A prominent feature of population redistribution, especially in developing countries, is the growth of major cities. Almost half of the world's population lives in cities. It is projected that there would be about eight billion city dwellers in the world by 2030, and 80 per cent of them would be living in developing countries.

## Composition of Population

Composition of Population includes sex ratio, literacy rate, age pyramids etc.

## Sex Ratio

The sex ratio is the ratio of males to females in a population.

As of 2014, the global sex ratio at birth is estimated at 107 boys to 100 girls (1000 boys per 934 girls).

**The sex ratio of India is 933 females for every 1000 males according to 2011.**

Kerala has the highest sex ratio in the country with 1084 females for 1000 males followed by Puducherry with 1037 females for 1000 males and **Tamil Nadu with 996 females for 1000 males.**

**Qatar-315 Males per 100 females (2019)**

With an astounding ratio of 315 males to 100 females, Qatar holds the number one spot among **countries with the highest male to female ratio in the world in 2018.**

## What Are Population Age Pyramids?

**Population pyramids** are graphical representations of the age and sex of a population. For this reason, population pyramids are also referred to as **age-sex pyramids**. We refer to these graphs as pyramids because they are usually shaped like triangles and population pyramids also take other shapes. Population pyramids usually have males on the left side and females on the right. There is also a vertical line in the middle of the graph that separates the males from the females.

## Fact File

## Latvia, country with the highest sex ratio in the world.

Latvia is a former Soviet Union country and experienced a great decline in male population during World War two. By 2015, there were 84.8 males for every 100 females. The proportion of the female was 54.10% of the total population. Men in Latvia have a high mortality rate due to issues such as alcoholism, smoking, and careless car driving. Around 80% of suicides in Latvia are committed by men, often because of unemployment and unrealized financial goals. Women enjoy a longer life expectancy living 11 years more than men.

## Literacy Rate

Total number of literate persons in a given age group, expressed as a percentage of the total population in that age group.

Literacy rates continue to rise from one generation to the next. Yet according to new data from the UNESCO Institute for Statistics, there are still 750 million illiterate adults, two-thirds of whom are women. These numbers are a stark reminder of the work ahead to meet Sustainable Development Goals (SDGs) 4 and 5 and the Education 2030 targets.

## Literacy rate variations between states in India

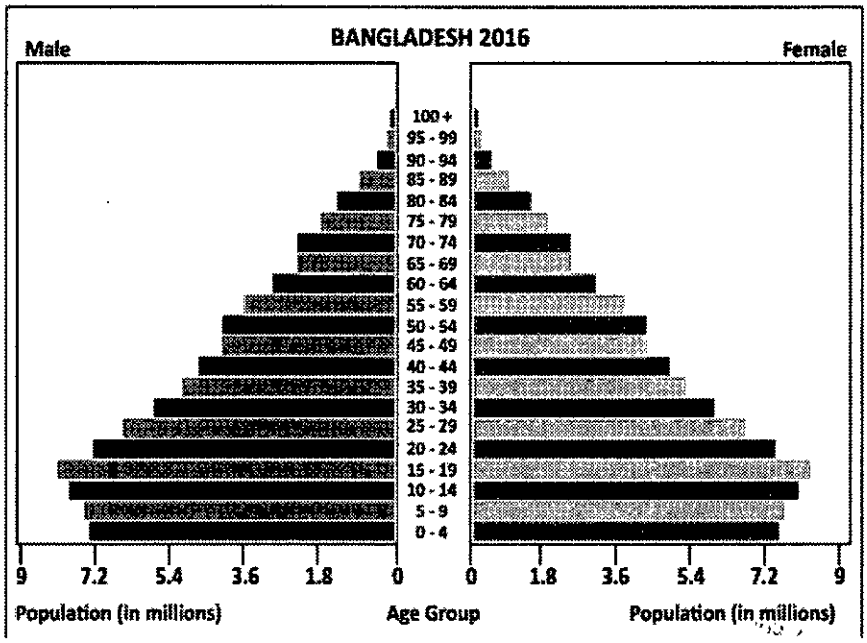
India's literacy rate is at 74.04%. **Kerala** has achieved a literacy rate of **93.91%. Bihar** is the **least** literate state in India, with a literacy of **63.82%.** Several other social indicators of the two states are correlated with these rates, such as life expectancy at birth (71.61 for males and 75 for females in Kerala, 65.66 for males and 64.79 for females in Bihar), infant mortality per 1,000 live births (10 in Kerala, 61 in Bihar), birth rate per 1,000 people (16.9 in Kerala, 30.9 in Bihar) and death rate per 1,000 people (6.4 in Kerala, 7.9 in Bihar).

**Six Indian states account for about 70% of all illiterates in India:** Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, Andhra Pradesh and West Bengal. Slightly less than half of all Indian illiterates (48.12%) are in the six Hindi-speaking states of Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Jharkhand and Chhattisgarh.

## Age - Sex pyramids

There are three types of Age - Sex pyramids: expansive, constrictive, and stationary.

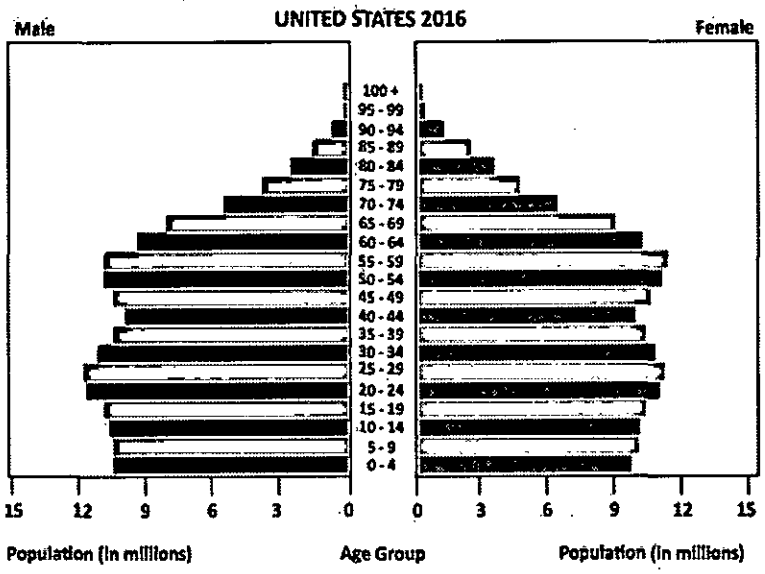
**Expansive Age - Sex pyramids** depict populations that have a larger percentage of people in younger age groups. Populations with this shape usually have high fertility rates with lower life expectancies. Many third world countries have expansive Age - Sex pyramids. Such a population pyramid is a characteristic of newly developing countries such as Afghanistan, Bangladesh, Kenya, and some countries of Latin America.




**Expansive Age - Sex pyramid**

**Constrictive Age - Sex pyramids** are named so because they are constricted at the bottom. There is a lower percentage of younger people. Constrictive Age - Sex pyramids show

declining birth rates, since each succeeding age group is getting smaller and smaller. The United States has a constrictive Age - Sex pyramid.

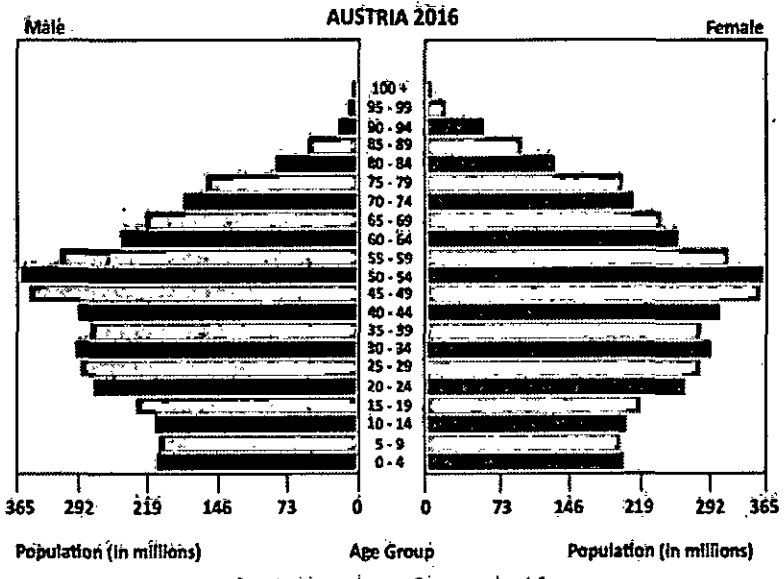



**Constrictive Age - Sex pyramid**

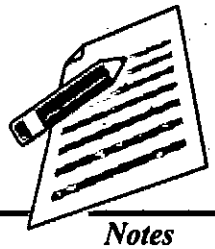
**Stationary Age - Sex pyramids** are those that show a somewhat equal proportion of the population in each age group. There is not a decrease or increase in population; it is stable. **Austria has a stationary Age - Sex pyramid.**

## The Purpose of the Age - Sex Pyramid

The purpose of making this Age - Sex pyramid is to find out the comparison between the number of men and women, the number of workers, and the structure of the population in a country quickly. In addition, the creation of the Age - Sex Pyramid also has a purpose to assist the government in taking development policies.




**Stationary Age - Sex pyramid**





## SUMMARY OF THE CHAPTER

The development of a country depends upon both quality and quantity of the human resources. The quality of human resource depends upon the population composition. They are rural - urban, sex - age, linguistic, religious, scheduled Castes, Scheduled Tribe, literate-non literate composition. India is proverbially known as the country of villages. Till today more than 72 percent of people live in rural areas. The rate of urbanisation is however increasing. The growth rate of urban population is higher than the average growth rate in the country. This is mainly due to migration of people from rural to urban areas. There are 35 metropolitan cities in India having population more than 10,00,000. On the other hand, sex ratio in India is unfavourable. The highest number of females per one thousand males in Karala (1058) whereas it is lowest in Haryana (861). If we take Union Territory into account then the lowest sex ratio in the country is in Daman and Diu (709).The sex ratio has been gradually decreasing in each successive censuses except some marginal increase in the 1951, 1981 and 2001 census. You will know about the status of sex ratio in your area by conducting the project work. The rate of literacy in India is not very high (65.38%). It is the highest in Kerala where the literacy rate is as high as 90.92% and on the other extreme is the state of Bihar where literacy is as low as 47.53% percent. India is a land of great social diversity. It is the home of people belonging to different racial stocks, languages and religions. The tribal people are the nearest relations of some of the original racial stocks.

## EXERCISE

### MCQ

**Question 1.** What percentage of India's population resides in the most populated state of India, Uttar Pradesh?

(a) 38.96 per cent (b) 14.37 per cent

(c) 16.16 per cent (d) 20.56 per cent

**Answer:** (c)

**Question 2.** Which state has the lowest population in India?

(a) Uttar Pradesh (b) Himachal Pradesh

(c) Sikkim (d) All of these

**Answer:** (c) Sikkim

**Question 3.** India accounts for what percentage of the world population?

(a) 16.7 per cent (b) 20 per cent

(c) 15 per cent (d) 18.6 per cent

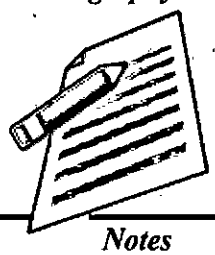
**Answer:** (a)16.7 per cent

**Question 4.** Which is the point of reference from which all other elements are observed?

(a) Fauna (b) Population

(c) Flora (d) All of these

**Answer:** (b) Population





**Question 5.** Which one of the following states of India has very low population density?

(a) Arunachal Pradesh (b) Sikkim

(c) Orissa (d) All of these

**Answer:** (a) Arunachal Pradesh

## Review Questions

1. Discuss in brief the following characteristics of Indian population. (a) age structure (b) rural-urban ratio and (c) sex ratio.
2. Give an account of literacy in India.
3. What are the factors responsible for the decline in sex ratio? Discuss in brief.
4. Discuss the regional distribution of tribal population in India.
5. To which major linguistic families do most of the Indian languages belong? Give a brief account of the distribution of various linguistic families in the country.

# 21 HUMAN SETTLEMENT

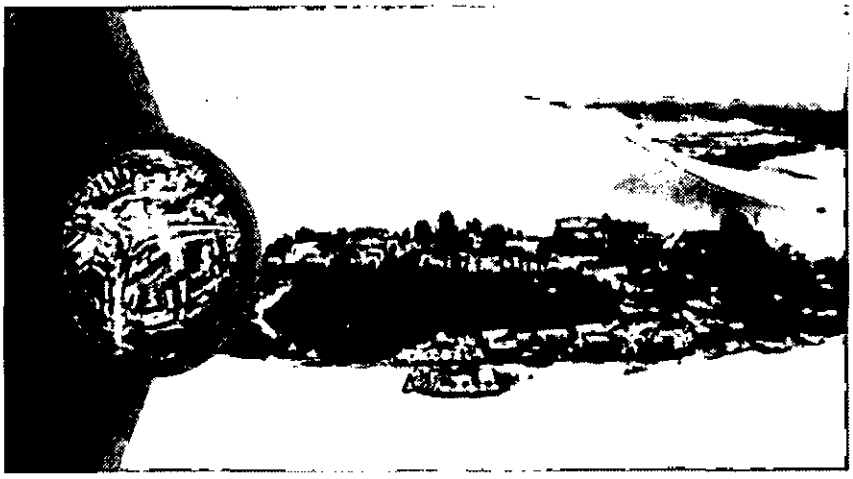
- Understand the concept of human settlement.
- Discuss the features of human settlement.
- Describe the types of human settlement.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of human settlement so that the features and types of human settlement can be learned.

## Introduction

Look at the front image of an oasis. It is an aerial view of the Huacachina oasis in Ica, Peru, 300 km south of Lima. The settlement is home to 96 residents, who live around the lake.



In simpler term we can define settlement as any form of human habitation which ranges from a single dwelling to a large city.

A human settlement is defined as a place inhabited more or less permanently. It includes building in which they live or use and the streets through which they travel. It also includes the temporary camps of the hunters and herders. It may consist of only a few dwelling units called hamlets or big cluster of building called urban cities.

## Origin and development of Settlement

Most anthropologists believe that humans first appeared in the Great Rift Valley of East Africa thousands of years ago. From there, they spread to the Middle East, Asia, Europe, America and Oceania. Neolithic Revolution (Agricultural Revolution) occurred

in Mesopotamia, people went from hunter-gatherers and nomads to domesticators. The population grew relatively quickly. The emergence of urban population occurred also in some areas. Agriculture became especially successful largely in the river valleys of Nile, Ganges and Yangtze kiang.

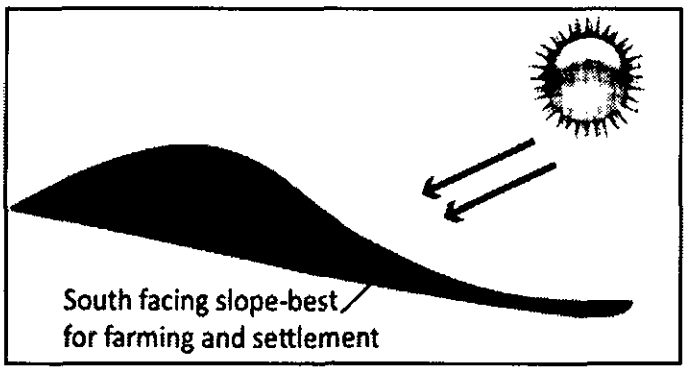
**Harappa Settlement on the Indus river valley**

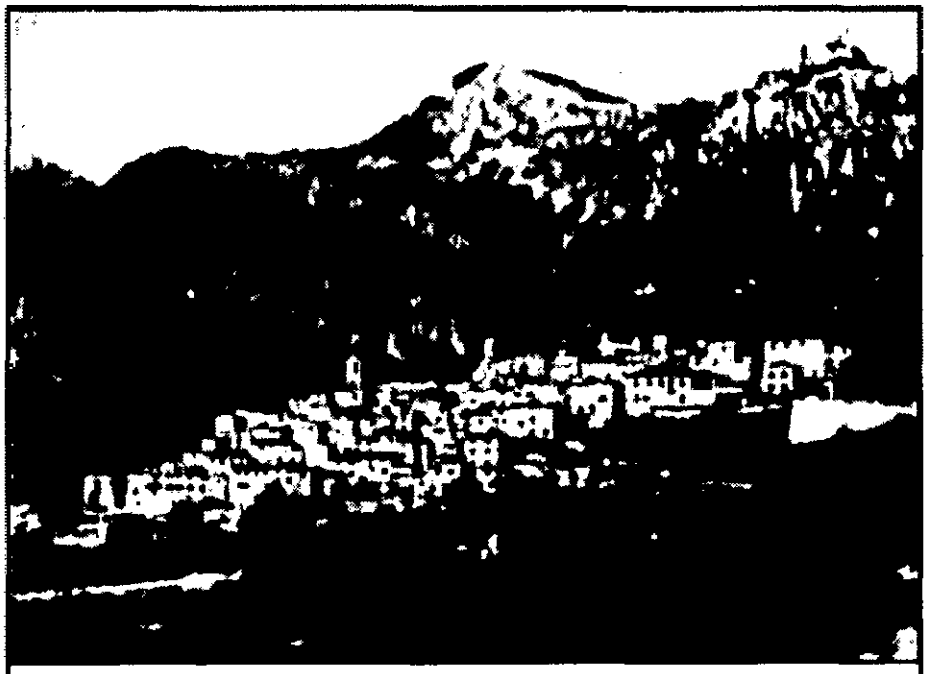
These areas had fertile soil from annual flooding which led to abundant harvest. First cities arose in these areas and people were able to grow surplus food to feed a non-farming urban population thereby leading to specialization among the population. The priests, scribes, architects, farmers, soldiers, traders, blacksmiths, etc. were some other people ventured in these areas.

## Site and Situation

### Site

The Site of a settlement describes the physical nature of where it is located. Factors such as water supply, building materials, quality of soil, climate, shelter and defence were all considered when settlements were first established. For instance, the site of Sydney, in Australia, initially took advantage of the excellent natural harbour and surrounding fertile farmland.





**Settlement in the south facing slope of the Alps**

**Aspect and shelter** are two of the most important factors that were considered when deciding where to locate a settlement. Aspect relates to the direction in which the land faces. In the Northern Hemisphere the best slopes to locate on are those that face south, as they will receive the most sunshine, and therefore be the best for agriculture. This can be seen clearly in many of the valleys of the Alps, where settlements have located on the south-facing slopes.

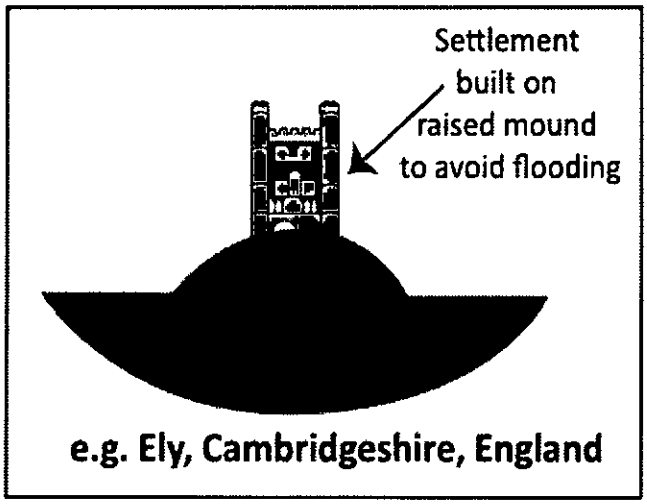
Shelter is also very important, particularly from the cold northerly winds and prevailing south westerly winds in the UK. A good example of settlements being sheltered by their natural surroundings are the many spring-line settlements found along the base of the chalk escarpments of the North and South Downs. These settlements would also have benefited from the good water source and fertile farmland nearby.

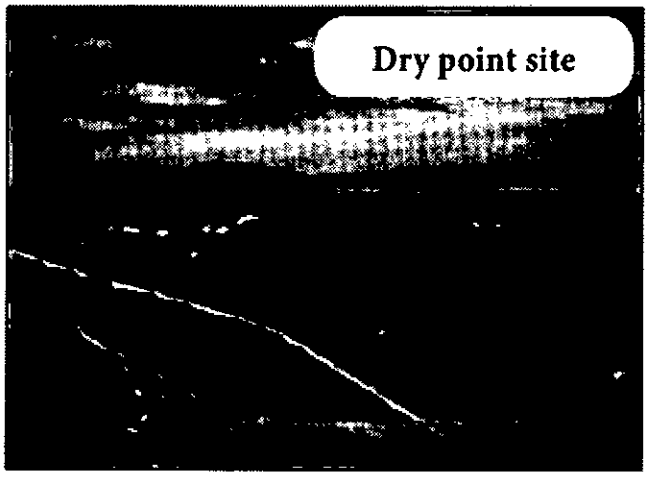
## 1. Water supply

Water supply is probably the single most important factor in deciding where a settlement might be located. Not only do rivers provide a source of clean drinking water, they also provide a food source through fishing, and a transport route. Most of the world's largest cities are located on rivers, especially the point at which they reach the sea, as this was often the first point that explorers landed.

## 2. Dry point sites

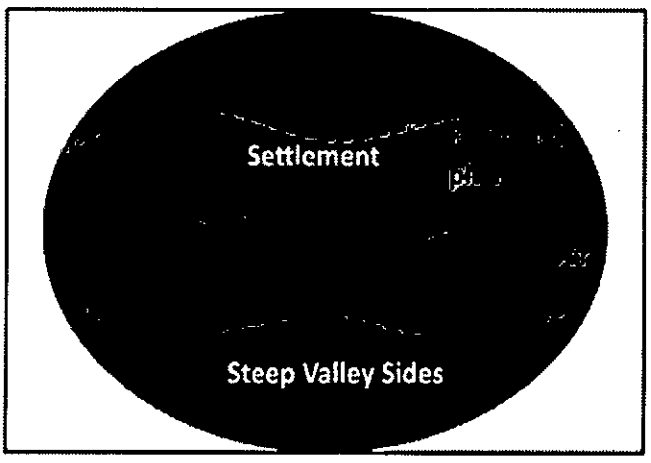
A dry point site is one that is slightly raised from the surrounding area, meaning that it is less likely to flood. Ely in Cambridgeshire, England, is a good example of dry point site.




### 3. Wet point sites

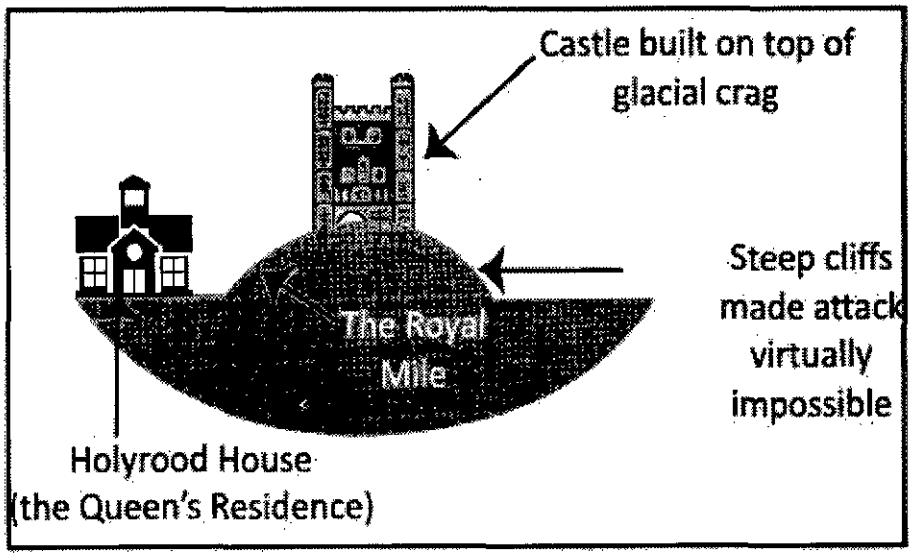
Wet point site refers to any site that has access to water, usually through being beside a river. Towns would either grow up along the river or clustered near the point at which the river enters the sea. Examples of wet point sites include the towns and villages of the Welsh valleys, which tend to extend along the flat valley floor, rather than up the steep valley sides. Spring line settlements in the North and South Downs, England are also good examples of wet point sites.

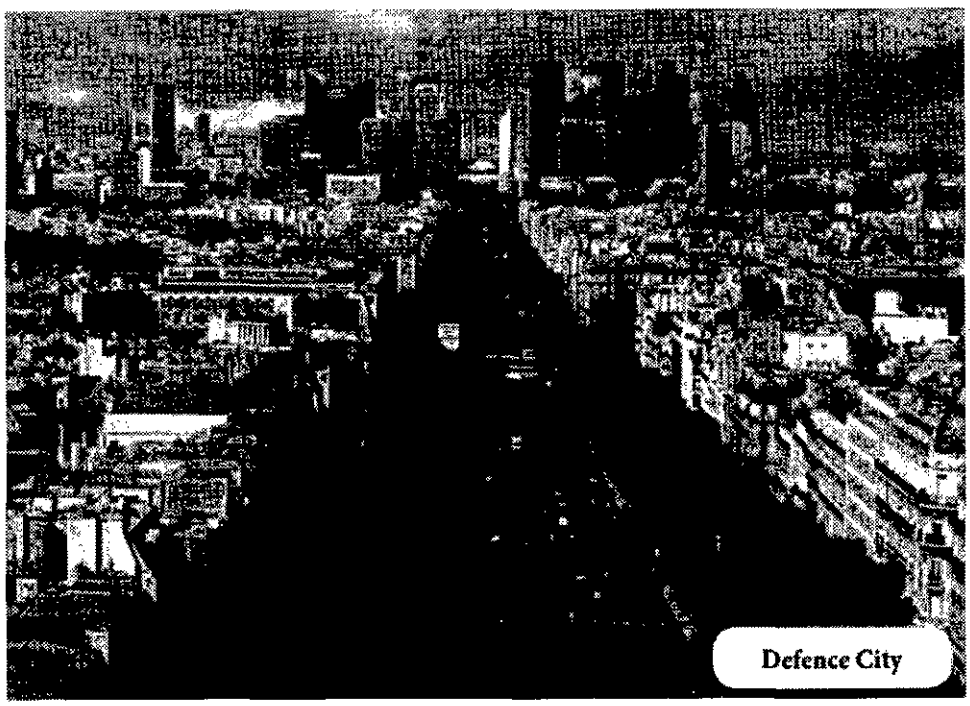


## 4. Defence

In medieval times, defence was one of the most important factors influencing the site of a settlement. The relief of the land often proved to be the best form of defence. Edinburgh castle sits on the top of a glacial crag, in an almost perfect position to defend itself, with very little chance for the attackers. In Italy, there are many walled hill-top villages, whilst the Maoris in New Zealand built their settlements (called Pa's) on the top of steep hills to prevent being attacked. In India, Ichhapur Defence Estate is a census town in Barrackpore, West Bengal.

The other common natural feature used for defence is water, and in particular rivers. Both Shrewsbury and Durham are very good examples of where a meander of the river has formed an area of land bounded by water on three sides. This provided both cities with excellent defence, as they only had a thin neck of land to defend.





Defence City

## 5. Resources

The idea of resources covers a huge number of different things. For early settlers the most important resources were fuel, building materials and food. Settlements grew in areas where wood was plentiful, stone easily accessible and good soil allowed agriculture to be developed.

Since in early days of settlement many different resources have become the focal points for the growth of urban areas.

## 6. Mining

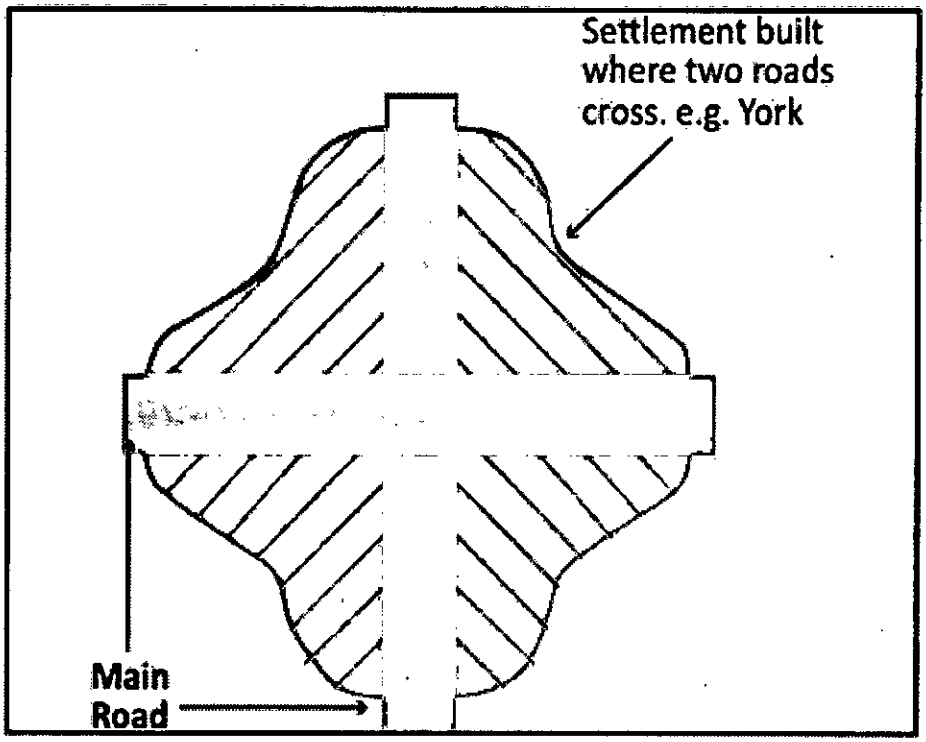
The coal mines of South Wales, Tin mines of Cornwall and large mining projects at Carajas in Northern Brazil, have all encouraged the rapid growth of settlements aimed at housing the workers and providing them with all that they require.

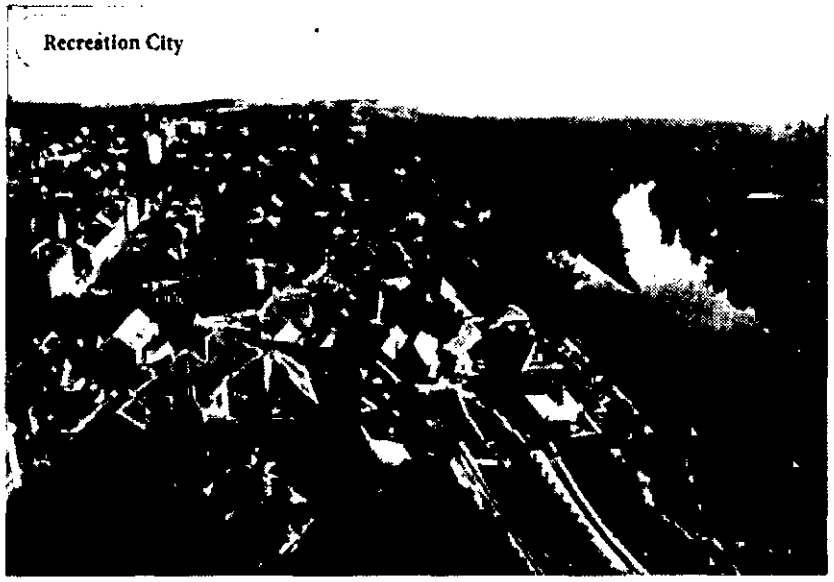
## 7. Precious metals

Settlements in South Africa have grown after the discovery of large deposits of precious metals such as gold. The most famous settlement grew due to finding gold is San Francisco, after the gold rush to California in 1849.

## 8. Route centres

Route centres are often called Nodal Points. Nodal Points are formed by the meeting of two valleys, but settlement nowadays will grow where two main roads meet. In the UK, York is a good example of a route centre. Birmingham also enjoys a very good location, where many routes join up, and this is one of the reasons for its growth to become one of the largest cities in the UK.



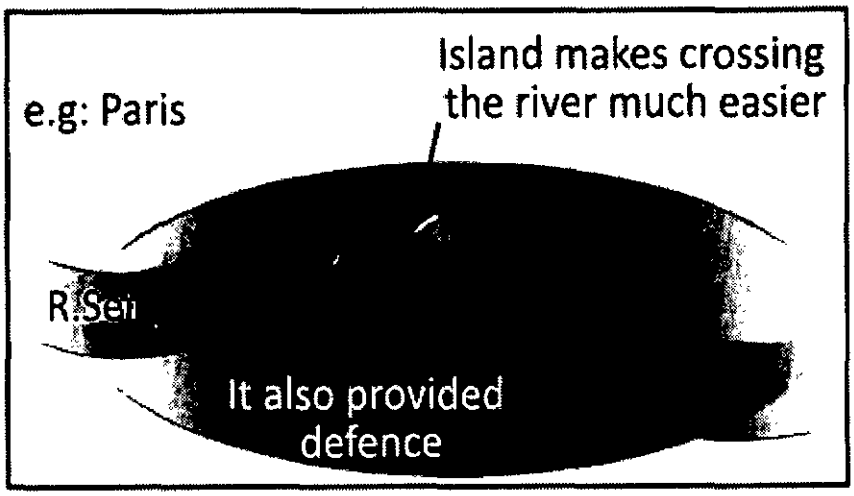



## 9. Bridging points

Just as water is very important for drinking, fishing, irrigation and navigation, so the ability to cross the rivers is also very important.

Many towns and cities have built up at points where it was the easiest to cross a large river. Exeter is one such example, crossing the river Exe in England.

However, one of the best examples is Paris in France. The original town was based on the tiny Ile dela Cite, which is an island in the middle of the River Seine. This island meant they could build two small bridges across the river rather than one large one.

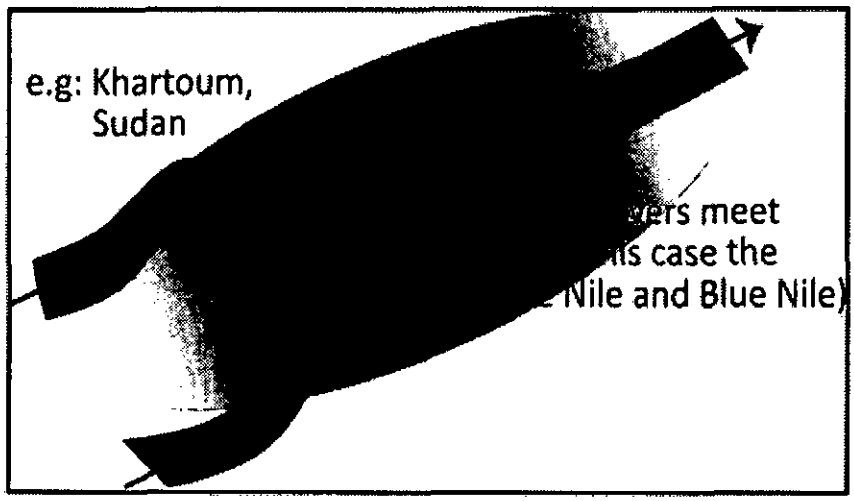



Nowadays the island has been engulfed by the huge city that Paris has become, however it does still have many bridges going to it and is the point where the huge Notre Dame Cathedral is built.

## 10. The confluence of two rivers

Just as two valleys, or roads, make a nodal point for settlement growth, so do two rivers join. One such example is found in Khartoum in Sudan, where the Blue and the White Nile meet.

In India, Allahabad is located at the confluence of River Ganga and Yamuna and Bhavani (Tamil Nadu) is at the confluence of River Cauvery and Bhavani.





## Situation

The situation of a settlement is the description of the settlement in relation to the other settlements and physical features around it. The situation of a settlement is the most important in determining whether it grows to become a large city or stays as a small town or village.

In the UK, Birmingham is an example of a city with excellent situation. It is located central to the country, with excellent links by road to the North and South to London.

As cities begin to fulfil different functions their importance can increase or decrease. Their situation plays an important part in deciding which of these functions will occur.

It refers to the location of the actual settlement. The initial choice of a site for a settlement depends on its meeting certain daily needs such as water supply, availability of potential farmland, building materials and fuels etc.

Settlements can broadly be divided into two types – rural and urban. Let us know some differences between rural and urban areas in general.

i. The major difference between rural and urban areas is the function. Rural areas have predominantly primary activities such as agriculture, whereas urban areas have domination of secondary and tertiary activities such as manufacturing industries and service sectors.

ii. Generally the rural areas have low density of population than urban areas.

iii. Urban settlements are defined by their advanced civic amenities, opportunities for education, and facilities for transport, business and social interaction and overall better standard of living whereas rural areas lack of such amenities.

iv. Rural areas do not have pollution or traffic problems that beset regular urban areas.

v. In the rural society there was very little scope for occupational mobility. In cities there are many occupations, so occupational mobility is frequent.

vi. Rural people are less mobile and therefore the social relations among them are intimate. In urban areas, the way of life is complex and fast, hence, the social relations are formal.

## Pattern of Rural Settlement

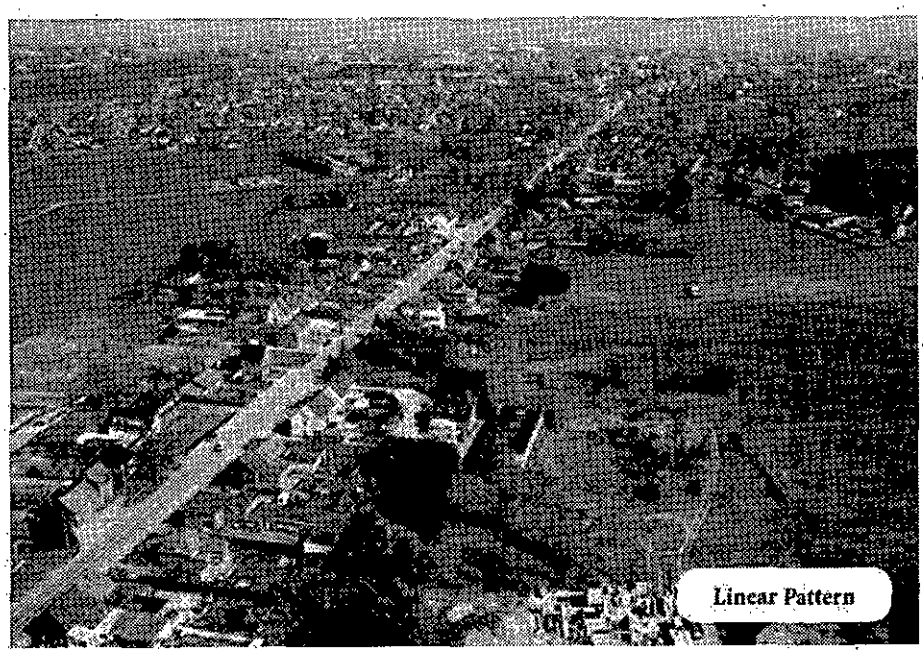
On the basis of forms or shapes of the settlements, rural settlements are classified as Linear, Rectangular, Circular, Star like, T-shaped village, Y-shaped village, Compact, Disperse, Planned, etc.

The settlement in which houses are constructed along a road, railway line, river, canal edge of a valley, or along a levee is known as **Linear Pattern.**

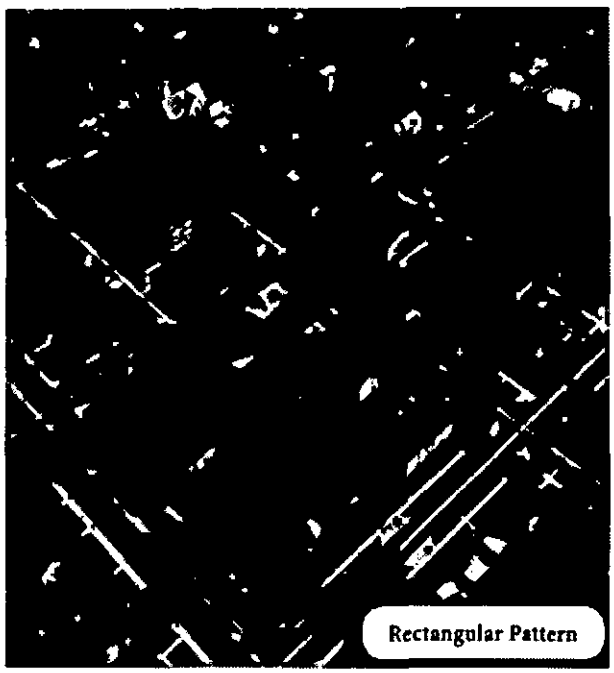
The settlements constructed in a rectangular shape are known as **Rectangular Pattern.** Such kind of settlements is found in plain areas and in wide inter-montane valley.

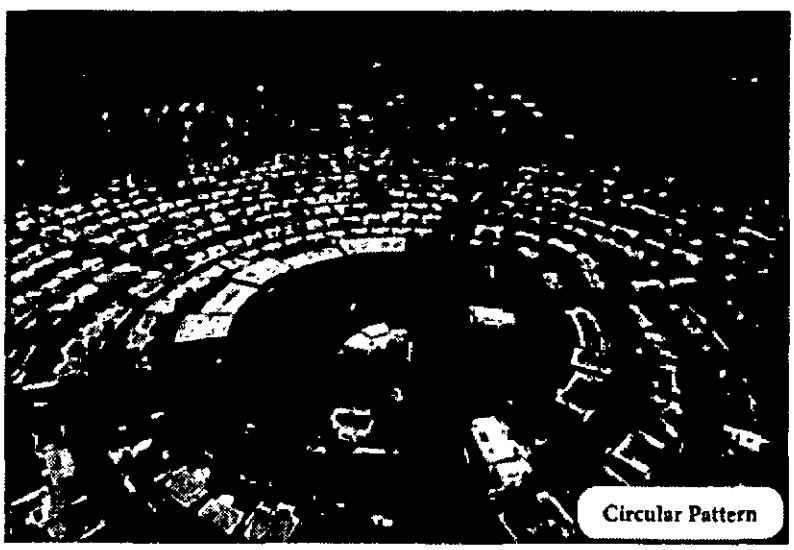
The settlements constructed in a circular shape are known as **Circular Pattern.** Such kind of settlement is found around lakes, tanks, or a planned village.

The settlements constructed in a star shape are known as Star like Pattern. Such kind of settlement is found around the points where several roads cross each other (making star-shape).



Linear Pattern


Rectangular Pattern


Circular Pattern

The settlements in which houses are constructed at the tri-junctions of the roads are known as **T-shaped Pattern.** Such kind of settlement is found along the road, which meets with another road at the dead end (the straight going road ends) and bifurcates left and right (T-Shape).

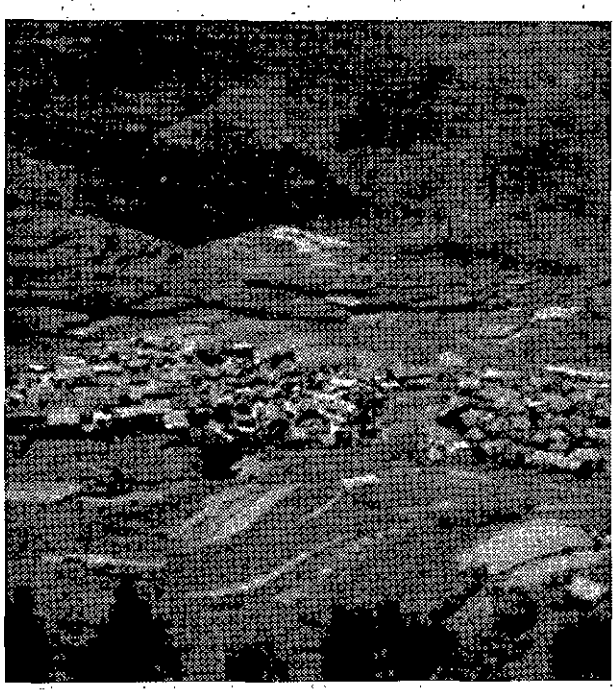
The settlement, in which houses are constructed along the straight road, is known as **Y-Shape pattern.** It is further bifurcated into two roads (similar to Y shape).

## Classification of Rural Settlement

Based on shape, the settlements are classified as

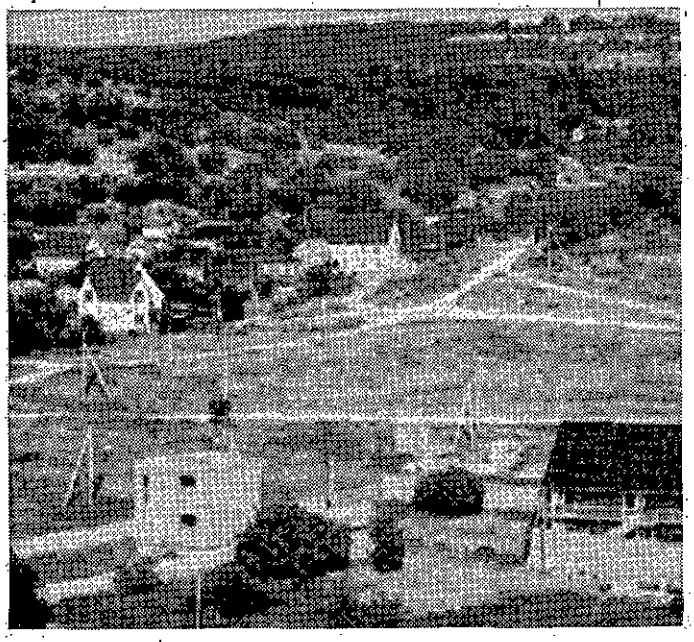
### 1. Compact or Nucleated Settlements

In the nucleated settlements, the houses are built very close to each other. Normally, fertile plain regions have such compact or nucleated settlements.



## 2. Dispersed Settlements

In such kind of settlements, houses are spaced far apart and often interspersed with fields, however, their market and some other activities are centralized where they participate together.



## Urban settlement

The census of India, 1991 defines urban settlements as "All places which have municipality, corporation, cantonment board or notified town area committee and have a minimum population of 5000 persons, at least 75 per cent of male workers are engaged in non-agricultural pursuits and a density of population of at least 400 persons per square kilometres are urban settlements.

## Evolution of Urban Settlement

The first urban settlement to reach a population of one million was the city of London by around C.E. 1810. By 1982 approximately 175 cities in the world had crossed the one million population mark. Presently 48 per cent of the world's population lives in urban settlements compared to only 3 per cent in the year 1800.

## Stages of Urban Settlement

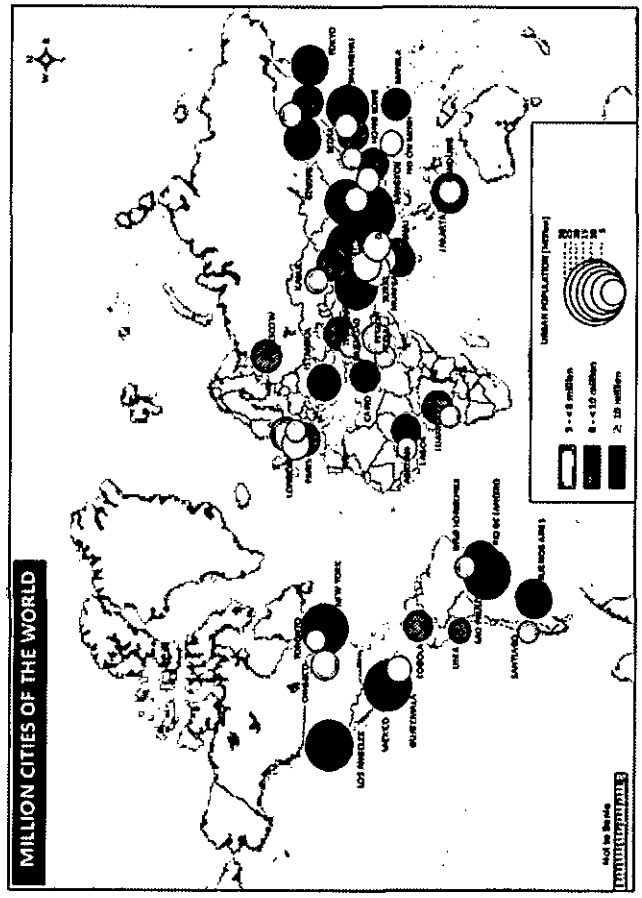
Depending on the size and the services available and functions rendered, urban centers are designated as town, city, million cities, conurbation, Megalopolis.

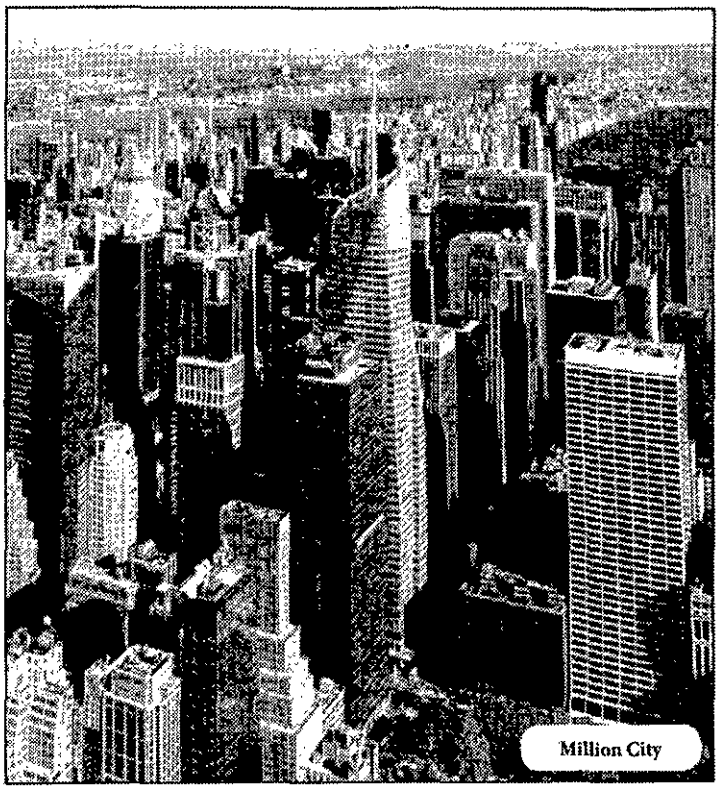
## Town (Population more than 5000 people)

The concept of 'town' can best be understood with reference to 'village'. Population size is not the only criterion. Functional contrasts between towns and villages may not always be clear cut, but specific functions such as, manufacturing, retail and wholesale trade, and professional services exist in towns.

## City (Population more than 100,000)

A city may be regarded as a leading town. Cities are much larger than towns and have a greater number of economic functions. They tend to have transport terminals, major financial institutions and regional administrative offices. When the population crosses the one million mark it is designated as a million city.






## Conurbation (Population of 2 or more cities combined)

The term conurbation was coined by Patrick Geddes in 1915 and applied to a large area of urban development that resulted from the merging of originally separated towns or cities. Greater London, Manchester, Chicago and Tokyo are examples. In India, Hyderabad and Cochin are the examples of conurbation cities.

## Megalopolis (Population more than 10 million)

This Greek word "Megalopolis" meaning "great city", was popularized by Jean Gottman (1957) and signifies 'super- metropolitan' region extending, as union of conurbations. The urban landscape which stretches from Boston in the north to south of Washington in the U.S.A is the best-known example of a megalopolis.

## Million City (Population more than 1million)

A city with million or more people is termed as the million cities. The number of million cities in the world has been increasing as never before. London reached the million marks in 1800, followed by Paris in 1850, New York in 1860, and by 1950 there were around 80 such cities. The rate of increase in the number of million cities has been three-fold in every three decades – around 160 in 1975 to around 438 in 2005.

## Definition of Town

In 2001, places were designated as urban or towns on the following principles.

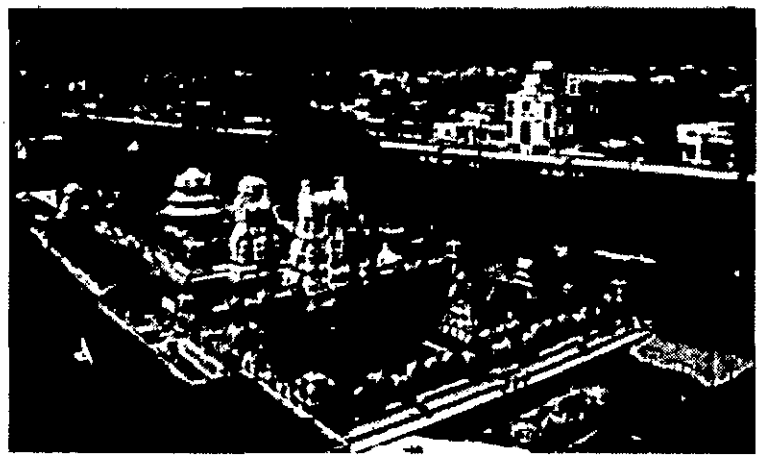
(a) All places with Municipality, Corporation, Cantonment Board, Sanitary Board, Notified Area Committee etc.

(b) All other places which satisfy the following criteria.

i) A minimum population of 5,000.

ii) At least 75 per cent of the male working population being engaged in non-agricultural (and allied) activity.

iii) A density of population of at least 400 persons per square kilometre (or one thousand persons per square mile).



## The Urban Agglomeration

As per census 2001, it was decided that the core town or at least one of the constituent towns of an urban agglomeration should necessarily be a statutory town and the total population of all the constituents should not be less than 20,000 (as per 1991 census).

Urban agglomeration is a continuous urban spread constituting a town and its adjoining urban outgrowths (OGs), or two or more physical contiguous towns together and any adjoining urban outgrowths of such towns. Examples of Outgrowth are railway colonies, university campuses, port area, military camps etc. that may have come up near a statutory town or city but within the revenue limits of a village or villages contiguous to the town or city. With these two basic criteria having been met, the following are the possible different situations in which urban agglomerations could be constituted.

i) A city or town with one or more contiguous outgrowths.

ii) Two or more adjoining towns with or without their outgrowths.

iii) A city and one or more adjoining towns with their outgrowths all of which form a continuous spread.

## Standard urban area

A new concept that had been developed for the 1971 Census for the tabulation of certain urban data was the Standard Urban Area.

The essential of a Standard Urban Area are:

i) It should have a core town of a minimum population size of 50,000.

ii) The contiguous areas made up of other urban as well as rural administrative units should have close mutual socio-economic links with the core town and

iii) The probabilities are that this entire area will get fully urbanized in a period of two to three decades.

The idea is that it should be possible to provide comparable data for a definite area of urbanization continuously for three decades which would give a meaningful picture. This replaced the concepts of Town Group that was in vogue at the 1961 Census. The town groups were made up of independent urban units not necessarily contiguous to one another but were to some extent inter-dependent. The data for such town groups became incomparable from census to census as the boundaries of the towns themselves changed and the intermediate areas were left out of account; this concept came for criticism at one of the symposium of the International Geographic Union in 1968 and the concept of Standard Urban Area came to be developed for adoption at the 1971 Census. If data for this Standard Area were to be made available in the next two or three successive censuses, it is likely to yield much more meaningful picture to study urbanisation around large urban nuclei.

## Basis for classification of urban settlements

The definition of urban areas varies from one country to another. Some of the common bases of classification are size of population, occupational structure and Administrative setup.

## Population size

In India the size of population, density of 400 persons per sq. km and share of non-agricultural workers are taken into consideration.

## Occupational structure

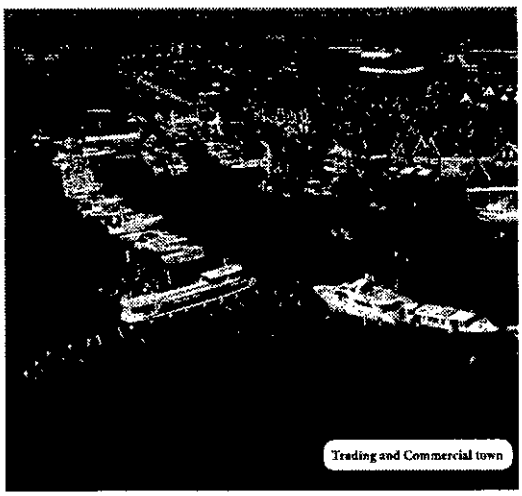
In India if more than 50 per cent of its economically productive population is engaged in non-agricultural pursuits.

## Administration Setup

For example, in India, a settlement of any size is classified as urban, if it has a municipality, Cantonment Board or Notified Area Council.

## Classification of Urban Settlement

Depending upon the functionality of the urban settlement, towns are classified as Administrative Towns, Commercial Towns, Cultural Towns, Recreational Towns, and Industrial Towns.


Trading and Commercial town

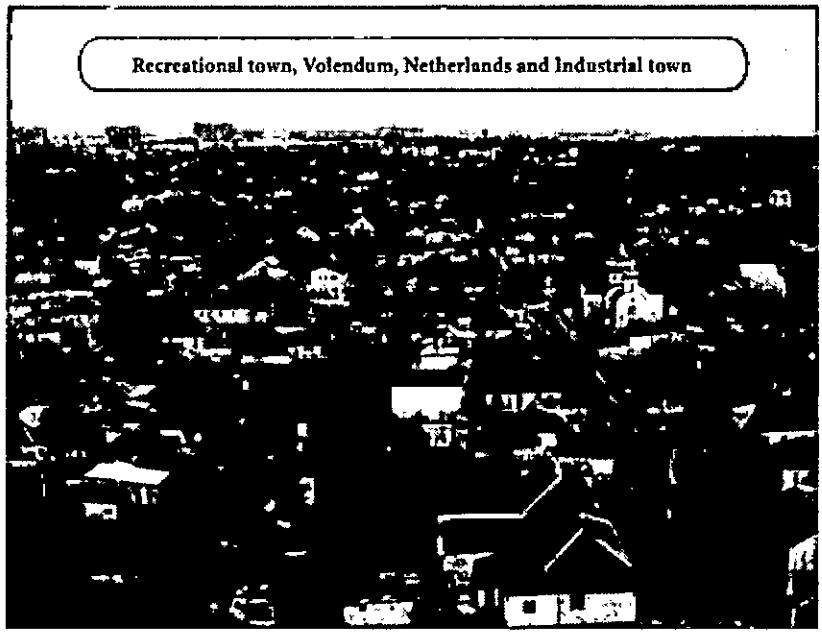
The settlements that established for the administrative purpose or having largely administrative function are known as **administrative towns.** For example, Washington D.C., New Delhi, Canberra, Paris, Beijing, Addis Ababa, and London etc.

The settlements that facilitate commercial opportunities are known as **trading and commercial towns.** For example, Agra, Lahore, Baghdad as an important transport node; Manchester and St Louis in land centers; Winnipeg and Kansas City as agricultural market towns; Frankfurt and Amsterdam as banking and financial centers; etc.

The settlements established because of religious adherence are known as **cultural or religious** towns. For example, Jerusalem, Mecca, Jagannath, Puri, Madurai and Varanasi, etc.

The settlements established for the recreational purpose are known as **recreational towns.** For example, Miami (U.S.A), Panaji (India), etc.

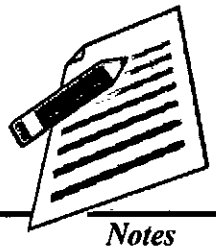
The settlements established because of industrial development are known as **industrial towns.** For example, Pittsburgh (U.S.A), Jamshedpur (India), etc.



Recreational town, Volendum, Netherlands and Industrial town

## SUMMARY

Settlement can be defined as any form of human habitation which ranges from a single dwelling to a large city. Settlements can be broadly divided into two types – rural and urban. The basic difference between rural and urban is on the basis of function. In India rural settlements are broadly grouped under four categories. These are compact, semi-compact, hamleted and dispersed. Compact settlements have closely built-up area and dwellings are concentrated in one central site. Maximum settlements of our country come under this category and geographically it spreads almost every part of the country. There are as much as eleven patterns are found within the compact settlement. Semi-compact settlements are characterised by a small but compact nuclear around which hamlets are dispersed. Some of the important patterns bound in semi-compact settlements are checkerboard, elongated and fan-shaped. Such settlements are found in tribal areas of Chota Nagpur region and Nagaland in north-eastern states of India. The places which satisfy the conditions mentioned in category (a) are known as statutory towns. The towns which satisfy conditions mentioned in the category (b) are





known as census towns. Like rural settlements, urban settlements are classified on various bases. However, classification based on size and function are most common. On the basis of population size all urban settlements can be town, city, metropolitan city and mega city. On the basis of functions, cities can be grouped as administrative, industrial, transportation, commercial, mining, cantonment, educational, religious, tourist, etc.

## EXERCISE

### MCQ

1. Consider the following statement (s) related to shapes of the settlements.

I. Linear pattern: Such patterns of rural settlements are found in plain areas or wide inter montane valleys.

II. Rectangular pattern: In such settlement's houses are located along a road, railway line, and river, canal edge of a valley or along a levee.

Which is / are correct option?

Code:

A. Only I
B. Only II
C. Both I and II
D. Neither I nor II

2. Consider the following statement (s) related to rural settlements.

I. The rural settlements are concerned with the degree of dispersion of the dwellings and the life is supported by land based primary economic activities.

II. Rural people are less mobile and therefore, social relations among them are intimate.

Which is / are correct option?

Code:

A. Only I
B. Only II
C. Both I and II
D. Neither I nor II

3. Consider the following statement (s) related to Hamleted rural settlement.

I. Units are locally called panna, para, palli, nagla, dhani, etc. in various parts of the country.

II. A pattern may also result from segregation or fragmentation of a large compact village.

Which is / are correct option?

Code:

A. Only I
B. Only II
C. Both I and II
D. Neither I nor II

4. Consider the following statement (s) related to dispersed or isolated rural settlement.

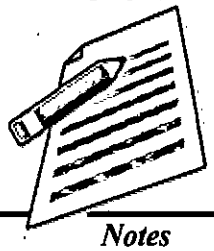
I. Pattern of settlement appears in the form of isolated huts or hamlets of few huts in remote jungles, or on small hills with farms or pasture on the slopes.

II. Extreme dispersion of settlement is often caused by extremely fragmented nature of the terrain and land resource base of habitable areas.

Which is / are correct option?

Code:

A. Only I
B. Only II
C. Both I and II
D. Neither I nor II





5. Which of the following statements concerning spatial systems is not correct?
   A. Maps cannot be used to measure and analyse systems, only models can.
   B. The analysis of the role of each component helps reveal the operation of the entire system.
   C. They function as units because their component parts are interdependent.
   D. Spatial systems may be the basis for regional identification.
6. The essential perspective used by geographers in forming their concepts is:
   A. Absolute. B. Human.
   C. Relative. D. Spatial.
7. Arithmetic density:
   A. cannot be used to compare regions.
   B. is an absolute relationship such as population per square kilometre
   C. is more meaningful than physiological density.
   D. refers to the number of persons per unit of arable land.
8. Site refers to the:
   A. External features of a place.
   B. Precise location of the centre of a city.
   C. Proximity to natural resources or transportation routes.
   D. Internal locational attributes of a place.
9. Regional boundaries are marked by:
   A. Precise decisions based upon the scale of the map.
   B. Dramatic changes in the region's unifying characteristic.
   C. Spatial reality.
   D. The boundaries of a city or incorporated political unit.
10. The statement that "the journey to work is 15 minutes by bus" is an example of:
   A. Absolute direction. B. Absolute distance.
   C. Relative direction. D. Relative distance.

## Answer

**1.** D **2.** C **3.** A **4.** C **5.** A
**6.** D **7.** B **8.** D **9.** B **10.** D

## Review Questions

1. What is a settlement? Describe various types of rural settlement in India.
2. Explain various patterns of compact settlements of India with examples.
3. Describe various factors influencing settlement types in India.
4. Explain the building materials used for walls and roofs in India.
5. Define an urban area as given by census of 2001. Explain the procedure adopted for functional classification of cities in 1991 census.



# 22 LOCAL AREA PLANNING

- Understand the concept of planning.
- Discuss the features of local area planning.
- Describe the types of planning.
- Discuss the challenges in planning.

## Objective of the chapter:

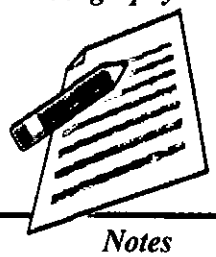
The basic objective of this chapter is to through some light on the initial concepts of local area planning so that the features and types of local aera planning can be learned.

## Introduction

In order to understand the concepts and approaches related to local area planning, we need to understand the terms that constitute the entire idea. The term local area is used variously in ecology, economy and society. It is a site-specific issue, commodity or community. In terms of attributes, local area is both a physical as well as cultural attribute like landscape of an area, surroundings of a locality, local products, folk dances, handicrafts etc.

**Local Area:** Products, Forms and Sites The attributes of a local area reflect strong bonds of association with the location and people. With regard to non-local area and people it reflects weakening bonds of association and growing variations. For example, sea breeze, a local wind, exercises considerable effect along sea shore and it gets weakened away from the sea. Sometimes local area product or identity becomes so popular and specialized that it becomes demanding across places and regions. Sandles of Kolhapur, sandal sticks of Mysore, fireworks of Shivakashi, Naga Shawls, Kashmiri Pashmina, Varanasi silk sarees, Madhubani art, Kuchipuri dance etc. are some of the local area products or specialities that are in great demand both from national as well as international markets.

A well-maintained locality with its clean and green environments acts as a source of attraction to the non-local people and acts as an ideal for other places to follow. For example, Shalimar Bagh (Srinagar), Mughal Garden (Delhi), Valley of Flowers (Uttaranchal), Rock garden (Chandigarh), Nagarjun Konda (Andhra Pradesh), Rajgir (Bihar), Kanya Kumari (Tamilnadu) etc. are the local area sites that present a sound balance of ecological and aesthetic significance. A sense of pride and attachment to the local product, area and people is a source of unity and activity. It also leads to common understanding and identity. Ecologically, local areas may be mountainous, plateaus, plains, coastal, desert or wetlands. Functionally local areas may be pastoral agricultural, industrial, institutional or service areas. In terms of habitations, local areas may be rural, urban, nomadic or tribal. Local areas could be modern or traditional with regard to their social setup.





Similarly, in terms of economic development local areas could be developed or less developed. An effort to devise ways and means to solve the problems of places and people is termed as "planning". As a student we plan for studies, examinations and even for other routine works. We also get ourselves associated in finding solutions to the common problems at the local level where we work and live. Maintenance of amenities and public utility services, sanitation, general health and education are some of the most common problems faced by the local people. Since local areas are the smallest units of planning, it is rather easier to find solutions to their problems which are also smaller and manageable in dimension.

Most of the problems that seek planning and solutions are related to the ecological imbalances, economic depressions and social tensions. To improve the general conditions of the people in a local area, provisions for basic social amenities and facilities need to be planned. The participation of local people helps in utilizing local materials, indigenous knowledge and maintaining infrastructure that are planned.

Planning also aims at improving the quality of local environment through tree plantation, maintaining the local water pools like rivers, tanks, lakes etc. and managing the depletion of rocks and soils. People's participations in the local area planning and continued cooperation in their maintenance results in developing healthy local environment. "Planning is thus, defined as conceiving, initiating, regulating and controlling environment as well as socio-economic activities by the local people and authority according to set priorities with a view to achieving objectives within a given time frame"

## Levels of planning

Planning is carried out at various levels. Beginning from a small local area to as large area as the world planning is an integral part of human progress and area development. People have been planning their affairs, activities, habitats, etc. from early times. It is, thus a continuous process across time and areas and is aimed at the welfare of people and the environment.

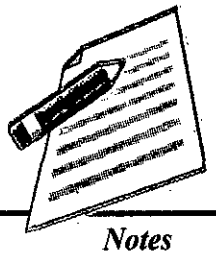
At the global level, planning for the whole world is taken up by the United Nations and countries provide cooperation in the implementation of the planning schemes. Various programmes such as UNEP, UNDP, etc. are initiated to deal with the global issues of environment, poverty, development, and so on.

At the country level, national plans are formulated for the welfare and development of the nation. In our country, Planning Commission is the central agency to design plans for various sectors of economy such as agriculture, industry, etc; different ecological zones like mountains, deserts, coastal areas etc. and different segments of society such as women, children, tribal groups, youths, aged persons, etc.

Prime Minister is the Chairman of the Planning Commission. Nation is further subdivided into several sub-units for administrative and planning purposes. It varies from country to country with different nomenclature. In our country, the nation is sub divided into states, districts and blocks.

At the state level there is a State Planning Board that develops plan for the entire state. This is also known as a regional plan. Chief Minister of the state is the Chairman of the State Planning Board. Districts are the third order planning units after nation and the states.

At the district level, planning and development agencies work together and District Magistrate coordinates the plan implementation. Community Development Blocks are the fourth (micro) level planning units. Each C.D. Block consists of about 50 villages. These blocks are responsible for plan implementation down to the village and household levels.





Block Development Officer (B.D.O.) is the coordinator of the plan at this level of planning. Local area planning is meant for small localities like a village, a Basti or Mohalla. The entire community, living and working at the place, is responsible for developing plans and seeking assistance and cooperation from the Governmental Organization, Non-Governmental Organization and others. It is not the endeavour of a few people but hard work of many that makes the local area clean, green and prosperous.

## Challenges to planning

There are serious challenges to the success of a planning scheme. More often planning is initiated without giving adequate thought to its effect on the area and people for whom it is meant. Since a planning scheme moves from top to bottom, it gets obstructed at various levels before it reaches to the target area and people. In spite of relatively higher economic development, India continues to run behind in terms of social advancement. Our country has the largest concentration of poor, malnutritional and illiterate persons. These serious challenges cannot be managed through governmental or some non-governmental agency level but one requires effective participation and co-operation of the local people. People wish and plan that roads reach to their door steps, every child study in a school, they have power and potable water, they have water to irrigate their fields and markets to sell their local products. Thus, infrastructure related to health and education can ensure people's awareness, effective participation and mobilization for the success of planning scheme. Ecological and economic considerations must be in perfect balance if planning has to succeed and remain sustainable. The following are the basic requirements of local area planning:

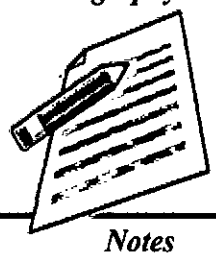
1) Formulation of objectives or goals.
2) Fixing targets of planning and its priorities to be achieved.
3) Mobilisation of resources for the execution of plan.
4) Creating necessary social group or organization for the implementation of the plan.
5) Regular evaluation and monitoring of the progress made.

## Bases of planning

There may be several bases of planning but here we are discussing only the bases of planning i.e., ecological and socio-economics.

## A. Ecological Basis of Planning

The study which explains the interrelationships among all-natural organisms with their environment is termed as Ecology. All those conditions, circumstances and influences that affect the development of an organism or a group of organisms is the environment. Thus, ecology and environment are closely related with each other in the context of organisms and systems that influence them. Geographically, the exchange of matter between land and sea is set in motion by two main physio geographical processes. The interaction between man and nature is inseparable. It is the highest form of interaction between life in general and the environment in particular. The diversity of life forms that has evolved over hundreds of millions of years and their adaptation to different, often extreme environmental conditions are amazing. The interaction of human beings with nature began at the time they separated themselves from the natural environment. The relations between man and nature take shape within his habitat.





The experience of man-nature interaction is an age-old practice of planning. To make the best use of nature, man has been making necessary adjustments in the ecological setup. The domestication of wild animals, selection of useful plants from the natural vegetation, making terraces on the mountain slopes, taming the rivers for irrigation or flood control etc. are a few examples of planning the welfare of people while keeping a balance on the ecological setup. Human habitations were planned in close proximity to water sources, work sites and on the considerations of safety and mobility. Most of the primary pursuits like agriculture, horticulture, sericulture, etc. are based on the natural considerations of productivity. Similarly, some of the secondary production systems such as software, paper, many foot loose industries etc. are also designed in a manner that causes minimum disturbance to the ecological setup. However, growing human needs and commercial considerations have caused serious damages to the ecological setup. Large scale developmental activities, deforestation, structural changes, waste generation, and so on have accelerated desertification, global warming, melting of ice caps, rise in the sea level, natural disasters, etc.

## B. Socio-Economic Basis of Planning

The population of the earth is increasing rapidly and has registered above 6 billion mark. To meet the ever-increasing needs of the people, utilisation of natural resources will grow. It is, therefore, necessary to maintain a balance between the scope of resource utilisation in a given ecological setup and human needs. The socio-economic planning has to remain eco-friendly for sustainable development. Besides utilising natural resources, sustained efforts need to be made to develop local surroundings, streets, drains, parks, playgrounds, open spaces, etc. with landscapes and tree plantations.

The designs for tree plantations need to be developed based on the geological structure, relief, climatic conditions, soil, drainage system and natural vegetation. Depending upon the available space, growing conditions of plants, local weather and climatic conditions; indigenous varieties of dwarf, medium and large trees need to be planted. For promoting and maintaining the local environment, peoples support is essential. In turn, a healthy local ecological setup satisfies several needs of the local people besides presenting a pleasing view of green surroundings.

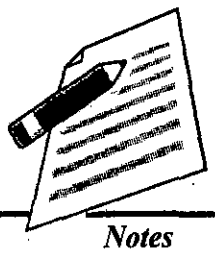
## Dimensions of local area planning

## A Basic and Higher Needs

The welfare of "local" community depends upon fulfilling the basic as well as higher needs of the people. The basic needs include food, cloth and shelter besides safe drinking water, basic education and health care, transport and communication facilities and so on. The higher needs include still higher order amenities, services, facilities etc. While basic needs are necessary for survival, higher needs help the society to become efficient, service oriented and dynamic. The process of planning is aimed at making the necessary provisions to meet the demands of people and places. Several schemes of planning are designed to fulfil the general as well as functional needs of the people. However, dynamics of population growth and concentration of activities at specific sites pose a challenge to the planning process.

## B Dynamics of Population Growth and Prospects of Planning

In places where growth of population remains normal, functional activities are largely unchanged and scheme of planning records success. For example, civil lines, mall roads,





cantonment settlements etc. present a striking balance between the provision of amenities and facilities with the growth of local population and concentration of functions and activities. On the contrary, the local areas where growth is high and concentration of activities continues unchecked, the performance of planning usually remains poor.

For example, busy markets, industrial sites, transport junctions, slum settlements and so on. register a higher population growth and concentration of activities. It leads to the congestion and crowding reflecting the poor planning performances. In the absence of adequate job opportunities in rural and backward regions, most of the rural youths out migrate towards cities. It leads to poor economic performance in the places of origin and unchecked concentration of population in the places of destination. While it leads to clustering in living spaces due to limited paying capacity of the migrant population, it offers adequate cheap labour to cities. The mismatch between population growth and provision of services, facilities and amenities causes unhygienic sanitary conditions, poor public health and above all degeneration of local environment. Thus, the provisions of planning fall short of the growing local demands in these areas.

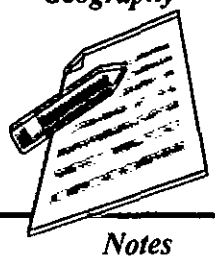
## C Economic Basis for Stability and Development

The economic development of an area is another dimension of local area planning. It aims at raising the production and service levels, job generation, improved marketing network, favourable price policy, efficient systems of transport and communication, etc. Economically advanced areas are usually capable of making significant investments towards natural conservation and ecological improvements. Similarly, social infrastructure and facilities can also be created if areas have a sound economic base. Almost all areas-rural or urban are endowed with natural potentials. While primary activities dominate in rural areas, secondary and tertiary activities dominate the urban areas. The pace of economic growth is accelerated through technological innovations and institutional backup.

Mechanisation of agriculture and modernisation of industries are the examples of technological innovations, while financial, educational and policy backups are the institutional roles in improving the economic base of an area. Issues such as the interests of producers, consumers, service providers and workers be taken care of in the planning. The status of income and employment generation, capacities of savings and investments will increase as a natural outcome of economic package. It has been observed that many of the economic packages turn out to be rewarding in the course of time. Reed works of Shillong, brassware works of Moradabad, silk and zari works of Varanasi and Kanjivaram, bandhani works of Sanganer, embroidery works of Lucknow, etc. are a few examples of success stories that had the backup of economic planning. Thus, the products and services of a local area mark the place identity and people's prosperity.

## D People's Participation in Planning

Awareness of the people and their participation in the local area planning can safeguard the interest of the community while maintaining the local ecological situations. The chances of the failure of a planning scheme, that involves local people, remain minimum as corruption, exploitation and mismanagement is greatly checked. Besides, above people being direct beneficiaries, keep a caring attitude towards maintaining the social welfare and area development. When local people develop a plan and set their priorities, it will maximise benefits to the people and minimize the cost of planning. It is more likely that the planning augments the cycle of growth and diversities in developmental activities.





## Utilisation of local resources

Resources of the area are being utilised by the local people to satisfy their needs. The air, water, food, cloth and shelter are the essential needs for human survival. Both inorganic as well as organic matters of the nature satisfy the basic needs of the local people. Selection of useful plants, animals and natural sites led to the promotion of human activities such as farming, fishing, horticulture and nomadic herding. The local needs of building construction, having of streets, drains, sources of water, scenic landscapes, etc. are fulfilled by local resources. Since most of the materials are the common property of the local people, they have been utilised by all as building materials and means of livelihood. Thus, need based utilisation of local resources remained eco-friendly and economically sustainable. A brief discussion about local resources is given below.

## Land Resources:

### A. Rocks and Soils

The most striking feature of a local area is its rocks and soils. These land resources are the basis of human settlements and primary activities besides being the base for scenic landscape. The exposed rock surfaces act as natural platforms while its slopes and steps remained the basis for plant growth. The places in such a setup are developed as sites for picnic, parks and natural beauties. Soils are the basis for a variety of human activities such as agriculture, animal herding, horticulture, etc. The fertile soils have always been a source of attraction for human civilisations and development. However, this rare gift of nature is threatened by massive erosion and degradation, and is fast converted to wastelands. Large scale deforestation and commercial uses of land have caused imbalances in soil setup.

Since formation of soil, its renewability and replacements require pretty long period, there is an urgent need for soil conservation and maintenance of its natural fertility.

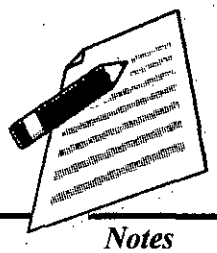
### B. Water Resources

One of the most basic requirements for life to develop and sustain on long term basis is the availability of water. It is central to all ecosystems. Most of the early human civilsations developed near water sources especially along fertile river valleys. Both for human activities and settlements water is an essential element. Water is being used for a variety of purposes like power generation, irrigation, for domestic and industrial uses besides keeping the local area clean and green. Misuse of water has created shortage. Water pollution have caused diseases.

Droughts and floods occur in different areas. Therefore, management of water is an essential requirement for life. Coordinated efforts need to be made towards water harvesting, reducing wastage of water and making judicious use of water for various purposes. Recharge of water to subsurface layer of soil is essential to check the surface flow of rain water. Use of tanks, lakes, percolation pits, bunds along the sloppy surface, help in the recharge of water.

### C. Plantations /Forest Resources

Plants are the basic form of life and act as the source of oxygen. They are means to livelihood and natural attraction. Due to ever increasing pressure of population, forest cover is fast declining causing serious environmental threats. Tree plantations along highways, railway tracts, hill slopes, canals have developed schemes like social forestry, farm forestry and so on.





Concerted efforts of the local people are central to plantations and their protection. It is being carried out in the form of rituals and practice of the people. For example, Bisnoi community is known for plant protection especially in parts of Haryana and Rajasthan. Similarly, Maiti is a marriage ritual practiced in Kumaon hills. During marriage ceremony bride plants, a sapling and bridegroom puts water on the plant. This practice has converted many villages green in Kumaon. Since trees provide building materials, fuel and firewood besides, a variety of fruits, flowers and green cover, protection, promotion of tree cover is basic to life support. At the local level, protection and increase of the tree cover is basic to support life.

## Assessing the local resources

An assessment of local resources is essential for planning. For finding solutions to the local problems as well as for the purposes of development we need to have an idea of local resources. Usually land, soil, water, forests, animals, other organisms, minerals and so on form the natural resources of an area. Similarly, human being, their educational levels, human activities, skills, health status, etc form human resources. An inventory of locally available resources need to be prepared with the help of records of the area and by conducting a field survey. For example, with regard to land resources an idea of the total area (of the village or an urban locality), nature of rocks and soils, size of the land holdings, number of plots, nature and type of land use, etc. should to be recorded. Similarly, in case of water resources, a survey of river, drains, ponds, lakes; their approximate length, width and depth of water need to be known to get an idea of water availability, water surplus or deficit positions, major problems linked to consumption water.

An estimate of trees, seasonal plants, their specific use for the community in the form of fire wood, fuel, timber, fruits, and flowers need to be worked out. Similarly, human as well as animal resources should to be assessed.

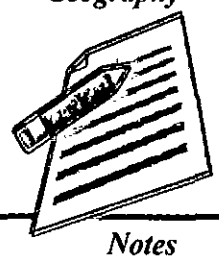
A. Sources of collecting data to assess local resources

   Thus, for assessing local resources, we can make use of governmental and non-governmental sources. Besides collecting information through secondary sources, we can also conduct field survey to collect certain information or primary data that is not available from secondary sources.

B. Preparing a Plan and Ensuring its Implementation Based on the assessment of local resources a plan of action needs to be prepared. This should broadly cover the aspects of education, health, transport, communication, retail markets etc. The plan should also cover the promotion of agricultural and industrial activities besides community functions. The formulation of the plan must be based on the availability of local resources, requirements of the people, likely expenditures and estimated benefits to the people.

The plan should be phased out with regard to time and the targets when the work is to be completed. For ensuring the implementation of Local Area Plan, efforts should to be made to mobilise the support of local people in the form of labour, raw material, skill and guidance. In addition to it, the support of governmental, non-governmental organisations, self-help groups etc. need to be obtained in the form of finances, technology and material help. Effective checks and controls should be exercised to ensure the monitoring of the work done.

It is usually observed that the maintenance of the structure once created by planning, remains poor due to misuse or careless handling of the operating/services such as buildings, tap water, public toilets etc. The local resources should not be exposed for commercial utilisation by non-local people as it leads to excessive exploitation of resources and their subsequent





depletion. It is, thus, necessary for the local people to be caring and remain concerned about the maintenance and upkeep of the planned projects.

It is, thus, established that need based utilisation of local resources is essential for survival and development of the community. However, balance needs to be maintained between the ecological conditions and socio-economic needs of the community. The process of planning, as such, will vary greatly with the ecological settings and socio-economic needs of the local people.

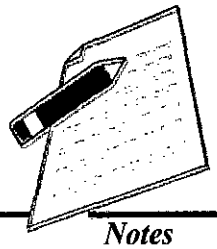
## Development over different five-year plans

India is making planned efforts to develop its economy, society and areas. Plans are designed for a period of five years. India's First Five Year Plan began in 1951 and currently it is the Tenth Five Year Plan period. The progress made so far is a record of 55 years of planned effort in India covered through ten Five Year Plans and a few annual plans.

1. First Five Year Plan Community Developing irrigation 1951 – 1956 Development networks and increasing Blocks Identified agricultural Productions
2. Second Five Year Plan Industrial Self-reliance in 1956 – 1961 Estates were industrial development established.
3. Third Five Year Plan Intensive Agricultural Achieving higher 1961 – 1974 District Programme output levels both in (IADP) agricultural and Industrial sectors of economy.
4. Fourth Five Year Plan Balanced Regional Target Area 1969 – 1974 Development (BRD), Target Group Command Area Development (CADP).
5. Fifth Five Year Plan Decentralised Planning National Programme of 1971 – 1979 Tribal Area, Hill Area Minimum Needs, Integrated Drought Prone Area Rural Development Programme (IRDP) Programme.
6. Sixth Five Year Plan Multi Sectoral Removal of Poverty 1980 – 1985 Approach DWCRA Small Farmers TRYCEM, RLEGP Development Border Areas, Backward (SFDA) Districts
7. Seventh Five Year Agro – climatic zones, Self-employment Plan 1985 – 1990 water shed Scheme (SES), Development Jawahar Rojgar Yojana (JRY)
8. Eighth Five Year Plan Panchayati Raj Human Resource 1992 – 1997 Institutions Development, Economic HADP, BADP WGDP Diversification NEC
9. Ninth Five Year Plan Basic Minimum Human resource 1997 – 2002 Services (BMS) Development, Housing to the people, Health education in remote rural areas.
10. Tenth Five Year Plan Cleaning of major Public Delivery system 2002 – 2007 rivers, Rain water (PDS), Total Literacy harvesting (renewal of campaign, National traditional methods.) Literacy Mission Interlinking of rivers (NLM), Provision of urban water, Harvesting in Amenities in Rural drier regions. Areas (PURA), Health for All.

## Unique needs of different planning areas

Nature has provided some resources to all areas which can help to develop the regions. Different areas have distinct problems and potentials. Hence it present, unique needs for planning. But every area which has problems has also possibilities to solve such problems. As such, there is a need to develop specific plans for the welfare of people and the development of the specific areas. For example, mining areas have large mineral deposits. But, by and large, these areas are faced with the problems of health and natural hazards, noise pollution,





collapse mine roofs, waterlogging and so on. The problems of mining areas could be specially taken up for planning.

A slum locality in a city is usually faced with the problems of poor sanitation, insufficient living space, acute shortage of basic social facilities and amenities. The quality of life is poor and full of health hazards. As such it demands for an urgent provision for essential infrastructures in its local area planning charge. Industrial areas are faced with the problems of pollutions, while market areas are faced with congestion, crowding and poor sanitation. As a result, industrial areas will have priority of planning for pollution control, while market areas will have priority to develop other centers of marketing to relieve the pressure and reduce congestion and crowding.

Agricultural areas have problems of floods and droughts, soil erosion, declining natural fertility and shrinking land-man ratio while pastoral areas suffer from the problems of range and management, conversion of grasslands into farmlands etc. The diversification in cropping pattern, cropping efficiency and increasing agricultural productivity are the priorities of agricultural planning while controlled grazing and effective range, land management and commercial pastoralism are the planning priorities in pastoral areas.

Areas with diverse physical and socio-economic set up have their unique needs. It calls for need based planning solutions. For example, hill areas have steep slopes, deep valleys, thin layer of soil and relatively low level of carrying capacity of land. Hill areas, therefore, need afforestation, promotion of horticulture, herbal and medicinal plants, eco-tourism and small hydro-power projects for their development.

Similarly, desert areas are characterized by the acute shortage of water leading to the vast expanse of wastelands, sand dunes and barren areas. The desert development requires the provision of water as its top planning priority. Indira Gandhi Canal serves the purpose of need based planning for the desert development in the Thar region of India.

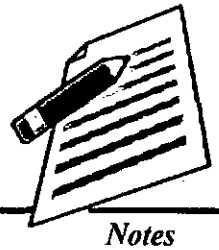
A brief discussion on need based planning is given below:

## A. Water Harvesting and Management

These areas reveal scientific and judicious use of water. from remote cold desert of Leh to hot desert of Thar; from Patha area of central India to far south in Kerala and Tamilnadu, water management techniques have completely changed the lives and landscape in these areas. (Recent examples of Arvari in Rajasthan and Tikaria in Patha area of central India are the initiatives of local people for managing water resources of the area). Traditional water harvesting and management methods are also found in every part of India.

## B. Protection and Promotion of Forests

Plants and animals need protection and promotion for keeping the ecological and biological balance in a locality. People have been partly protecting plants and animals due to religion and partly due to prevailing customs and traditions. Sacred groves are protected due to age old practice and ritual. They signify the judicious use of natural resources in the long-term interest of the community. Plants like Pipal, Neem, Tulsi, Beri are sacred in Hindu tradition while Dates, Oak, Bargad are sacred in Islamic, Christian and Buddhist traditions respectively. Depending upon the ecological conditions in different areas, plants are protected. Such as coconut and casurina in coastal areas, Dates and Beri in desert areas and orchards in hill areas are part of the regional practices towards protection and promotion. There is also a similar tradition of protecting sacred animals like cow, goats and sheep, camels, snake and so on.





## C. Tribal Communities and Protection of Wild Life

Tribal communities and wild life both are faced with the problems of survival and development in the face of deforestation. Forest dwellers have protected wildlife, for example Ban Gujars of Rajaji National Park (Uttarnchal), Abujhmars of Bastar and Todas of Nilgiri Hills are known for their skill in wild life protection. However, some of these forest dwellers are now evicted and rehabilitated in areas where they have no access to forests. This has happened in Nagarhole National Park in Karnataka and Rajaji National Park in Uttaranchal. Involvement of tribal people and protection of their forest rights has now succeeded in using better methods of wild life protection.

## D. Power to People

Local Level Environment Management Environmental management at the local level is giving power to the people to manage their natural resources. Even after spending large sums on development and welfare activities, India could not perform too well in tackling environmental management. It is, therefore, widely felt that local affairs should to be managed by local people for taking care of their needs and aspirations. The 73rd and 74th amendments to the constitution have made decentralized planning possible in a democracy. A few examples of local level environmental management.

Constructing tanks, bunds, mini reservoirs for water harvesting, plantations along sloppy tracks and controlled pastoral activities are some of the local initiatives that have improved the quality of environment.

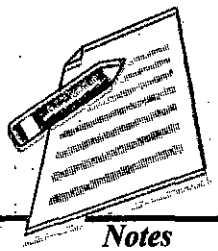
## Resource utilisation and interrelationships

Resources are all the materials and objects that are ready for use or available as needed by people. Utilisation of resource is a situation in which a commodity in nature is used. These should be balanced utilization of resources. Resources utilised beyond the critical limit or without replacement leads to imbalances in the ecosystems and ultimately in the environment. Thus, the rationale use of resources is of utmost importance. It helps human progress in the long run.

## A. Types and Utilisation of Resources

Primarily, there are two kinds of resources : non-renewable (mineral wealth) which exhaust after bearing utilized once and there is a certain fixed amount of such resources in the world; and renewable resources (fresh water in rivers, oxygen in the atmosphere, the forests and the biological mass), which come from natural processes taking place on the earth and are balanced between annual increase and annual consumption, including the utilisation by human beings. Let us see how the environment influences man and in turn what influence society exerts on the nature. Today there is hardly a place where human beings would not be able to live and work. The effect of human intervention is on the increase in nature. For example, while extracting mineral wealth, burning fuel, or irrigating crops in arid lands, we extract certain substances from nature. Similarly, while discharging industrial and agricultural waste and other such by products into the atmosphere and hydrosphere, we introduce new components into the environment. By Farming marshlands or piping water for household and industrial needs, we alter some of the elements of the water balance.

The fragile ecosystems like mountains and valley areas are threatened by Felling of trees, road constructions, blasting of rocks and constructing mega dam projects. These activities





are responsible for changes in the structure of earth surface and imbalances in the ecological set up. The use of soil resources for crop production, commercial plantation and pastures are eco-friendly activities carried out by human beings. However, unscientific practices of high intensely or cropping or overgrazing leads to soil erosion and becomes a challenge to the ecosystem. Similarly, deforestation, slash and burn cultivation, polluting industries etc. cause ecological as well as environmental crisis. Hence, it is important to understand the local resources and their utilisation in an eco-friendly and sustainable manner failing which ecological crisis will be inevitable.

## B. Depletion of Resources

People have drawn quite a lot through their activities from our natural resources both renewable and non-renewable. Some of them are depleted to a large extent or almost in full and others far a lesser degree. Human activities have increased to the extent that it alters the established patterns of cyclic movement of matter affecting the natural course of various processes on the Earth's surface.

The depletion of resources , the growing impact of humans on nature and above all the pollution of environment are matters of growing concern. This concern is further highlighted by the energy crisis and increasing food shortage. As a consequence, very serious ecological crisis is likely to occur. However, it will be possible to avoid the crisis, if measures are taken up to utilise resources on a rational manner, and a policy to conserve resources is adopted beginning from local to global levels.

## C. Optimal Resource Utilisation

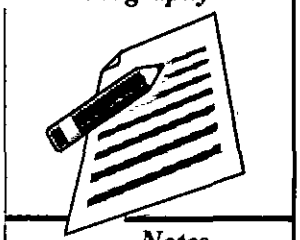
The transformation of environment in the course of production by society is inevitable. Not only human society but in fact any form of life affects Nature with its activity. Ecologists persist in their belief that the development of society will inevitably have negative effects on humans. These consequences in association with the depletion of resources augments ecological as well as economic crisis. The efforts of local area planning are aimed at maintaining a critical balance between available natural resources and their optimal utilisation in a sustainable manner, while private enterprise is guided solely by the profit motive regardless of social benefits or evils.

It has been seen that the public sector development too suffers from a bias towards developing areas for political or commercial reasons. For example, production of luxuries on a commercial scale leads to the exhaustion of resources. As a result, the masses suffer even for the bare necessities of life. Since both public as well as private sector enterprises suffer from inherent weaknesses in the system, people's participation in planning and management of resources is of utmost significance.

The utilization of resources must be guided by the availability, existing efficiency and current and future needs of the society. The continuous monitoring of conservation practices keeping in mind the cyclic process of resource renewal and search for viable alternatives are some of the measures to meet the challenges of resources depletion.

## SUMMARY

Local area planning is a process of planning that is concerned with resolving local level problems and issues. Local area is both a physical as well as a cultural attribute like





landscape of an area, local products of folk dances, handicrafts etc. An effort to devise way and means to solve the problems of places and people is termed as planning. Planning is carried out of various levels from small local area to as large area as the world. However, it is the sincere effort of the local people that ensures local area clean, green and prosperous. For local area planning, formulation of objectives fixing targets and priorities to be achieved, mobilization of local and other resources for the execution of plan, creating social group for the implementation of the plan and monitoring of progress are the basic requirements. The success of local area planning largely depends upon the ecological and socioeconomic base of the locality. As such local area plans vary significantly from place to place. The dimensions of local area planning are essentially to fulfil the basic and higher needs of the people besides creating adequate opportunities for employment and income generation to meet the growing needs of local people. Hence, need based utilization of local resources is a precondition for such a planning. Local resources refer to land resources like rocks and soils, water resources, plantations and forest resources. Assessment of local resources helps in data collection and preparation of plan and its implementation. Planning is, thus, a continuous process. India is making planned efforts to develop its economy and areas for the welfare of people. India has designed 10 Five Year Plans based on its priorities so far. Priorities have been changing during different plan periods. However, all of these plans were aimed at achieving higher economic growth rates while keeping general welfare of the people as the main goal.

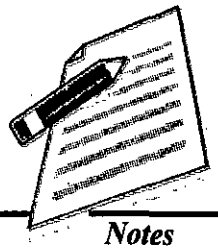
## EXERCISE

### MCQ

1. Which of the following is not a benefit of planning?
   (a) Planning reduces overlapping and wasteful activities.
   (b) Planning is a mental exercise.
   (c) Planning provides directions
   (d) Planning reduces the risks of uncertainty.
   **Answer:-b**

2. Which of the following is a benefit of planning?
   (a) Helps in avoiding confusion and misunderstanding.
   (b) Ensures clarity in thought and action.
   (c) Useless and redundant activities are minimised or eliminated.
   (d) All of the above.
   **Answer:-d**

3. Which of the following is not a feature of planning?
   (a) Planning is futuristic.
   (b) Planning is pervasive.
   (c) Planning establishes standards for controlling.
   (d) Planning focuses on achieving objectives.
   **Answer: c**





4. All other managerial functions are performed within the framework of the plans drawn. Identify the related feature of planning.
   (a) Planning focuses on achieving objectives.
   (b) Planning is pervasive.
   (c) Planning is futuristic.
   (d) Planning is primary function of management.

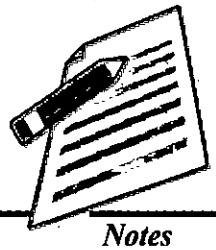
   **Answer:** d

5. Planning requires logical and systematic thinking rather than guess work or wishful thinking. Identify the related feature of planning.
   (a) Planning is futuristic.
   (b) Planning is a mental exercise.
   (c) Planning establishes standards for controlling.
   (d) Planning focuses on achieving objectives.

   **Answer:** b

## Review questions

1. Describe any two dimensions of local area planning in brief.
2. Discuss the basic features of developing a local area plan.
3. How can local people help to improve their local area by local self-initiative.
4. What is the utility of maps in managing the local area planning.
5. Explain the unique needs of tribal areas.



*Notes*

# 23 DATA COLLECTION, PROCESSING AND ANALYSIS

- Understand the concept of data.
- Discuss the methods of data collection.
- Describe the concept of data processing.
- Discuss the concept of data analysis.

## Objective of the chapter:

The basic objective of this chapter is to through some light on the initial concepts of data collection, processing and data analysis so that the methods of data collection and techniques of data analysis can be learned.

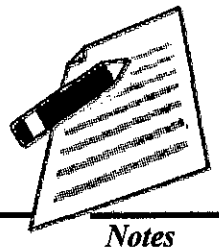
## Introduction

It is important for a researcher to know the sources of data which he requires for different purposes. Data are nothing but the information. There are two sources of information or data they are - Primary and Secondary data. The data are name after the source.

Primary data refers to the data collected for the first time, whereas secondary data refers to the data that have already been collected and used earlier by somebody or some agency. For example, the statistics collected by the Government of India relating to the population is primary data for the Government of India since it has been collected for the first time. Later when the same data are used by a researcher for his study of a particular problem, then the same data become the secondary data for the researcher. Both the sources of information have their merits and demerits. The selection of a particular source depends upon the (a) purpose and scope of enquiry, availability of time, (c) availability of finance, (d) accuracy required, statistical tools to be used, (f) sources of information (data), and (g) method of data collection.

## Purpose and Scope of Enquiry:

The purpose and scope of data collection or survey should be clearly set out at the very beginning. It requires the clear statement of the problem indicating the type of information which is needed and the use for which it is needed. If for example, the researcher is interested in knowing the nature of price change over a period of time, it would be necessary to collect data of commodity prices. It must be decided whether it would be helpful to study wholesale or retail prices and the possible uses to which such information could be put. The objective of an enquiry may be either to collect specific information relating to a problem or adequate data to test a hypothesis. Failure to set out clearly the purpose of enquiry is bound to lead to confusion and waste of resources.





After the purpose of enquiry has been clearly defined, the next step is to decide about the scope of the enquiry. Scope of the enquiry means the coverage with regard to the type of information, the subject-matter and geographical area. For instance, an enquiry may relate to India as a whole or a state or an industrial town wherein a particular problem related to a particular industry can be studied.

## Availability of Time:

The investigation should be carried out within a reasonable period of time, failing which the information collected may become outdated, and would have no meaning at all. For instance, if a producer wants to know the expected demand for a product newly launched by him and the result of the enquiry that the demand would be meager takes two years to reach him, then the whole purpose of enquiry would become useless because by that time he would have already incurred a huge loss. Thus, in this respect the information is quickly required and hence the researcher has to choose the type of enquiry accordingly.

## Availability of Resources:

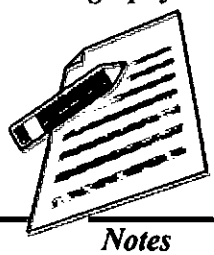
The investigation will greatly depend on the resources available like number of skilled personnel, the financial position etc. If the number of skilled personnel who will carry out the enquiry is quite sufficient and the availability of funds is not a problem, then enquiry can be conducted over a big area covering a good number of samples, otherwise a small sample size will do.

## The Degree of Accuracy Desired:

Deciding the degree of accuracy required is a must for the investigator, because absolute accuracy in statistical work is seldom achieved. This is so because (i) statistics are based on estimates, (ii) tools of measurement are not always perfect and (iii) there may be unintentional bias on the part of the investigator, enumerator or informant. Therefore, a desire of 100% accuracy is bound to remain unfulfilled. Degree of accuracy desired primarily depends upon the object of enquiry. For example, when we buy gold, even a difference of 1/10th gram in its weight is significant, whereas the same will not be the case when we buy rice or wheat. However, the researcher must aim at attaining a higher degree of accuracy, otherwise the whole purpose of research would become meaningless.

## Statistical Tools to Be Used:

A well-defined and identifiable object or a group of objects with which the measurements or counts in any statistical investigation are associated is called a statistical unit. For example, in socio-economic survey the unit may be an individual, a family, a household or a block of locality. A very important step before the collection of data begins is to define clearly the statistical units on which the data are to be collected. In number of situations the units are conventionally fixed like the physical units of measurement, such as meters, kilometres, quintals, hours, days, weeks etc., which are well defined and do not need any elaboration or explanation. However, in many statistical investigations, particularly relating to socioeconomic studies, arbitrary units are used which must be clearly defined. This is a must because in the absence of a clear cut and precise definition of the statistical units, serious errors in the data collection may be committed in the sense that we may collect irrelevant data on the items, which should have, in fact, been excluded and omit data on certain items which should have been included. This will ultimately lead to fallacious conclusions.





## Sources of Information (Data):

After deciding about the unit, a researcher has to decide about the source from which the information can be obtained or collected. For any statistical inquiry, the investigator may collect the data first hand or he may use the data from other published sources, such as publications of the government/semi-government organizations or journals and magazines etc.**Method of Data Collection:**

There is no problem if secondary data are used for research. However, if primary data are to be collected, a decision has to be taken whether (i) census method or (ii) sampling technique is to be used for data collection.

In census method, we go for total enumeration i.e., all the units of a universe have to be investigated. But in sampling technique, we inspect or study only a selected representative and adequate fraction of the population and after analysing the results of the sample data we draw conclusions about the characteristics of the population. Selection of a particular technique becomes difficult because where population or census method is more scientific and 100% accuracy can be attained through this method, choosing this becomes difficult because it is time taking, it requires more labour and it is very expensive. Therefore, for a single researcher or for a small institution it proves to be unsuitable.

On the other hand, sample method is less time taking, less laborious and less expensive but a 100% accuracy cannot be attained through this method because of sampling and non-sampling errors attached to this method. Hence, a researcher has to be very cautious and careful while choosing a particular method.

## Methods of Collecting Primary Data:

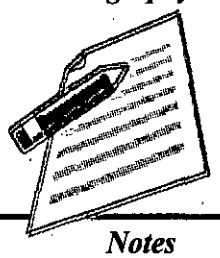
Primary data may be obtained by applying any of the following methods:

1. Direct Personal Interviews.
2. Indirect Oral Interviews.
3. Information from Correspondents.
4. Mailed Questionnaire Methods.
5. Schedule Sent Through Enumerators.

## Direct Personal Interviews:

A face-to-face contact is made with the informants (persons from whom the information is to be obtained) under this method of collecting data. The interviewer asks them questions pertaining to the survey and collects the desired information. Thus, if a person wants to collect data about the working conditions of the workers of the Tata Iron and Steel Company, Jamshedpur, he would go to the factory, contact the workers and obtain the desired information. The information collected in this manner is first hand and also original in character. There are many merits and demerits of this method, which are discussed as under:Merits:

1. Most often respondents are happy to pass on the information required from them when contacted personally and thus response is encouraging.
2. The information collected through this method is normally more accurate because interviewer can clear doubts of the informants about certain questions and thus obtain correct information. In case the interviewer apprehends that the informant is not giving accurate information, he may cross-examine him and thereby try to obtain the information.





3. This method also provides the scope for getting supplementary information from the informant, because while interviewing it is possible to ask some supplementary questions which may be of greater use later.
4. There might be some questions which the interviewer would find difficult to ask directly, but with some tactfulness, he can mingle such questions with others and get the desired information. He can twist the questions keeping in mind the informant's reaction. Precisely, a delicate situation can usually he handled more effectively by a personal interview than by other survey techniques.
5. The interviewer can adjust the language according to the status and educational level of the person interviewed, and thereby can avoid inconvenience and misinterpretation on the part of the informant.

## Demerits:

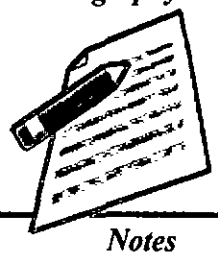
1. This method can prove to be expensive if the number of informants is large and the area is widely spread.
2. There is a greater chance of personal bias and prejudice under this method as compared to other methods.
3. The interviewers have to be thoroughly trained and experienced; otherwise, they may not be able to obtain the desired information. Untrained or poorly trained interviewers may spoil the entire work.
4. This method is more time taking as compared to others. This is because interviews can be held only at the convenience of the informants. Thus, if information is to be obtained from the working members of households, interviews will have to be held in the evening or on week end. Even during evening only an hour or two can be used for interviews and hence, the work may have to be continued for a long time, or a large number of people may have to be employed which may involve huge expenses.

## Conclusion:

Though there are some demerits in this method of data collection still we cannot say that it is not useful. The matter of fact is that this method is suitable for intensive rather than extensive field surveys. Hence, it should be used only in those cases where intensive study of a limited field is desired.

In the present time of extreme advancement in the communication system, the investigator instead of going personally and conducting a face-to-face interview may also obtain information over telephone. A good number of surveys are being conducted every day by newspapers and television channels by sending the reply either by e-mail or SMS. This method has become very popular nowadays as it is less expensive and the response is extremely quick. But this method suffers from some serious defects, such as (a) those who own a phone or a television only can be approached by this method, (b) only few questions can be asked over phone or through television, (c) the respondents may give a vague and reckless answers because answers on phone or through SMS would have to be very short.**Indirect Oral Interviews:**

Under this method of data collection, the investigator contacts third parties generally called 'witnesses' who are capable of supplying necessary information. This method is generally adopted when the information to be obtained is of a complex nature and informants are not inclined to respond if approached directly. For example, when the researcher is trying to obtain data on drug





addiction or the habit of taking liquor, there is high probability that the addicted person will not provide the desired data and hence will disturb the whole research process. In this situation taking the help of such persons or agencies or the neighbours who know them well becomes necessary. Since these people know the person well, they can provide the desired data. Enquiry Committees and Commissions appointed by the Government generally adopt this method to get people's views and all possible details of the facts related to the enquiry.

Though this method is very popular, its correctness depends upon a number of factors such as

1. The person or persons or agency whose help is solicited must be of proven integrity; otherwise, any bias or prejudice on their part will not bring out the correct information and the whole process of research will become useless.
2. The ability of the interviewers to draw information from witnesses by means of appropriate questions and cross-examination.
3. It might happen that because of bribery, nepotism or certain other reasons those who are collecting the information give it such a twist that correct conclusions are not arrived at. Therefore, for the success of this method it is necessary that the evidence of one person alone is not relied upon. Views from other persons and related agencies should also be ascertained to find the real position .Utmost care must be exercised in the selection of these persons because it is on their views that the final conclusions are reached.

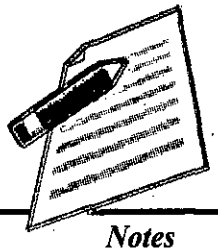
## Information from Correspondents:

The investigator appoints local agents or correspondents in different places to collect information under this method. These correspondents collect and transmit the information to the central office where data are processed. This method is generally adopted by newspaper agencies. Correspondents who are posted at different places supply information relating to such events as accidents, riots, strikes, etc., to the head office. The correspondents are generally paid staff or sometimes they may be honorary correspondents also. This method is also adopted generally by the government departments in such cases where regular information is to be collected from a wide area. For example, in the construction of a wholesale price index numbers regular information is obtained from correspondents appointed in different areas. The biggest advantage of this method is that, it is cheap and appropriate for extensive investigation. But a word of caution is that it may not always ensure accurate results because of the personal prejudice and bias of the correspondents. As stated earlier, this method is suitable and adopted in those cases where the information is to be obtained at regular intervals from a wide area.

## Mailed Questionnaire Method:

Under this method, a list of questions pertaining to the survey which is known as 'Questionnaire' is prepared and sent to the various informants by post. Sometimes the researcher himself too contacts the respondents and gets the responses related to various questions in the questionnaire. The questionnaire contains questions and provides space for answers. A request is made to the informants through a covering letter to fill up the questionnaire and send it back within a specified time. The questionnaire studies can be classified on the basis of:

1. The degree to which the questionnaire is formalized or structured.
2. The disguise or lack of disguise of the questionnaire.
3. The communication method used.





When no formal questionnaire is used, interviewers adapt their questioning to each interview as it progresses. They might even try to elicit responses by indirect methods, such as showing pictures on which the respondent comments. When a researcher follows a prescribed sequence of questions, it is referred to as structured study. On the other hand, when no prescribed sequence of questions exists, the study is non-structured.

When questionnaires are constructed in such a way that the objective is clear to the respondents then these questionnaires are known as non- disguised; on the other hand, when the objective is not clear, the questionnaire is a disguised one. On the basis of these two classifications, four types of studies can be distinguished:

1. Non-disguised structured,
2. Non-disguised non-structured,
3. Disguised structured and
4. Disguised non-structured.

There are certain merits and demerits of this method of data collection which are discussed below: Merits:

1. Questionnaire method of data collection can be easily adopted where the field of investigation is very vast and the informants are spread over a wide geographical area.
2. This method is relatively cheap and expeditious provided the informants respond in time.
3. This method has proved to be superior when compared to other methods like personal interviews or telephone method. This is because when questions pertaining to personal nature or the ones requiring reaction by the family are put forth to the informants, there is a chance for them to be embarrassed in answering them.

## Demerits:

1. This method can be adopted only where the informants are literates so that they can understand written questions and lend the answers in writing.
2. It involves some uncertainty about the response. Co-operation on the part of informants may be difficult to presume.
3. The information provided by the informants may not be correct and it may be difficult to verify the accuracy.

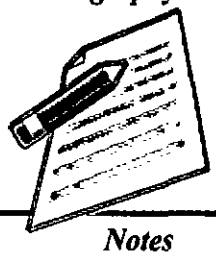
## Schedules Sent Through Enumerators:

Another method of data collection is sending schedules through the enumerators or interviewers. The enumerators contact the informants, get replies to the questions contained in a schedule and fill them in their own handwriting in the questionnaire form. There is difference between questionnaire and schedule. Questionnaire refers to a device for securing answers to questions by using a form which the respondent fills in himself, whereas schedule is the name usually applied to a set of questions which are asked in a face-to face situation with another person. This method is free from most of the limitations of the mailed questionnaire method.

## Merits:

The main merits or advantages of this method are listed below:

1. It can be adopted in those cases where informants are illiterate.





2. There is very little scope of non-response as the enumerators go personally to obtain the information.
3. The information received is more reliable as the accuracy of statements can be checked by supplementary questions wherever necessary.

This method too like others is not free from defects or limitations. The main limitations are listed below:

## Demerits:

1. In comparison to other methods of collecting primary data, this method is quite costly as enumerators are generally paid persons.
2. The success of the method depends largely upon the training imparted to the enumerators.
3. Interviewing is a very skilled work and it requires experience and training. Many statisticians have the tendency to neglect this extremely important part of the data collecting process and this result in bad interviews. Without good interviewing most of the information collected may be of doubtful value.
4. Interviewing is not only a skilled work but it also requires a great degree of politeness and thus the way the enumerators conduct the interview would affect the data collected. When questions are asked by a number of different interviewers, it is possible that variations in the personalities of the interviewers will cause variation in the answers obtained. This variation will not be obvious. Hence, every effort must be made to remove as much of variation as possible due to different interviewers.

## Secondary Data - Data Collection & Sources of Data

As stated earlier, secondary data are those data which have already been collected and analysed by some earlier agency for its own use, and later the same data are used by a different agency.

## Secondary Data:

As stated earlier, secondary data are those data which have already been collected and analysed by some earlier agency for its own use, and later the same data are used by a different agency. According to W.A.Neiswanger, "A primary source is a publication in which the data are published by the same authority which gathered and analysed them. A secondary source is a publication, reporting the data which was gathered by other authorities and for which others are responsible."

## Sources of Secondary Data:

The various sources of secondary data can be divided into two broad categories:

1. Published sources, and
2. Unpublished sources.

## Published Sources:

The governmental, international and local agencies publish statistical data, and chief among them are explained below:

(a) International Publications:

There are some international institutions and bodies like I.M.F, I.B.R.D, I.C.A.F.E and U.N.O who publish regular and occasional reports on economic and statistical matters.

(b) Official Publications of Central and State Governments:

Several departments of the Central and State Governments regularly publish reports on a number of subjects. They gather additional information. Some of the important publications are: The Reserve Bank of India Bulletin, Census of India, Statistical Abstracts of States, Agricultural Statistics of India, Indian Trade Journal, etc.

(c) Semi-Official Publications:

Semi-Government institutions like Municipal Corporations, District Boards, Panchayats, etc. Publish reports relating to different matters of public concern.

(d) Publications of Research Institutions:

Indian Statistical Institute (I.S.I), Indian Council of Agricultural Research (I.C.A.R), *Indian Agricultural Statistics Research Institute* (I.A.S.R.I), etc. Publish the findings of their research programmes.

(e) Publications of various Commercial and Financial Institutions

(f) Reports of various Committees and Commissions appointed by the Government as the Raj Committee's Report on Agricultural Taxation; Wanchoo Committee's Report on Taxation and Black Money, etc. Are also important sources of secondary data.

(g) *Journals and News Papers*

Journals and News Papers are very important and powerful source of secondary data. Current and important materials on statistics and socio-economic problems can be obtained from journals and newspapers like Economic Times, Commerce, Capital, Indian Finance, Monthly Statistics of trade etc.

## Unpublished Sources:

Unpublished data can be obtained from many unpublished sources like records maintained by various government and private offices, the theses of the numerous research scholars in the universities or institutions etc.

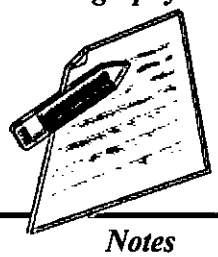
## Precautions in The Use of Secondary Data:

Since secondary data have already been obtained, it is highly desirable that a proper scrutiny of such data is made before they are used by the investigator. In fact, the user has to be extra-cautious while using secondary data. In this context Prof. Bowley rightly points out that "Secondary data should not be accepted at their face value." The reason being that data may be erroneous in many respects due to bias, inadequate size of the sample, substitution, errors of definition, arithmetical errors etc. Even if there is no error such data may not be suitable and adequate for the purpose of the enquiry. Prof. SimonKuznet's view in this regard is also of great importance. According to him, "the degree of reliability of secondary source is to be assessed from the source, the compiler and his capacity to produce correct statistics and the users also, for the most part, tend to accept a series particularly one issued by a government agency at its face value without enquiring its reliability".

Therefore, before using the secondary data the investigators should consider the following factors:

## The Suitability of Data:

The investigator must satisfy himself that the data available are suitable for the purpose of enquiry. It can be judged by the nature and scope of the present enquiry with the original





enquiry. For example, if the object of the present enquiry is to study the trend in retail prices, and if the data provide only wholesale prices, such data are unsuitable.

## (A) Adequacy of Data:

If the data are suitable for the purpose of investigation then we must consider whether the data are useful or adequate for the present analysis. It can be studied by the geographical area covered by the original enquiry. The time for which data are available is very important element. In the above example, if our object is to study the retail price trend of India, and if the available data cover only the retail price trend in the state of Bihar, then it would not serve the purpose.

## (b) Reliability of Data:

The reliability of data is must. Without which there is no meaning in research. The reliability of data can be tested by finding out the agency that collected such data. If the agency has used proper methods in collection of data, statistics may be relied upon.

## Data Processing

It is not enough to have baskets of data in hand. In fact, data in a raw form are nothing but a handful of raw material waiting for proper processing so that they can become useful. Once data have been obtained from primary or secondary source, the next step in a statistical investigation is to edit the data i.e. To scrutinize the same. The chief objective of editing is to detect possible errors and irregularities. The task of editing is a highly specialized one and requires great care and attention. Negligence in this respect may render useless the findings of an otherwise valuable study. Editing data collected from internal records and published sources is relatively simple but the data collected from a survey need excessive editing. While editing primary data, the following considerations should be borne in mind:

- The data should be complete in every respect
- The data should be accurate
- The data should be consistent, and
- The data should be homogeneous.

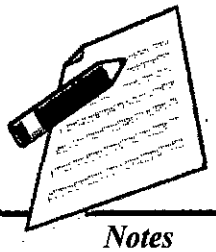
Data to possess the above-mentioned characteristics have to undergo the same type of editing which is discussed below:

## Editing for Completeness:

while editing, the editor should see that each schedule and questionnaire is complete in all respects. He should see to it that the answers to each and every question have been furnished. If some questions are not answered and if they are of vital importance, the informants should be contacted again either personally or through correspondence. Even after all the efforts it may happen that a few questions remain unanswered. In such questions, the editor should mark 'No answer' in the space provided for answers and if the questions are of vital importance then the schedule or questionnaire should be dropped.

## (a) Editing for Consistency:

At the time of editing the data for consistency, the editor should see that the answers to questions are not contradictory in nature. If they are mutually contradictory answers, he





should try to obtain the correct answers either by referring back the questionnaire or by contacting, wherever possible, the informant in person. For example, if amongst others, two questions in questionnaire are (a) Are you a student? (b) Which class do you study and the reply to the first question is 'no' and to the latter 'tenth' then there is contradiction and it should be clarified.

## (b) Editing for Accuracy:

The reliability of conclusions depends basically on the correctness of information. If the information supplied is wrong, conclusions can never be valid. It is, therefore, necessary for the editor to see that the information is accurate in all respects. If the inaccuracy is due to arithmetical errors, it can be easily detected and corrected. But if the cause of inaccuracy is faulty information supplied, it may be difficult to verify it and an example of this kind is information relating to income, age etc.

## (c) Editing for Homogeneity:

Homogeneity means the condition in which all the questions have been understood in the same sense. The editor must check all the questions for uniform interpretation. For example, as to the question of income, if some informants have given monthly income, others annual income and still others weekly income or even daily income, no comparison can be made. Therefore, it becomes an essential duty of the editor to check up that the information supplied by the various people is homogeneous and uniform.

## Data Processing Meaning:

Data processing means taking raw data (facts and figures) and processing them manually or with the help of machines to produce, organized and useful information. It is restructuring or recording of data to increase their usefulness and value for some particular purpose. Data processing can be performed

- Manually with the aid of simple tools as paper, pencil and filing cabinets
- Electro-mechanically with the aid of unit record machines
- Electronically with the aid of a computer.

Data processing is a series of operations that use information to produce a result. Common data processing operations include validation, sorting, classification, calculation, interpretation, organization and transformation of data.

## Electronic Data Processing:

Electronic data processing (EDP) refers to the use of automated methods to process commercial data. Typically, this uses relatively simple, repetitive activities to process large volumes of similar information. For example: stock updates applied to an inventory, banking transactions applied to account and customer master files, booking and ticketing transactions to an airline's reservation system, billing for utility services.

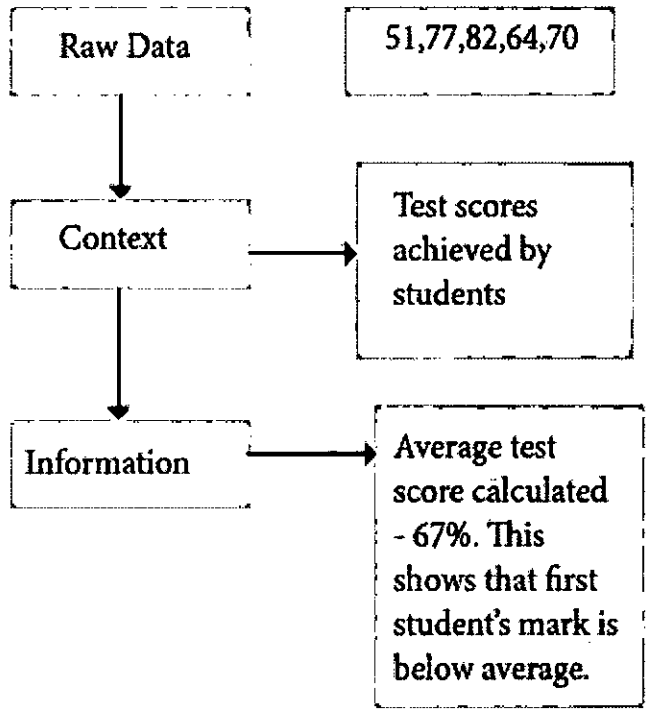
The term electronic data processing dates back to the 1960s when automation began to replace manual data processing tasks. In modern times, the term tends to be associated with large scale automation of administrative tasks.

Data processing is manipulation of data by a computer. It includes the conversion of raw data to machine-readable form, flow of data through the Central Processing Unit (CPU) and

memory to output devices, and formatting or transformation of output. Any use of computers to perform defined operations on data can be included under data processing.

## Data Processing in a Computer:

Computer data is information processed or stored by a computer. This information may be in the form of text documents, images, audio clips, software programs, or other types of data. Computer data may be processed by the computer's CPU and is stored in files and folders on the computer's hard disk.

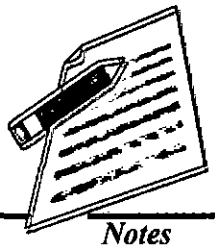



Hence, data processing is defined as series of actions or operations that converts data into useful information. The data processing system is used to include the resource such as people procedures, and devices that are used to accomplish the processing of data for producing desirable output. Data processing is restructuring or recording of data to increase their usefulness and value for some particular purpose.

## Data analysis

After completing the psychosocial assessment, the nurse analyses all the data that he or she has collected. Data analysis involves thinking about the overall assessment rather than focusing on isolated bits of information. The nurse looks for patterns or themes in the data that lead to conclusions about the client's strengths and needs and to a particular nursing diagnosis. No one statement or behaviour is adequate to reach such a conclusion. The nurse also must consider the congruence of all information provided by the client, family, or caregivers, as well as his or her own observations. It is not uncommon for the client's perception of his or her behaviour and situation to differ from that of others. Assessments in a variety of areas are necessary to support nursing diagnoses such as Chronic Low Self-Esteem or Ineffective Coping.

Traditionally, data analysis leads to the formulation of nursing diagnoses as a basis for the client's plan of care. Nursing diagnoses have been an integral part of the nursing





process for many years. With the sweeping changes occurring in health care, however, the nurse also must articulate the client's needs in ways that are clear to health team members in other disciplines as well as to families and caregivers. For example, a multidisciplinary treatment plan or critical pathway may be the vehicle for planning care in some agencies. A plan of care that is useful to the client's family for home care may be necessary. The nurse must describe and document goals and interventions that many others, not just professional nurses, can understand. The descriptions must contain no jargon or terms that are unclear to the client, family, or other providers of care.

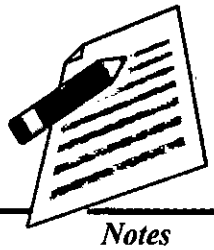
## Psychological Tests

Psychological tests are another source of data for the nurse to use in planning care for the client. Two basic types of tests are intelligence tests and personality tests. Intelligence tests are designed to evaluate the client's cognitive abilities and intellectual functioning. Personality tests reflect the client's personality in areas such as self-concept, impulse control, reality testing, and major defences (Adams & Culbertson, 2005). Personality tests may be objective (constructed of true-and-false or multiple-choice questions). Table 8.1 describes selected objective personality tests. The nurse compares the client's answers with standard answers or criteria and obtains a score or scores.

**Table OBJECTIVE MEASURES OF PERSONALITY**

| Test | Description |
|---|---|
| Minnesota Multiphasic Personality Inventory (MMPI) | 566 multiple-choice items; provides scores on 10 clinical scales such as hypochondriasis, depression, hysteria, and paranoia; four special scales such as anxiety and alcoholism; three validity scales to evaluate the truth and accuracy of responses |
| MMPI-2 | Revised version of MMPI with 567 multiple-choice items; provides scores on same areas as MMPI |
| Milton Clinical Multiaxial Inventory (MCMI) and MCMI-II (revised version) | 175 true–false items; provides scores on various personality traits and personality disorders |
| Psychological Screening Inventory (PSI) | 103 true–false items; used to screen for the need for psychological help |
| Beck Depression Inventory (BDI) | 21 items rated on scale of 0–3 to indicate level of depression |
| Tennessee Self-Concept Scale (TSCS) | 100 true–false items; provides information on 14 scales related to self-concept |

Other personality tests, called projective tests, are unstructured and are usually conducted by the interview method. The stimuli for these tests, such as pictures or Rorschach's inkblots, are standard, but clients may respond with answers that are very different. The evaluator analyses





the client's responses and gives a narrative result of the testing. Table 8.2 lists commonly used projective personality tests.

Both intelligence tests and personality tests are frequently criticized as being culturally biased. It is important to consider the client's culture and environment when evaluating the importance of scores or projections from any of these tests; they can provide useful information about the client in some circumstances but may not be suitable for all clients.

**Table ... PROJECTIVE MEASURES OF PERSONALITY**

| Test | Description |
|---|---|
| Rorschach test | 10 stimulus cards of inkblots; client describes perceptions of inkblots; narrative interpretation discusses areas such as coping styles, interpersonal attitudes, characteristics of ideation |
| Thematic Apperception Test (TAT) | 20 stimulus cards with pictures; client tells a story about the picture; narrative interpretation discusses themes about mood state, conflict, quality of interpersonal relationships |
| Sentence completion test | Client completes a sentence from beginnings such as "I often wish," "Most people," and "When I was young." |

*Source:* Adams, R. L., & Culbertson, J. L. (2005). Personality assessment: Adults and children. In B. J. Sadock & V. A. Sadock (Eds.), *Comprehensive textbook of psychiatry* (Vol. 1, 8th ed., pp. 874–895). Philadelphia: Lippincott Williams & Wilkins.

## Psychiatric Diagnoses

Medical diagnoses of psychiatric illness are found in the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, Text Revision (DSM-IV-TR). This taxonomy is universally used by psychiatrists and by some therapists in the diagnosis of psychiatric illnesses. The DSM-IV-TR classifies mental disorders into categories. It describes each disorder and provides diagnostic criteria to distinguish one from another. Although the DSM-IV-TR is not a substitute for a thorough psychosocial nursing assessment, the descriptions of disorders and related behaviours can be a valuable resource for the nurse to use as a guide. The DSM-IV-TR uses a multiaxial system to provide the format for a complete psychiatric diagnosis:

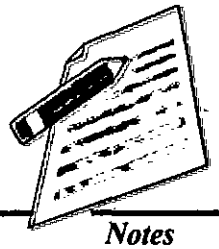
Axis I: clinical disorders, other conditions that may be a focus of clinical attention

Axis II: personality disorders, mental retardation

Axis III: general medical conditions

Axis IV: psychosocial and environmental problems

Axis V: global assessment of functioning (GAF).





The psychosocial and environmental problems categorized on axis IV include educational, occupational, housing, financial, and legal problems as well as difficulties with the social environment, relationships, and access to health care.

The GAF is used to make a judgment about the client's overall level of functioning. The GAF score given to the client may describe his or her current level of functioning as well as the highest level of functioning in the past year or 6 months. This information is useful in setting appropriate goals for the client's care.

## Mental Status Exam

Often, psychiatrists, therapists, or other clinicians perform a cursory abbreviated exam that focuses on the client's cognitive abilities. These exams usually include items such as orientation to person, time, place, date, season, and day of the week; ability to interpret proverbs; ability to per-form math calculations; memorization and short-term recall; naming common objects in the environment; ability to follow multistep commands; and ability to write or copy a simple drawing. The fewer tasks the client completes accurately, the greater the cognitive deficit. Because this exam assesses cognitive ability, it is often used to screen for dementia. However, cognition may also be impaired (usually temporarily) when clients are depressed or psychotic.

## SUMMARY

The data collected from the field are very extensive and unprocessed. While surveying in the field some objects remain surveyed and data, therefore, becomes dissimilar. Hence, there is need for processing the data properly. The different steps involved in processing data are editing, coding, organisation and classification. Only then the data becomes in the presentable form. The presentation of data could be tabular, statistical and cartographic forms. Bar diagram is used for comparing different units. Compound bar diagram issued for representation the sub units of an element proportionately. Different types of maps are prepared with the help of primary data. The dot map is the most popular map. The dot map shows the distribution of an element. It also depicts the concentration and dispersion of the element. Isopleth map also depicts distribution of phenomenon. In this map, points of the same values are joined by curve lines. Distribution maps are also shown by shading methods. The following points are kept in mind while interpreting the information. Clarity and explicitness, segregation of common and special features, highlight the focus, organise the matter in small paragraphs and facts should be complete and accurate. Report is the most important component of the field work. It is a written document highlighting the conclusions drawn from the field work and data collected. The report should be extensive and related to ground realities. It should be written under the heads in a sequential order of introduction, analysis, results and recommendations. .

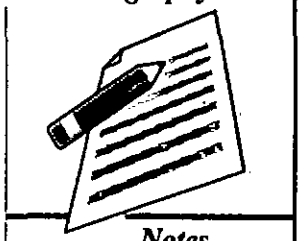
## EXERCISE

### MCQ

1. Questionnaire is a _____

   a. Research method
   b. Measurement technique
   c. Tool for data collection
   d. Data analysis technique

   **Answer:** c





2. What does the term 'reliability' indicate?
   a. We can trust that the research has being carried out to a high standard.
   b. That the results are accurate.
   c. That the researcher can be trusted.
   d. That the tool of data collection can be regarded as measuring accurately and consistently.

   **Answer:** d

3. What is a pilot study?
   a. A small scale study.
   b. A study involving pilots.
   c. A study to test the tool of data collection.
   d. A study that is the first of its type.

   **Answer:** c

4. How many points should a rating scale have?
   a. Five
   b. Four
   c. Ten
   d. Somewhere from 4 to 11 points

   **Answer:** d

5. What is the problem(s) with this set of response categories to the question "What is your current age?" 1-5 5-10 10-20 20-30 30-40
   a. The categories are not mutually exclusive
   b. The categories are not exhaustive
   c. Both a and b are problems
   d. There is no problem with the above set of response categories

   **Answer:** c

## Review Questions

1. What is data collection ? Describe any three issues that need to be covered in case of local area planning.
2. What are the tools and techniques of data collection?
3. Why is cross matching and array of data necessary in the organization of field data? Give any three reasons in support of your answer.
4. Explain any three steps in the processing of primary data.
5. What points should be kept in mind while interpreting the information.

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